

ABSTRACT

Title of Document: ANALYSIS OF THE EFFECT OF YOGA ON
SELECTIVE ATTENTION AND MENTAL
CONCENTRATION IN YOUNG ADULTS

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Despite an increase in interest pertaining to the benefits of yoga practice, research focusing on the relationship between yoga practice and attention is limited. This study employed a quasi-experimental pre-test, post-test design to measure whether physical activity had an immediate effect on selective attention and mental concentration in young adults, aged 18 to 25. More specifically, this study compared yoga and aerobic exercise classes to assess whether yoga practice improved attention beyond aerobic activity. The yoga and aerobic groups completed two surveys and the d2 Test of Attention at two observation points: immediately prior to and immediately following participation in their respective classes. An analysis of variance (ANOVA) found a statistically significant improvement between pre- and post-test scores on attention for both groups, with a greater improvement for the aerobic group. The findings show that physical activity had an immediate effect on the attention of the sample.

ANALYSIS OF THE EFFECT OF YOGA ON SELECTIVE ATTENTION AND
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By

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Chapter 1: Introduction

In the past decade, the practice of yoga in the United States has increased dramatically. In 2001, the number of Americans recorded as practicing yoga (about 15 million) was double that of 1996 (Casden, 2005). By 2001, 75% of all health clubs in the United States offered yoga classes (Corliss, 2001) and by 2004 that number had grown to 86% (Cowens & Adams, 2005). According to the Yoga Journal website, their reader circulation numbered 66,000 in 1995 and today has grown to 350,000, and a survey conducted by the same publication found that over 15 million Americans now practice yoga (Macy, 2009).

Due to this increase, many different styles of yoga have appeared across the nation to accommodate the growing interest. The Ashtanga style yoga remains one the most popular forms of yoga in the United States and has even been endorsed by various celebrities (Shaver, 2007; Casden, 2005). The rise in the popularity of yoga can be partially attributed to the positive portrayal of yoga by the popular media (Glamour, 2009) and to the publishing of official governmental reports that describe yoga as an activity that provides positive health benefits (National Institutes of Health, 2009).

Yoga was selected as the focus of this research based on the claims that have been made regarding yoga's benefits for college students (Milligan, 2006; Schure, Christopher & Christopher, 2008) and its unique coupling of meditation and physical activity. In addition to the apparent positive influence that yoga has on physical health (Cowens & Adams, 2005), many recent studies have investigated its influence on cognitive function. Although several studies focused on various aspects of how

yoga affects cognition, the knowledge specifically pertaining to the effects of yoga on attention is still limited. Attention is the mind's filtering process, which allows an individual to focus on a few important aspects of the surrounding environment (Goldstein, 2007). In this study, selective attention, which requires individuals to focus upon target stimuli while ignoring other stimuli, is explored in an effort to understand the relationship between yoga and attention.

The Benefits of Yoga and Meditation

Yoga practice has been documented for over 2,000 years (NCCAM, 2008) and was originally a branch of Indian philosophy. Indian philosophy remains the cornerstone of the modern yoga form known as Ashtanga yoga. The holistic practice of yoga includes ethical, physical, emotional, and mental disciplines as well as the attainment of enlightenment (Burkett, 2006). Many modern yoga classes isolate specific aspects, such as posture holding, from the original holistic view of yoga. In the literature, there is a lack of consensus on the definition of yoga. For the purposes of this study, yoga is defined as an exercise that combines movements through a series of postures with regulated breathing (Salmon, Lush, Jablonski, & Sephton, 2009) and mindfulness meditation. Due to yoga's blending of physical activity and meditation, it is intriguing to examine its effects on the human body and psyche.

Yoga has many physiological and psychological benefits. Numerous studies have asserted that yoga practice improves flexibility and strength (Cowen & Adams, 2005; Schure, Christopher & Christopher, 2008). In addition, Cowen and Adams (2005) found that yoga lowers blood pressure and it may have a positive effect on immunity (Schure, Christopher & Christopher, 2008). Schure, Christopher &

Christopher (2008) also reported improvements in balance and aerobic capacity. In terms of psychological benefits, Schure, Christopher & Christopher (2008) confirmed that yoga improves perceived quality of life and lowers anxiety and depression. Cowen and Adams (2005) reported that there is a strong correlation between perceived stress and yoga activity and Milligan (2006) recommends yoga as a stress reliever for college students.

The psychological benefits of yoga may, in part, result from yoga's meditative component. Several studies have investigated the correlations between various forms of meditation and the constructs of stress and attention. Based on discussions in Shapiro and Walsh (2006) and the descriptions of meditation in yoga literature (Johnston, 1912), meditation is a self-regulating practice that focuses on training attention and awareness over a period of time. It was found that a mindfulness program resulted in an improvement on perceived stress and even though yoga was not practiced as frequently as the other meditation exercises, yoga also had a strong correlation with lower stress scores (Carmody & Baer, 2007). Valentine and Sweet (1999) found that there were statistically significant increases in attention test scores after both a mindfulness meditation and concentrated meditation session. Thus, meditation, an exercise included in yoga practice, has been shown in the literature to have a positive effect on attention.

The Benefits of Physical Activity

Yoga also includes a physical component that, according to research, has many positive effects. Physical activity has been defined as "any bodily movement produced by skeletal muscles that result in energy expenditure" (Shephard & Balady,

1999). Numerous studies have found a link between physical activity and improvements in physical and psychological health. These improvements are derived from the impact that physical activity has on lifestyle characteristics such as stress and sleep, and which often lead to better overall physical health. For example, Haugland, Wold, and Torsheim (2005) found that physical activity was correlated with decreased health complaints. The relationship between high stress levels and health complaints found in this study indicates that physical activity has a role in lowering stress levels (Haugland, Wold, & Torsheim, 2005).

In addition to the many physiological benefits, several studies have asserted that physical activity has positive effects on various cognitive functions. According to Hillman, Erickson, and Kramer (2008), physical activity was positively correlated with perceptual skills, intelligence quotient, achievement, verbal tests, mathematical tests, and developmental level/academic readiness in children. In another study, it was found that children who had high levels of aerobic fitness had an increased processing speed, attention, working memory, and response speed (Hillman, Castelli, & Buck, 2005). Budde, Voelcker-Rehage, Pietrabyk-Kendziorra, Pedro, and Tidow (2008) found that 10 minutes of coordinated exercise compared to 10 minutes of a standard physical fitness course had a statistically significant effect on raising scores of selective attention. Therefore, although physical activity has been demonstrated to have a positive effect on various cognitive functions, activity requiring coordinated movement may have an even greater effect.

Yoga's Correlations with Attention

Several studies have investigated yoga's effect on cognitive functions and have found that yoga has an effect on attention. One study, conducted in India, found that practicing yoga improves memory and attention in children (Sahasi, 1984). Another study found that children had improved function on measures of attention after practicing yoga (Peck, Kehle, Bray, & Theodore, 2005). Although these two studies provide statistically significant evidence supporting yoga's positive correlation with attention, not all research supports this conclusion.

Other studies that attempted to observe the effects of yoga on attention proved inconclusive. For example, Williams (1993) investigated yoga's effect on concentration using two measures of attention, but did not find a statistically significant difference between the yoga group, the martial arts group, and the non-exercise control group. Williams suggested that perhaps if there were more participants, then the study would have produced statistically significant results. Another study that investigated the effect of yoga on the entire body required participants to complete psychological surveys, physical fitness tests, and measures of attention after a six-week yoga intervention (Casden, 2005). It found that the differences in attention scores after the yoga intervention compared to those obtained prior to the intervention were not statistically significant. However, these findings can be attributed to the small sample size. Another limitation of the study was that the researchers used a number of different testing materials at each observation, which may have fatigued the participants. As there is a contrast between the findings of Williams (1993) and Casden (2005), on the one hand, and Sahasi (1984) and Peck,

Kehle, Bray, and Theodore (2005), on the other, more research on yoga's potential effects on attention is needed before any definite conclusions can be drawn.

Study Development

As there is some evidence that exercise influences attention (Budde, et al., 2008) but the findings with regard to yoga practice are mixed, the current study aimed to examine the immediate effects of short-term instructional yoga practice on selective attention and mental concentration by comparing yoga to other physical activities. Therefore, the research question is: Will young adults who attend yoga classes show increased selective attention and mental concentration beyond that of an aerobic exercise control group? This question was formulated to potentially contribute to the body of yoga literature by addressing inconsistencies in previous research. The researchers also hoped to discover if there would be legitimacy in making recommendations to the subject population (young adults) based on this study's results.

Organization of Thesis

This thesis is broken down into six chapters. This opening section, Chapter 1, contains the research question and serves as an introduction to the study. Chapter 2 introduces the relevant literature on yoga and cognition and provides a rationale for the research question, study design, and hypotheses. Chapter 3 covers the study design used to test the hypotheses and describes the participants, procedure, intervention, and measures. The results of this study are detailed in Chapter 4, which includes a description of the statistical analysis of the data. Results are broken down into two sections: the first section contains the preliminary analysis that was run to

determine whether or not the two groups were comparable; the second section describes the primary analysis, which consists of a comparison of the measures of mental concentration and selective attention between the yoga and aerobic exercise groups using two, one-way analyses of variance (ANOVA). A discussion of the findings of this study follows in Chapter 5, which contains an interpretation of the results, a comparison between the findings of this study and previous research in this area, and details the limitations of this study. The paper concludes with Chapter 6 which provides a discussion of the practical applications of this study and suggests guidelines for future research. It is recommended that future studies investigate more specific interventions in order to observe which types of physical activity produce the greatest cognitive effects.

Chapter 2: Literature Review

This chapter of the thesis describes the literature relevant to the construction of this study. It provides definitions of the constructs used in this study. The first focus of the literature review is the importance of studying selective attention and mental concentration in a young adult population. This is followed by a discussion of variables that correlate with a change in attention. Specifically, stress, sleep, alcohol consumption, and prescription and illegal drug use are examined in the literature as potential confounds to the study of yoga and attention. Discussions of physical activity and meditations indirect and direct effect on attention are also provided. Finally, literature examining yoga and its ambiguous effect on attention is also presented and discussed.

The literature review concludes with a summarization of the key points that the researchers considered when designing the study methodology. This includes a discussion of the limitations of previous research and the research question and hypotheses of the current study.

Attention

Definition of Attention. According to William James, one of the first cognitive psychologists to define attention: “Everyone knows what attention is. It is the taking possession of the mind in clear and vivid form of what seem several simultaneous objects or trains of thought (James, 1890, p. 404).” Modern cognitive psychology describes attention as the ongoing process of filtering out information from the perceived environment and of focusing on specific elements (Ashcraft, 2005; Goldstein, 2007). Human cognitive systems process all of the sensory information that is gathered by their sensory organs (Bisley & Goldberg, 2005; Ashcraft, 2005; Gilbert & Sigman, 2007; Posner, 2004). Attention is the mechanism that acts as a filter for this sensory information so that the most important and relevant aspects of the environment can be processed quickly and efficiently (Ashcraft, 2005; Goldstein, 2007). Since the brain only has a limited amount of resources to process and understand this vast amount of information, the process of focusing on only important stimuli is critical in an environment where infinite amounts of sensory stimuli are constantly presented (Ashcraft, 2005; Goldstein, 2007). In this research paper, the term attention is defined as the process of allocating mental energy to a specific task. This definition assumes that there is a limited amount of cognitive resources that can be used for a task, asserting the proven fact

that the brain can only process a finite amount of tasks at one time (Ashcraft, 2005; Goldstein, 2007; Posner, 2004).

Generally, attention is known as an automatic task, in which the brain filters out irrelevant information immediately and without conscious decision, automatically eliminating what would otherwise be overwhelming sensory stimulation (Ashcraft, 2005; Goldstein, 2007). It is possible, however, to consciously choose to mentally concentrate on specific environmental information within the context of a goal or a task. This deliberate mental concentration is known as a controlled response (Ashcraft, 2005). The process of actively concentrating on one aspect of the environment while ignoring others is known as selective attention (Ashcraft, 2005; Goldstein, 2007; Posner, 2004). In selective attention, the brain can concentrate on specific information while ignoring distracting information or data that has been deemed unimportant (Ashcraft, 2005). People may normally not think about these specific isolated differences in their attention capabilities, but it is quite telling how far some may go to improve them.

College Students. Since young adults, especially those on college campuses, are exposed to an extraordinary number of stimuli, there are many instances where their selective attention is tested and many of them search for ways to improve it. A study examining the illicit use of prescription stimulants by college students reported that one of the primary reasons students took the stimulants was to improve their ability to concentrate on their academic work (DeSantis, Webb, & Noar, 2008). The researchers surveyed 1,811 undergraduate students on a university campus to obtain information regarding their experience with stimulants commonly used to treat

Attention Deficit Hyperactivity Disorders (ADHD). In addition to surveys, the researchers conducted qualitative interviews with 175 undergraduates to obtain specific information regarding the reasons why college students took the stimulants illegally. Self-administration of prescription stimulants without a prescription is a federal offence under the Controlled Substance Act. Of the students surveyed 4% used ADHD medication legally and 34% had used ADHD medication illegally at some point during their lifetime. Of the 585 participants who reported using stimulants without a prescription, 389 (66%) responded that they used stimulants to help them “concentrate” on their academic requirements. This response was broken down into three main categories: the ability to study for longer periods of time, the ability to maintain focus on a single task without distraction, and increased productivity. The study also found that first time use of illicit stimulants generally occurred during periods of high stress, such as during exams, as students hoped to improve their academic performance (DeSantis, Webb, & Noar, 2008). As many college students feel driven to illegally obtain and consume prescription stimulants to improve their concentration and academic performance it is important to study healthier and legal alternatives for improving attention and concentration.

Some studies have indicated that academic performance may be related to attention. Advokat, Guidry, and Martino (2008) examined the GPAs of three distinct groups of undergraduate students. The first group consisted of 163 undergraduate students who had Attention Deficit Hyperactivity Disorder (ADHD) and were taking prescribed medication, (many were taking Adderall, some also took Strattera, Ritalin, Concerta, or Dexedrine). The second group of 591 students did not have ADHD but

took stimulant medications illegally. The vast majority of participants in this group reported taking Adderall, although Strattera, Ritalin, Concerta and Dexedrine were also reported. Some participants in both the prescribed and non-prescribed group used a combination of any of the aforementioned medications. The third group consisted of 794 students who were neither diagnosed with ADHD nor reported taking any prescription stimulants. The results showed that the mean GPA of both groups that did not have ADHD, regardless of their medication use, were statistically significantly higher than the mean GPA of the group of students with ADHD (Advokat, Guidry, & Martino, 2008). These results support that attention problems negatively affect the GPAs of undergraduate students compared to those who do not have attention problems, which then leads to the conclusion that attention affects GPA. The literature continues with a discussion of factors that have been shown to affect attention.

Factors that Influence Attention. Although the previous study focused on the relationship between attention and academic performance, other studies have concentrated on investigating additional factors that may affect attention. Many studies have demonstrated that lifestyle factors such as the amount and quality of sleep (Taras & Potts-Datema, 2005; Noland, Price, Drake, & Telljohann, 2009), level of stress (Braunstein-Bercovitz, 2003; Bartholow, Pearson, Sher, Wieman, Fabiani, & Gratton, et al., 2003); and amount and type of exercise (Budde, et. al., 2008) influence attention. The way that these variables affect attention is examined in the sections that follow.

Sleep and Attention. One study conducted a meta-analysis on how sleep affected the school performance, of students between 5 and 18 years of age (Taras & Potts-Datema, 2005). The researchers collected data from multiple studies that had recorded students' GPAs and their attention by cognitive and achievement tasks. A summation of the results from 21 studies over the past 10 years led the researchers to conclude that suboptimal (short, erratic, poor quality, and/or lack of) sleep was found to negatively affect a student's learning ability and general school performance. Therefore, an individual's amount of sleep is one factor that has been found to influence attention and school performance.

In a literature review by Noland, Price, Drake, and Telljohann (2009) it was found that stress, caffeine consumption, alcohol consumption, exercise, jobs, schoolwork, and time management skills are all factors that have been shown to affect the quality and quantity of sleep. Some of these factors have also been found to affect attention, such as stress (Braunstein-Bercovitz, 2003), alcohol consumption (Bartholow, Pearson, Sher, Wieman, Fabiani, & Gratton, et al. 2003), and exercise (Budde, et. al., 2008). As such, when someone has sleep deprivation, or has gotten less than 9 hours of sleep, they have been found to perform more negatively in school (Wolfson & Carskadon, 1998). More specifically, sleep deprived participants have reported lower grades, decreased alertness and academic performance and concentration, and depression (Taras & Potts-Datema, 2005; Curcio, Ferrara, & DeGennaro, 2006; Wolfson & Carskadon, 2003).

Noland, Price, Drake, and Telljohann, (2009) surveyed the sleep patterns and perceptions of sleep of 384 high school students. The instrument used was a 37 item

questionnaire developed by the researchers, which was given twice in order to establish stability. The majority of participants in the study averaged fewer than nine hours of sleep during the school week and reported having inconsistent sleep schedules and sleeping longer on weekends. Eighty-three point six percent of the participants reported having difficulty paying attention, 60.8% reported lower grades, 59.0% reported experiencing higher levels of stress, and 57.7% of participants reported difficulty getting along with others. The study found a statistically significant correlation between lower levels of sleep and higher stress levels (Noland, Price, Drake, & Telljohann, et. al., 2009). Given the large number of students in this study who reported difficulty paying attention and a drop in academic performance, it is not surprising that other research has supported a connection between lack of sleep and the manifestation of attention difficulties.

For example, a study conducted at Brown University researched the effects of routine sleep deprivation on healthy children who were between the ages of 8 and 14. The study reported that healthy children who slept less than or equal to six and a half hours of sleep a night over several nights began to show symptoms of ADHD. Further, the symptoms of ADHD increased each additional night that the child did not get enough sleep. The study further reported that children who slept for 10 hours each night did not exhibit ADHD symptoms (Williams, 2003). Therefore, not getting enough sleep has been shown to be related to the expression of attention difficulties in young children, which is a finding that may also hold true for college students.

Millman (2005) analyzed previous research and literature on the effects of excessive sleepiness on school performance, cognitive functioning, and mood in

students between 13 and 22 years of age. Excessive sleepiness, or sleep deprivation, correlated with a decrease in participants' alertness and vigilance. Individuals who suffer from excess sleepiness may be able to perform well when initially beginning tasks but their ability to maintain high levels of performance decreases as the task continues. This impairment to alertness and vigilance results in slowed motor and cognitive reactions, increased difficulty in completing tasks that require sustained attention and increased working memory errors.

The impact that sleep deficiency has on attention is of particular importance as young adults are so affected by it. Young adults are the target population of the study and many are students. Considering sleep as an active player in the participant's attention was a necessary step. Because sleep affects attention of students, it was necessary for the researchers of this study to ask the amount of sleep participants were getting to see if it impacted their attention scores.

Stress and Attention. Another factor that significantly influences attention is stress. A study conducted by Braunstein-Bercovitz (2003) examined the relationship between stress and selective attention. Specifically, this study randomly assigned 40 participants, aged 18-31, most of whom were first year Psychology students, to either a high stress group or a low stress group. Participants' stress levels were manipulated by a number series task. The high stress group was given a difficult task to complete while the low stress group was given a simple task to complete. Subjects then completed a computer response task that measured for selective attention, with varying amounts of irrelevant stimuli. When the groups were compared based upon their response times and errors, it was found that selective attention was negatively

affected by stress. Participants in the high stress condition performed worse on the test of selective attention than participants in the low stress group. Based on these results, Braunstein-Bercovitz (2003) asserted that stress impairs the ability to distinguish between various stimuli by increasing the amount of attention given to distractions. These results are disputed in the literature by studies that observed an improvement in selective attention after stress was induced (Chajut & Algom, 2003).

Chajut and Algom (2003) conducted a three-part experiment in which 160 participants, aged 20 to 25, were divided into four equal groups. All subjects were first subjected to tasks of analogy formation, estimation, and number series. These tasks were intended to induce stress due to the difficulty of the problems, time constraints, and strains to the participant's ego by including some unsolvable questions on the tests— participants were led to believe that their names and log-in number would be associated with data. Each group also completed a computerized version of the Stroop Test, a timed test that measures selective attention. The reaction times between groups were compared using an ANOVA analysis to gauge performance. It was found that the ability of participants to selectively focus was improved by the presence of stress.

In the second part of the study, 20 participants performed a version of the Stroop Test used in the first part under both high and low levels of stress, with a five minute separation intervals. Stress was induced via a noise stimulus. Stress was again found to contribute to improved performance. The third part of the study measured performance on the Stroop Test by 40 participants in the same target population. Instead of a stress stimuli, a monetary incentive was used to motivate the

participants to improve their performance. One group was offered a more substantial amount of money to complete the task than the other. However, this particular motivation was not found to have an effect on attention. Overall, this multi-faceted study reached the conclusion that stress positively impacts attention. Although the literature is inconclusive regarding the correlation between stress and attention, the research shows that a correlation does exist (Braunstein-Bercovitz, 2003; Chajut & Algom, 2003). This correlation depends on the level of stress and the amount of tasks that need to be completed. Since stress is a variable that affects attention it is an important variable to control for.

Alcohol and Attention. Various studies have demonstrated that alcohol consumption can dramatically impact cognitive processes of an individual. Parsons and Nixon (1998) conducted a review of the literature and found a distinct correlation between the amounts of alcohol that an individual consumes daily over the course of a given period of time and the decline in their cognitive functions. For example, their research suggests that individuals who consume seven to nine U.S. standard drinks per day for extended periods of time will exhibit mild cognitive deficiencies. Similarly, those who consume 10 or more drinks daily in the same time frame will show more severe cognitive impairments, representative of those conditions found in alcoholics.

Research was performed that compared people who are dependent on alcohol with those who are social drinkers and their responses to both alcohol-related and non-alcohol-related verbal stimuli (Todor, 2007). The 35 participants were all abstinent alcohol-dependent people between the ages of 34 and 67 from a

detoxification program. Participants were presented with groups of 20 words, 10 of which they were instructed to forget and the other 10 they were instructed to remember. Half of the words in each group were alcohol related and half were from the RaysMemory Test. The study found that alcohol-dependent individuals have difficulty inhibiting alcohol-related verbal stimuli while social drinkers do not. In the case of alcohol-dependent individuals, cognitive functions may suffer as a result of long-term impairment resulting from continuous and heavy consumption of alcohol (Todor, 2007).

A study performed by Bartholow, Pearson, Sher, Wieman, Fabiani, and Gratton (2003) examined the impacts of alcohol on attention and response inhibition in healthy young adults between the ages of 21 and 30. Participants consumed one of three fixed quantities of alcohol, characterized as a placebo, moderate, or higher-level dosage. The participants then completed a derivation of the Erikson “flanker task” that involved distinguishing whether a target letter, which appeared in the center of a five-letter unit, was compatible or incompatible with a letter to its left or right. Individuals performing the task were scored based upon both reaction time and accuracy. The results of the study demonstrated that response selection and execution are more sensitive to alcohol’s acute effects than are attention control processes. These findings support that alcohol has an impact on cognitive functions by causing interferences in response processing.

According to a study by Abrams, Gottlob, and Fillmore (2006), automatic cognitive processes such as selective attention are affected after the consumption of a moderate amount of alcohol. Twelve adult participants consumed three drinks in set

intervals with fixed levels of absolute alcohol in each. They were subjected to two tasks beginning 30 minutes after the first drink. The Delayed Ocular Response Task measured the capability of intentional inhibitory control and the Saccadic Interference Task quantitatively assessed the capability of one to not saccade (rapidly move one's eyes) with irrelevant and interfering stimulus present. Intentional inhibitory control was found to be more negatively affected by the alcohol than selective attention and changes in the capability of automatic processing was not statistically significant. Therefore, alcohol has been found to have an effect on some attention constructs and no effect on others.

Cognitive functions, including attention, are susceptible to the effects of alcohol consumption. Research has demonstrated that other substances, including different legal and illegal drugs, are also capable of exerting considerable influence over attention and other cognitive processes.

Drugs and Attention. Some illegal, prescription, and other drugs have been found to affect attention. For example, attention is negatively affected by marijuana use (Pope & Yurgelun-Todd (1996) and positively affect by nicotine (Levin, Connors, Silva, Hinton, Meck, March, et. al., 1998), which is commonly found in cigarettes.

Like alcohol, many drugs enjoy substantial use on college campuses, making their impact on the attention of college students highly relevant to this study. Pope and Yurgelun-Todd (1996) investigated the cognitive effects of heavy and occasional marijuana use among undergraduate college students. Participants included heavy and light users of marijuana who were screened and sorted into groups based on the amount of marijuana they reported using in a 30-day period. Sixty-five participants

were heavy marijuana users who used marijuana at least 27 days out of a 30-day period and showed cannabinoids in their urine. Sixty-four participants were light users who used marijuana a maximum of nine days out of the 30-day period.

All participants were supervised at a hospital for 24 hours before administration of the cognitive measures to prevent use of marijuana and other drugs. The participants were given tests to measure their Verbal Intelligence Quotient (VIQ) (Wechsler Adult Intelligence Test-Revised) and their attention and memory (Stroop test; the Wisconsin Card Sorting Test; the Benton Verbal Fluency Test; the Wechsler Memory Scale; the California Verbal Learning Test; and the Rey-Osterreith Complex Figure Test) after the 24-hour observation period. By comparing the scores on these tests between the light users and the heavy users, the researchers concluded that heavy marijuana use has a distinct effect on sustained attention and attention shifting. As the researchers did not employ a waitlist control group the results are only applicable to marijuana users. The results can only be used to compare between marijuana users so it is unknown how the marijuana users' attention may have differed from that of a student population that does not use marijuana. The study further discussed that withdrawal, which would cause insomnia, restlessness or irritability, drug residue in the brain or long term toxic effects of the drug, may have attributed to the lower scores. The literature supports that marijuana use correlated with an impairment in attention, but it is unclear whether light users would differ from non-users.

Levin, Conners, Silva, Hinton, Meck, March, et. al. (1998) investigated the effect of nicotine on the attention of non-smoking adults, aged 18 to 29, without

attention deficits. Their study was based on previous research, which has shown nicotine to have positive effects on the attention of smokers, adults diagnosed with ADHD, Alzheimer's patients, and schizophrenics. The participants in this study were either given a transdermal nicotine patch exposing them to 7mg/day for 4.5 hours or were given a placebo. Conner's Continuous Performance Test was used as a measure of attention. It was found that nicotine significantly decreased errors of omission (which are errors induced by skipping) but did not increase correct hit reaction time, or errors of commission. This study shows that nicotine can have positive effects on attention in nonsmoking adults.

Lundqvist (2005) compared the effects of cannabis, stimulants, and heroin on attention, memory, and executive function. He performed a review of the literature and found that cannabis causes cognitive impairment of attention, memory as well as attentional processing and executive functioning. This trend is clearly seen during intoxication and is suspected to have long term effects as well. People taking ecstasy, a stimulant, are more easily distracted, suffer memory loss, and are less efficient at focusing attention on complex tasks. Similarly, cocaine decrease individual's attentional faculties. Attention seemed to be unaffected by heroin use, although another study found variations in the executive processes of attention in heroin users. Overall, these illegal drugs, which could be used by college students, have been found to have a negative effect on cognitive faculties, including attention.

The above studies have demonstrated that high levels of stress, alcohol and drug consumption, and lack of sleep all affect cognitive functions, including attention. College students are typically susceptible to many of these factors. This includes the

stress that accompanies the attempt of many college students to balance hectic social and academic commitments, the lack of sleep that often occurs as a result of meeting these obligations, and the consumption of alcohol (and drugs, sometimes to a lesser extent) that frequently takes place on college campuses. Therefore, each of these variables is important to consider when determining the relative levels of attention demonstrated by college students.

Physical Activity

Definition of Physical Activity. Physical activity is shown in the literature to correlate with attention. Physical activity can be broadly defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Shephard & Balady, 1999, p. 963). For vigorous physical activity to be considered aerobic exercise, such movements must be sustained for a period of time and at an intensity that will cause stress to the cardio respiratory system (Igbanugo & Gutin, 1978). This type of physical training has been proven to have many physical and psychological benefits.

The physiological effects of aerobic activity, both long-term and short-term, are well documented. The most important and overriding long-term benefit of aerobic exercise is the role it plays in reducing the chance of cardiac problems. This includes reducing the common risk factors of heart disease such as high blood pressure (hypertension), diabetes, obesity, and high cholesterol (Shephard & Balady, 1999). In the short-term, aerobic activity strengthens skeletal muscles and reduces resting heart rate and blood pressure (Shephard & Balady, 1999).

In addition to substantial literature regarding the health benefits of physical activity, various studies have supported that a positive correlation exists between physical activity and factors that effect attention and attention itself.

Physical Activity and Academic Performance. One of physical activity's proposed benefits is that its practice can improve academic performance. One study examined 89 high school seniors to determine the effects that levels of physical activity had on various physical and psychological constructs (Field, Diego, & Sander, 2001). Participants completed a questionnaire, which asked them to report on their levels of physical activity using a five-point scale, and also included questions about their depressive habits, sports involvement, drug use, and grade point average (GPA). The group with higher exercise levels exhibited many significant correlations; they had lower depression levels, lower levels of drug use, and higher GPA. Causality could not be determined from these results (Field, Diego & Sanders, 2001), but the high correlations confirm the benefits of physical activity, especially on factors that effect attention. Since the group that exhibited higher levels of exercise also had higher GPAs it is possible to suggest that exercise can, in fact, facilitate good academic performance.

A main component of having good academic performance is having the ability to focus and use one's attention. Physical activity has been shown to improve attention, which may be why increases in academic performance are also correlated with its practice.

Physical Activity and Sleep. As stated before, lack of sleep has been found to negatively affect attention. Physical activity has been found to improve one's quality

of sleep. A study at the Fred Hutchinson Cancer Research Center specifically looked at how variations in the time of day that the exercise takes place could affect sleep, but the overall conclusions of the study supported the postulation that exercise is beneficial for sleep quality (“Early-bird risers sleep easier”, 2004). Over the course of a year, 173 participants were asked to participate in 45 minutes of exercise consistently in either the morning or evening. Those who practiced physical activity in the morning were 70% less likely to have trouble sleeping than others who awoke at the same time. In addition, stretching or relaxation was found to cause 30% decrease in trouble sleeping for participants when compared to their sleep prior to the start of the study. Because physical activity affects the quality of sleep and the amount of sleep affect attention, it can be assumed that physical activity contributes to an indirect improvement in attention.

Physical Activity and Stress. Physical activity has been found to effect stress levels as well. Fort et. al. (1979) measured the immediate effect of aerobic activity has on stress. Forty participants, 20 males and 20 females, between the ages of 18-30 where asked to complete a 30-minute session of aerobic activity. No control group was included in the study. The aerobic session involved participants running on a treadmill, and speed was adjusted to maintain at heart rate to 60% of the participant’s maximal heart rate. An EKG was used to determine the participants’ resting heart rate, as well as their heart rate during the intervention. Both groups completed two measures that detected stress, both before and after the aerobic intervention. There was a physical measure of stress (Palmer Sweat Index) and a measure of psychological stress (State-Trait Anxiety Inventory). There were statistically

significant decreases on both measures of stress immediately following the aerobic intervention, and researchers concluded that short-term aerobic exercise immediately reduces stress. Since aerobics reduces stress and stress can have a negative impact on attention (Braunstein-Bercovitz, 2003) it is reasonable to conclude that aerobic exercise will indirectly increase attention.

A study of Norwegian 15-year-olds analyzed the impact of participation in leisure time physical activities on school-related stress and health complaints (Haugland, Wold, & Torsheim, 2003). Participants who reported a greater number of health complaints also reported higher stress levels. According to the research, participants who took part in low levels of leisure time physical activity reported higher stress levels and a greater number of health complaints than those that pursued a more active approach to their leisure activities. The study concluded that participation in physical activity moderates this relationship such that high-stress adolescents lodge fewer health complaints if they take part in a leisure time physical activity (Haugland, Wold, & Torsheim, 2003.) Because physical activity as a leisure time activity would decrease stress it may also help increase attention.

These articles and many others have supported the idea that physical activity has the ability to reduce stress. Stress, like lack of sleep, can negatively affect one's attention and therefore the researchers of this study suggest that physical activity may also indirectly increase one's attention due to its ability to decrease stress (Braunstein-Bercovitz, 2003; Haugland, Wold, & Torsheim, 2003).

Physical Activity and Attention. In addition to these benefits of physical activity, a significant amount of research corroborates the contention that such

activity improves various cognitive functions, including attention. The impact of aerobic activity on cognition and psychological functions is an area of expanding research. A recent study analyzed the impact of physical activity on the cognitive functions on school-age children (ages 4-18) (Hillman, Erickson, & Kramer, 2005). The children were evaluated with regard to perceptual skills, intelligence quotient, achievement, verbal tests, mathematic tests, memory, and developmental level/academic readiness. All of these areas, with the exception of memory, demonstrated a positive correlation with physical activity, showing that increased physical activity was related to enhanced cognitive and academic performance. This trend persisted for all age groups, although the correlations tended to be stronger in the 4-7 and 11-13-year age groups than in the 8-10 and 14-18-year age groups (Hillman, Erickson, & Kramer, 2005).

Another study examined the connections between aerobic fitness, age, and various cognitive functions (Hillman, Castelli, & Buck, 2005). Twenty-four children (mean age of 9.6 years) and 27 young adults (mean age of 19.3 years) of two degrees of fitness (high-fit or low-fit) were evaluated using both physical and cognitive measures. Physical fitness was gauged using the *Fitnessgram* which measures aerobic capacity, muscle fitness, flexibility, and body composition by calculating body mass index. The cognitive measure used in this study was a visual odd-ball paradigm where the participant is required to respond to a target that does not appear frequently while ignoring another target that appears frequently. Reaction time and response accuracy were measured and compared between a high-fit adult group, a low-fit adult group, a high-fit child group, and a low-fit child group. Both adult

groups reacted faster than the children groups and both high-fit groups reacted faster than the low-fit groups. The researchers concluded that the results suggested a correlation between fitness and increased attention and working memory capacity (Hillman, Castelli, & Buck, 2005).

Both Hillman studies show a correlation between increased cognitive functioning and levels of aerobic exercise. The observation that aerobic fitness has a positive impact on the overall mental and physical well-being is supported many times throughout the literature.

Another study investigated if the attention of older subjects (63-82 years old) could be increased by an intervention of mild aerobic exercise (Hawkins, Kramer, & Capaldi, 1992). They had 37 participants in the study, half of whom engaged in a 10-week aquatics exercise program that took place three times a week for 45 minutes per session. The control group received weekly newsletters about health related topics to maintain their interest. Researchers examined attentional flexibility tasks in which the participants had to respond to audio and visual signals that were given in two different manners. There were visual only tests, audio only tests, and tests that alternated between visual and audio stimuli. They also administered time-sharing tasks where they would introduce an audio and visual stimulus simultaneously. In these tasks, participants had to try to respond to both stimuli while treating the auditory stimulus as primary. Results for time-sharing showed that overall both groups performed better at the second observation and with one rather than two stimuli. The difference in time it took the participants to respond to the dual versus the single task stimuli decreased significantly at the second measurement session,

meaning the aerobic group became faster and better at responding to dual stimuli. The results for attentional flexibility showed that the aerobic group responded faster to dual stimuli than the control. This study found that aerobics does in fact improve one's attention and ability to process stimuli more efficiently. This observation led to the hypothesis that physical activity would increase attention of participants in the current study.

Weuve, Kang, Manson, Breteler, Ware, and Grodstein (2004) examined the exercise habits of 16,466 women over the age of 70. In the study, six repeated cognitive assessments were used, including tests of general cognition, verbal memory, category fluency, and attention. Trained professionals administered these measures over the telephone. The study found that reported long-term physical activity was associated with increased cognitive function. Women who were in the highest of five reported activity brackets had a 20% lower risk for cognitive impairment, as compared with the women who fell in the lowest reported activity bracket. With regards to limitations within this study, the use of observations and unmeasured factors stands out. There was no real control for external variables and therefore many variables could have caused the change in score. That said, the results of this study suggest a correlation between participation in physical activity and the improvement of overall cognitive function. This result too added to the idea that the physical activity group in the current study would see an increase in their attention scores on the d2 test of attention.

To narrow the effects of physical activity, studies have been carried out to see what kind of attention is affected by it. Physical activity has been found to have a

positive effect on selective attention. Budde et. al. (2008) studied a population of teenagers split into a coordinated exercise group and a normal sport lesson group. Both groups were given the d2 Test of Attention before and after the intervention. Scores on the d2 Test measure selective attention and inhibitory control and they increased in both groups from pre- to post-test, although the scores of the coordinated exercise groups improved beyond those of the normal sport lesson group. Research suggests that this type of coordinated exercise may lead to increases in attention. The current study uses an aerobic group for the study which has coordinated movements so one can hypothesize from this study's results that improvements in attention would be observed for the participants of the aerobic group.

In the past, extensive research has been done regarding physical activity and its impact on various physiological and cognitive functions. This research has demonstrated that practicing physical activity can have a positive effect in both of these areas. Those who take part in physical activity often have less trouble sleeping, experience lower levels of stress, and witness an improvement in many cognitive functions, including attention. This enhancement of cognitive abilities often manifests itself in the form of better academic performance in the case of students. That said, studies regarding the impact of physical activity on cognitive functions is a relatively new area and, therefore, is the subject of much ongoing research.

Meditation

Definition of Meditation. Meditation is also another factor that has been found to affect attention (Chan & Woollacott, 2007; Kratter & Hogan, 1983; Sarang & Telles, 2007; Valentine & Sweet, 1999) and it also influences variables that

negatively effect attention (Marlatt & Chawla, 2007). In this study, meditation was isolated as a variable that would affect attention scores, and this study also contributes to the clarification of an inconsistency regarding research done on yoga. Therefore for the intents and purposes of this paper, meditation and its affect on stress, alcohol use, academic performance, and attention will be discussed.

Numerous definitions have been found and given regarding meditation. Meditation is currently difficult to define, and has hence resulted in measurement conflicts (Grossman, 2008), yet a comprehensive discussion on the connection between religion and meditative practices and their affect on cognitive function has been provided (Walsh & Shapiro, 2006). Two types of meditation were discussed, transcendental meditation and mindfulness meditation. Transcendental meditation, which is focus on a higher power, is derived from Hindi yoga practice, while mindfulness meditation, or being aware of things on earth, is derived from Buddhist practice. Walsh and Shapiro (2006) also provided a list of varieties based on themes, relationships, and goals. The overarching definition provided for meditation was a self-regulating practice that focuses “on training attention and awareness” so that practitioners may control their mental processes (228). Stone (2006) defined meditation as “the practice of being aware of your immediate surroundings and your current sensations rather than worrying [...] It’s the practice of experiencing the moment.” So, meditation is defined as a prolonged holding of the perceiving consciousness to an idea or a certain region on the body in this paper.

Meditation and Academic Performance. Academic performance has been found to improve when meditation is employed as a study booster (Hall, 1999). This

study examined how meditation affected memory and attention by observing academic performance in college-aged students, pre- and post-intervention. Two groups of students from one class were required to attend a weekly study hall for one hour. The experimental group performed breathing, relaxation, and attention-focusing techniques before and after studying to see if it would have an effect on their memory and the attention being focused on their assignments. The results showed that the GPA and academic performance of the students who practiced meditation did indeed improve beyond those of the control group, whose members only studied and did not practice any meditative techniques. These results suggested a correlation between meditation, which includes breathing and relaxation exercises, and improved GPA and decreased stress levels.

Meditation and Stress. Meditation is becoming an alternative to modern medicine in reducing stress. Researchers at Harvard, Yale, and MIT found that routine meditation may result in long-term cognitive benefits, such as improved ability to think, reason, remember, and imagine. Because stress is physically taxing on one's physical and mental well-being, meditation was recommended to slow breathing, lower heart rate, and bring the body to a relaxed state ("Simple Ways to Beat Stress," 2008) so its mitigating influence on stress may induce attention scores to increase. One study did a comparison between two types of meditation exercises to determine if they were uniquely different from each other in their effects on perceived stress, and medical and psychological symptoms (Carmody & Baer, 2007). By administering the Mindfulness-Based Stress Reduction (MBSR) program, they monitored the home practice of meditation exercises (body scan, yoga, sitting) in 174

adults over an eight session period. With their pre and post-test design, they found that levels of mindfulness increased after the intervention; meditation significantly increased mindfulness and measures of symptoms and well-being. This signifies that practicing meditation regularly can significantly reduce psychological distress and perceived stress and enhance well-being.

Meditation and Alcohol Use. Alcohol is also sometimes used by individuals seeking to relax and relieve anxiety. As meditation has been found to have relaxation inducing benefits, and has not been found to damage health when used in excess, Marlatt and Chawla (2007) investigated meditation practice as a replacement for alcohol to reduce its use. Their meta-analysis found that the mindfulness learned through meditation was helpful to those overcoming addictions, including alcoholism, and that meditation practice reduced overall alcohol consumption (especially in college students). Meditation was even found to extend the effects of other treatments. The researchers concluded that in addition to, and perhaps in part because of the benefits meditation has for psychological functioning, there are strong implications for the use of meditation in treating alcohol abuse. Moreover, meditation may induce less alcohol consumption which could contribute to an indirect improved long term effect on attention.

Meditation and Attention. In an effort to specifically investigate the role of meditation in cognitive function, Yuille and Sereda (1980) isolated meditation as a variable that could affect specific cognitive variables. The goal was to discover if participants who practiced transcendental meditation (TM) experienced any unique effects on associative memory, attention, and intelligence as compared to those who

practiced savasana yoga, pseudo-meditation, or no intervention. The participants were randomly assigned. The interventions lasted three months, containing pre-test and post-test sessions. A numerosity estimation test was used to measure perception and attention skills. Yuille and Sereda found no statistically significant increases in any of the groups and concluded that meditation did not improve any of the cognitive faculties measures. Small group sizes, due to high drop-out rates, may have contributed to these findings. At the beginning of the study there were 136 total participants, but the study had a dropout rate of 47.25%. Possible limitations included the large number of measures given at once and the lack of particular tests to measure certain aspects affected by meditation.

In a report from the U.S. Department of Education, the effect of meditation and progressive relaxation on 24 boys aged 7-12 who had been diagnosed with Attention Deficit Disorder with Hyperactivity was investigated (Kratte & Hogan, 1983). Researchers hypothesized that both a muscle-relaxation and mediation group would decrease in impulsivity, but only the meditation group would increase in attention. Participants attended two weekly 20 minute sessions of meditation, progressive relaxation, or non-intervention over a four-week period and they were encouraged to practice at home. Researchers measured or recorded impulsivity, selective attention, internal control of behavior, and behavior of the students at home. Out of the three interventions, meditation was the only one that had a statistically significant effect on selective attention. Kratte and Hogan (1983) asserted that this was due to meditation's ability to induce relaxation, in addition to training their attention skills.

One study measured how relaxation techniques affect psychological and cognitive constructs. Galvin, Benson, Deckro, Fricchione, and Dusek (2006) investigated if a “relaxation response (RR)” training program would decrease anxiety, increase attention, and increase declarative memory. Fifteen aging adults were split into a control or RR group. The experimental group did one and a half hour RR training sessions for five weeks and listened to RR audiotape for 20 min a day at home. The sessions did not seem to include just meditation as some muscle relaxation and other techniques for relaxation were also employed. The control group did nothing. They used 14 tests, and two of them (Trail Making Test A and Test B) measured attention. Test A measured for attention and performance on psychomotor tasks and the measured variable for Test B was not provided. They found significant improvement in RR group on attention from Test A ($P < .0025$). No significant findings were found for Test B. Even with an aging population and small sample size, this study found that relaxation techniques, including meditation significantly improved scores on a simple attention test, yet it could mean that this particular population did not have lifestyles that supported the maintenance of attention and therefore experienced the spike as they began retraining. All in all, the coupling of meditation with other relaxation techniques was found to effect attention.

Slagter, Lutz, Greischar, Francis, Nieuwenhuis, et al. (2007) examined attentional blinking which is when stimuli are happening too quickly and the brain misses a step. They used a group of people experienced in vispassana meditation, which trains for non reactive awareness, who meditated for 10 to 12 hours a day for three months. A group of inexperienced participants meditated for only 20 minutes a

day for the three months. Both groups were given the attentional blink test which flashes a series of letters (non-target stimuli) and embedded in this series are two numbers (target stimuli) they are asked to identify. Results showed that the inexperienced group would see the first, but not the second because the first would get their attention and they would still be dwelling on the first and therefore miss the second number if it was shown within .5 seconds after the first. The more experienced meditators would pay less attention to the first number and be able to catch the second. All of the experienced meditators improved their awareness from before to after the three month period while 16 of 23 inexperienced participants improved. This result was also seen in electrical changes in the brain. People who saw both target stimuli had a smaller reaction to the first which allowed them to notice the second. The investigators suggest that attention is trainable via meditation.

Chan and Woollacott (2007) wanted to know how meditation would effect “executive processing (inhibits proponent/incorrect responses)” and orientational processing (orienting one’s attention to specific targets in the attentional field). Fifty meditators and 10 control participants of varying experience levels and broke them into two kinds of meditation. Concentrative meditation asks participants to focus on one object and to return to it if focus shifts away. Opening up meditation lets any feelings or straying thoughts in freely to increase awareness. The participants took the Stroop Test, which measures executive attention and Global –Local Letters test which measures orientational attention. Results showed that the more experienced people increased their executive attention, but did not improve their orientational attention.

Valentine and Sweet (1999) investigated the short-term effects and differences between two types of meditation practice. Researchers found that individuals who practiced either mindfulness or concentrated meditation strategies showed statistically significant increase in their post-meditation scores on Wilkin's counting test, a measure of attention, as compared over a non-meditative control group.

Sarang and Telles (2007) conducted a short-term effect study using a randomized experimental design comparing three groups. There were two experimental groups who participated in yoga-based relaxation techniques (Cyclic Meditation and Supine Rest) and a control group. The study consisted of 69 male volunteers, aged 18 to 48. Compared to the control, both experimental groups produced higher test scores on a visual selectivity task that required sustained attention, visual scanning, and response inhibition. The results suggested that short-term meditation exercises, a component of yoga practice, improved attention.

The vast majority of the literature suggests that meditation of any type will lead to increased levels of attention. Despite the variety of meditation techniques investigated in other studies (cyclic meditation, supine rest, mindfulness, concentrated meditation and meditation), most meditative showed significant increase in attention scores (Sarang & Telles, 2007; Valentine & Sweet, 1999). In addition, the high drop out rates and large number of tests used in Yuille and Sereda (2004) study brings question to the lack of an effect in the savasana yoga and pseudo meditation group. It seems to be fairly conclusive from the literature that meditation can increase scores of attention.

As was the case with physical activity, the practice of meditation has been shown to reduce stress by acting as an effective method of relaxation. Many studies have concluded that meditation improves attention and academic performance. Since many people consume alcohol for the purpose of calming down, the function of meditation as a relaxation technique is believed to reduce alcohol consumption which, as previously discussed, may also help to improve attention. The impact of meditation on attention is one of the cornerstones of this study.

Yoga

Definition of Yoga. Given that physical activity and meditation have been shown to positively affect attention, it is possible that yoga, which combines both coordinated physical activity and meditative components, will also likely influence attention. As an increasing number of Americans practice yoga, the potential relationship with attention could have far-reaching implications. Between 1996 and 2001, there was a 50% increase in the number of American adults practicing yoga (Casden, 2005). According to the National Health Statistics Reports, there was a statically significant increase in the number of adults practicing yoga in the United States between 2002 and 2007 (Barnes, Bloom, & Nahin, 2008). In addition, 75% of all health clubs offered yoga classes in 2001 (Corliss, 2001). Even popular American magazines, from *Time* (Corliss, 2001) to *Glamour* (Leive, 2009), have incorporated articles detailing yoga practices and their purported benefits.

This popularity is likely due to the perceived and documented benefits that yoga provides to its participants. Health scientists have carried out extensive research projects investigating the wide-ranging effects of yoga on the body, mind, and psyche

(Oken, Zajdel, Kishiyama, Flegal, Dehen, Haas, et. al., 2006; Casden, 2005). Yoga has been shown in the literature to improve quality of life, strength, flexibility and balance, and to lower anxiety and depression. (Schure, Christopher, & Christopher, 2008). Even though these benefits have been confirmed, there is still some ambiguity regarding yoga's effect on attention due to the inconsistency of assertions made by empirical studies; some studies assert that yoga has a positive effect on attention (Sahasi, 1984; Peck, 2005) while others say that they did not collect data that supported this conclusion (Casden, 2005; Oken, Zajdel, Kishiyama, Flegal, Dehen, Haas, et. al., 2006; Williams, 1993). It appears that overall, yoga has been found provide multiple benefits to the people who practice it, but some information remains disputable or ambiguous. This section of the literature review discusses the definition of yoga, the discrepancies regarding its effect on attention, and the premise for this study's research question.

Before specific yoga research is examined, it should be noted that yoga is described in many different ways throughout the literature, and therefore should be clearly defined. It is helpful to refer back to the historical foundations of yoga in order to obtain a deeper understanding of the underlying theories. Yoga originated in India approximately 5,000 years ago, and was first documented over 2,000 years ago (NCCAM, 2008). In its earliest form, yoga is one of six orthodox schools of Indian philosophy based on the Yoga Sutras, developed by the sage Patanjali. This school of Indian philosophy is the cornerstone of the most practiced form of yoga today, known as Raja or Ashtanga Yoga. Patanjali, the father of yoga, defines yoga as "that which restrains the thought process and makes the mind serene" (Garfinkel & Schumacher,

2001). The original emphasis was on personal verification with conscious thought to reaching spiritual discipline (Garfinkel, 2001). The word itself comes from the Sanskrit word “yuj,” meaning yolk or union (NCCAM 2008). Yoga practice was said to strengthen both body and mind, which were viewed as indistinguishable from each other (Watts, 2000). Moreover, yoga as a holistic practice includes ethical and physical disciplines, emotional or mental disciplines, and the attainment of enlightenment (Burkett, 2006). In the yoga philosophy, the first step to enlightenment is to achieve ethical and physical discipline by living a good life, following the rules and commandments, and strengthening the body through poise.

Even though in its origins yoga was foremost a holistic practice, the more spiritual aspects of yoga are often overlooked in western cultures. Postures are often taught in isolation to alleviate stress or illness. In addition, many of the specific techniques of yoga have been broken up or modified as a result of the diverse yoga classes offered within the United States (Shaver, 2007). This leads to inconsistencies between yoga classes, and it can be difficult to discern whether or not the yoga being taught strictly adheres to the style from which it developed.

According to the National Institute of Health (NIH), yoga combines physical postures, breathing exercises, meditation, and the ancient Yoga Sutra philosophies. (National Institutes of Health, National Center for Complementary and Alternative Medicine, 2009). Burkett, Todd, and Adams (2006) stated that the aim of yoga practice is to cultivate awareness of fluctuations of the physical body and transcend them. Yoga emphasizes the awareness and regulation of breath, while maintaining focus on an activity (Burkett, Todd, & Adams, 2006). According to Watts (2000),

yoga's use of postural or breathing focus, rather than mental focus, is something that sets it apart from many other meditation techniques. Although the various explanations above result in a broad theoretical description of yoga, in practice, there are many variations on these themes.

The most common form of yoga practiced in gyms throughout the world evolved from the lifestyle described in the Hatha Yoga Pradipika, an influential text that describes asanas (poses), pranayama (breathing techniques), mudras (symbolic gestures), and samadhi (perfect meditation) as components of yoga. For the purpose of this study, yoga was defined as a combination of the asanas (postures), pranayama (regulated breathing) and dyhana (meditation) (Salmon, et al., 2009).

Benefits of Yoga. The positive effects of yoga on physical and mental fitness have been well documented in many populations, including college students. Many studies have documented results which correlate yoga practice to increased physical abilities. Cowen and Adams (2005) recruited 26 adults, aged 20 – 58, who had not regularly practiced yoga in the 6 months prior to the study, and assigned them randomly to participate in either an Ashtanga or Hatha yoga class. An assortment of physical variables were measured prior to the first class and after the last class; including trunk dynamic muscular strength and endurance using a curl-up test, flexibility of the trunk using a sit-and-reach box, blood pressure, and heart rate. Both groups showed significant improvements from their pre to post-test scores in diastolic blood pressure, upper body and trunk muscular strength and endurance, and flexibility.

Another researcher focused on the effect of a yoga intervention on back pain, compared with exercising and self-care control groups. After the intervention, participants in the yoga group reported lower scores on the Roland Disability Scale, a measure of back-related dysfunction. (Sherman, 2006) Research has validated claims that yoga practice can have positive physical effects.

Yoga and Stress. As stress has been found to affect attention, correlations between yoga and stress levels were investigated to explore possibilities that yoga may affect attention indirectly. There seems to be a clear correlation between stress and yoga. In a study by Cowen and Adams (2005), participants took 75-minute yoga classes twice a week for six weeks and reported lower perceived stress on the General Well-Being Schedule after the yoga intervention.

The use of yoga to reduce stress was further supported by Schure, Christopher and Christopher (2008). Thirty-three graduate students (aged 20-50) participated in a 15-week elective course at their university consisting of mindfulness exercises (including yoga, meditation, and a form of sitting yoga called qigong) twice a week. Practice outside the class was also required four times each week. Data was collected over the course of four years (multiple courses were used). Based upon qualitative self-report data, collected via a weekly journal assignment, subjects noted varying positive changes physically, emotionally, mentally, spiritually, and in their interpersonal relationships. Yoga in particular was found to yield an increased awareness of the body, increased energy, and increased mental clarity and concentration. With regards to stress, subjects found that participation in these mindfulness exercises, they were able to address the causes of their stress, and were

able to let go of stress and other negative emotions. Subjects further offered that they would continue to implement such practices in their lives. While the study relied on self-report data that may have been falsely positive because it was required for a course, the study strongly presents some of the potential benefits of yoga that Schure, Christopher and Christopher (2008) recommend other researchers expand upon quantitatively.

Research claims regarding the practice of yoga results and its reduction of stress are of particular importance to this study. Given the previous discussion with respect to the impact of lower stress on the improvement of attention, it is logical to assume that if practice of yoga does indeed reduce stress, it will also correlate with increased attention scores. The accuracy of these claims will be explored next.

Yoga and Attention. As previously stated, due to the correlations between yoga and stress, and between stress and attention, it can be surmised that there would in turn be a correlation between yoga and attention. An examination of the literature, however, reveals that this relationship has not been clearly delineated.

In India, Sahasi (1984) investigated the effectiveness of yoga in improving cognitive faculties of 12-year-old school children over a 7-month intervention period. Participants were randomly divided into a yoga intervention group which had a yoga class added to their curriculum, and a control group which continued with regular classes. They took five tests of attention before and after the intervention period. Four of the given tests were taken from the PGI memory scale and one test measured color cancellation ability. Based on the participants' performance on these tests, Sahasi

concluded that the experimental yoga group showed more consistent and overall improvement in mental faculties compared to that of the control group.

A short term intervention study, which investigated the correlation between yoga and attention, was conducted by Peck, Kehle, Bray and Theodore (2005). This study investigated the effect of yoga on 10 children who had been observed over a period of three weeks to have attention problems. The school psychologist observed students' eye contact and performances on assignments in the classroom as a way of measuring their attention. The researchers observed increased eye contact and performance levels after the yoga intervention and calculated that yoga had a large effect size on attention directly after the intervention. In some grades, this large effect size was also recorded during a follow-up probe that occurred after the intervention (yoga) had been withdrawn. The key limitation of this study was that there was only one person implementing the intervention and observing the participants for changes in behavior. This researcher knew the purpose of the study and, as such, his or her observations may have been biased from the start. According to peer comparison records, the participants did not change the times they spent on classroom tasks, so Peck et al. asserted that the results should be interpreted with caution.

The purpose of Casden's (2005) study was to assess the effects of Ashtanga yoga on autonomic homeostasis and respiratory function, and the effects of Ashtanga yoga as a mediator for cognitive functioning, psychological symptoms, and somatic complaints in healthy adults. Casden observed and recorded data for 48 healthy adults (aged 19-38) who either participated in a yoga program (22 participants) or

were placed in a wait-list control group (26 participants) for six weeks. After the intervention, a variety of tests were conducted including the Trail Making Test, a measure of concentration. Although overall the yoga group scores did improve over those of the control group, neither group's scores indicated a statistically significant increase in attention. Casden (2005) mentioned various limitations of her study, including the fact that the battery of tests was extensive and may have fatigued the participants and that there was a high drop-out rate for the study.

Oken, Zajdel, Kishiyama, Flegal, Dehen, and Haas (2006) studied the effects of yoga in healthy men and women aged 65-85 on cognition, fatigue, mood, and quality of life years over the course of six months. The purpose of the study was to contribute to the lack of literature regarding randomized, controlled yoga studies with large subject pools. The participants were divided into three groups; a yoga class, a walking exercise class, and a wait-list control group. In addition to taking the class, the participants were encouraged to exercise 5 times a week and they completed daily log sheets that recorded whether or not they practiced yoga that day and for how long. Two measures of cognitive function were used: the Stroop Test, a measure of attention, and a quantitative electroencephalogram (EEG), which assesses cortical activity and brain function. A total of 118 participants (38 in exercise, 38 in yoga, 42 in wait-list control) completed the study, but there were no statistically significant improvements on the cognitive tests in either the exercise or yoga groups when compared to the control. The authors noted that there were not enough participants to measure for a small effect size in the yoga group.

In response to the minimal amount of experimental research conducted regarding the effects of yoga on concentration, Williams (1993) studied the effects of practicing yoga on psychological variables and concentration. The study analyzed three groups of young adults: a yoga group (26 participants), an exercise (martial-art) control group (33 participants), and a non-exercise control group (25 participants). The Visual Scanning and Attention Test and the Press Test, which are both tests of attention, were used to measure the participants' concentration. Pre-and post-test observation sessions were held 11 weeks apart. No statistically significant differences were found between any of the groups for any of the measures from the post-test data; however, Williams asserted that if there had been more participants, more statistically significant results might have been revealed. The study also recommended that only one measure be used because participants' time after the conclusion of the class is limited and, therefore, reducing the amount of time the measure requires might help prevent a large drop out rate.

The physical benefits of practicing yoga, such as improved balance, flexibility, and strength, have been verified through numerous studies. Research has also demonstrated that performing yoga can greatly reduce stress. However, unlike physical activity and meditation (which also reduced stress), there is no clear relationship between the practice of yoga and the improvement of cognitive functions such as attention and concentration. Due to various limitations or complications present in many of these studies, convincing conclusions could not be drawn with respect to this relationship.

To address the limitations in previous studies, the current research employed a quasi-experimental design. In doing so, comparisons could be made between a yoga group and aerobic control group while maximizing the number of participants included. It also allowed for consideration of the time and convenience of the participants, thereby minimizing factors that increase drop-out.

Summary and Research Question

To summarize the findings of the literature review, both meditation and aerobic activity seems to have a positive effect on attention. However, the practice of yoga, which contains both physical and meditative aspects, has not yielded clear results. In particular, research remains inconclusive with regard to the possible effects of yoga on attention (Sahasi, 1984; Williams, 1993; Casden, 2005; Oken et al., 2006). On one hand, there is some evidence that participating in yoga activity can enhance attention (Sahasi, 1984), while on the other, some studies have shown no such effect (Williams, 1993; Casden, 2005; Oken et. al, 2006). When examining the limitations of the studies that found no clear association between yoga and attention, it is noted that high drop-out rates and failure to make comparison to an adequate control groups may have been partly to blame for the inconclusive findings.

The literature suggests that physical activity will have a positive effect on attention and, therefore, aerobic exercise and the physical component of yoga should also produce increases in attention. Thus, the following research question was investigated in this study:

R1: Will young adults who attend yoga classes show increased selective attention and mental concentration beyond that of an aerobic exercise control group?

After developing this research question, two hypotheses were formed. As Budde et. al. (2008) proved that attention scores will increase after an intervention of coordinated exercise, it was assumed that participants in a yoga and aerobics intervention would show an increase in attention. Since yoga has a meditative component in addition to physical activity, and since research has asserted that meditation has a correlation with an improvement in attention (Sarang & Telles, 2007; Valentine & Sweet, 1999), the researchers predicted that yoga would increase the attention of participants more so than an aerobic intervention. As meditation and physical activity alone have both been shown to have an immediate positive effect on attention, the researchers believed that participants who practiced yoga, an exercise that combines meditation with physical activity, would demonstrate improved attention beyond that of aerobic activity which is not known to have a meditative component. Thus, the following two hypotheses were proposed:

H1: Participants who take two yoga classes or physical activity classes will both show increased attention scores.

H2: Participants who take two yoga classes will have higher attention scores over those of the participants who take two physical activity classes.

Chapter 3: Methodology

Study Design

This study used a quasi-experimental pre-test, post-test design, with non-equivalent groups. Participants were not randomly assigned to the intervention groups since they self-selected their instructional exercise classes. Participants were split into two groups: a yoga experimental group and an aerobic control group. The experimental group participated in instructional yoga classes that combined physical activity with mindfulness meditative exercises. The control group participated in instructional aerobic exercise that involved physical activity without a mindfulness meditative component. Participants in both groups attended a measurement session immediately before one class and immediately following the next class they attended. There was at least one week between measurement sessions to ensure that learning did not affect the scores on the d2 Test of Attention. Measurement sessions were equivalent pre and post intervention; each session included the administration of the d2 Test of Attention and a behavioral survey. This design allowed for the observation of the immediate effect on attention produced by short-term instructional yoga practice. The independent variable in this study was the type of class in which the participants took part and the dependent variable was the score on the d2 Test of Attention at each observation point.

To ensure that the two groups were equivalent on constructs that the literature suggests might influence attention, the behavioral survey asked questions about sleep, stress, prescription medications, and drug and alcohol use, as well as participation in yoga or aerobic activity outside of the instructional classes in this study. Participants

from all classes received identical instruction on how to complete the d2 Test of Attention at both measurement sessions.

Participants

Participants in this study were individuals between the ages of 18 and 25 at a large, mid-Atlantic university. Participants for each group were recruited from various different instructional exercise classes offered on the university campus. Experimental group participants were recruited from beginner-level yoga courses. The yoga classes focused on asanas (postures) and pranayama (breathing techniques) and included a mindfulness meditative aspect, all of which were consistent with the way that yoga is defined for the purposes of this study. Participants for the control group were recruited from beginner-level aerobic courses, which included cycling and various dance classes. These classes required varying levels of attention to instruction, but all included an instructed physical activity. As with the beginner-level yoga courses, the contents of the classes selected to comprise the control group were consistent with our prior definition of aerobic activity. During the course of the study, members of both groups were asked not to participate in any other yoga or relaxation classes. Upon completion of the study, all participants received a \$10 incentive.

Demographic and behavioral information and selective attention and concentration scores were collected from 95 participants. Fifty-three of these individuals participated in yoga classes while the other 42 participated in instructional classes that focused on aerobic activity. The sample included 22 males and 73 females. The average age of the sample was 20.6 years ($SD = 2.19$). According to

participants' responses on the demographic survey, 58.5% of the yoga group participants indicated that they had previously practiced yoga. Within the yoga group, the majority of participants (67.8%) did not practice yoga regularly or practiced for an hour or less a week. Similarly, while 42.9% of individuals in the aerobic group responded that they had practiced yoga in the past, the majority of those individuals (26.2%) did not do so on a regular basis. Sixty-six percent of the participants in the yoga group had practiced aerobics before and, of that majority, 24.4% practiced for about 2-4 hours per week. Likewise, 73.8% of the aerobic group had prior experience with aerobics, and of these 23.8% engaged in aerobic exercises 2-4 hours per week. When asked to indicate why they decided to take part in their respective classes, participants were able to choose multiple responses, including the option to answer "other." The results of a frequency analysis performed on these responses demonstrated that the most common reasons participants in the yoga group enrolled in their classes were for stress management (71.1%) and enjoyment (66.0%). Most participants in the aerobic group enrolled in their classes for social purposes or with a friend (52.4%) and for enjoyment (50.0%).

Table 1

Summary of Demographic Data in the Total Sample and by Group

| Variable | Total (n = 95) | Yoga (n = 53) | Aerobics (n = 42) |
|---|-------------------|------------------|----------------------|
| Gender: | | | |
| Female | 76.8% | 77.4% | 76.2% |
| Male | 23.2 | 22.6 | 23.8 |
| Age: | | | |
| Mean | 20.60 | 20.09 | 21.24 |
| SD | 2.19 | 2.00 | 2.27 |
| Range | 18-25 | 18-25 | 18-25 |
| Why did you decide to take this class? | | | |
| Enjoy Yoga or Aerobics | 56.0% | 66.0% | 50.0% |
| Recovery / Injury | 5.3 | 5.7 | 4.8 |
| Socially / With a Friend | 49.5 | 47.2 | 52.4 |
| Health Benefits | 35.8 | 43.4 | 26.2 |
| Relaxation / Stress Management | 60.0 | 71.7 | 45.2 |
| Class Recommended | 8.4 | 9.4 | 7.1 |
| Other | 10.5 | 7.5 | 14.3 |
| Have you ever practiced yoga before? | | | |
| Yes | 51.6% | 58.5% | 42.9% |
| No | 48.4 | 41.5 | 57.1 |
| If yes, how long have you been practicing yoga? | | | |
| Less than one month | 11.6% | 15.1% | 7.1% |
| 1-2 months | 7.4 | 5.7 | 9.5 |
| 3-6 months | 7.4 | 9.4 | 4.8 |
| 7 months-1 year | 4.2 | 3.8 | 4.8 |
| 1-2 years | 15.8 | 20.8 | 9.5 |
| 3-5 years | 4.2 | 3.8 | 4.8 |
| 5+ years | 0.0 | 0.0 | 0.0 |
| How regularly do you practice yoga? | | | |
| I do not practice yoga regularly | 23.2% | 20.8% | 61.1% |
| 0-1 hours per week | 13.7 | 18.9 | 7.1 |
| 2-4 hours per week | 13.7 | 17.0 | 9.5 |
| 5-7 hours per week | 1.1 | 1.9 | 42.9 |
| 7+ hours per week | 0.0 | 0.0 | 0.0 |
| How have you practiced yoga in the past? | | | |
| Class | 34.7% | 43.4% | 23.8% |
| Video | 14.7 | 13.2 | 16.7 |
| Self-Guided | 10.5 | 11.3 | 9.5 |
| Personal Yoga Instruction | 5.3 | 5.7 | 4.8 |
| Other | 1.1 | 1.9 | 0.0 |

| | | | |
|---|-------|-------|-------|
| When was the last time you practiced yoga? | | | |
| Within the past week | 9.5% | 9.4% | 9.5% |
| One week | 6.3 | 11.3 | 0.0 |
| 2-4 weeks | 10.5 | 13.2 | 7.1 |
| 1-2 months | 5.3 | 5.7 | 4.8 |
| 3-6 months | 6.3 | 5.7 | 7.1 |
| 7 months-1 year | 3.2 | 3.8 | 2.4 |
| 1-2 years | 6.3 | 7.5 | 4.8 |
| 3-5 years | 2.1 | 1.9 | 2.4 |
| 5+ years | 0.0 | 0.0 | 0.0 |
| Have you ever practiced aerobics before? | | | |
| Yes | 69.5% | 66.0% | 73.8% |
| No | 30.5 | 34.0 | 26.2 |
| If yes, for how long have you been practicing aerobics? | | | |
| Less than one month | 7.4% | 9.4% | 4.8% |
| 1-2 months | 6.3 | 3.8 | 9.5 |
| 3-6 months | 6.3 | 5.7 | 7.1 |
| 7 months-1 year | 4.2 | 5.7 | 2.4 |
| 1-2 years | 8.4 | 11.3 | 4.8 |
| 3-5 years | 10.5 | 7.5 | 14.3 |
| 5+ years | 25.3 | 18.9 | 33.3 |
| How regularly do you practice aerobics? | | | |
| I do not practice aerobics regularly | 18.9% | 22.6% | 14.3% |
| 0-1 hours per week | 13.7 | 9.4 | 19.0 |
| 2-4 hours per week | 24.2 | 24.5 | 23.8 |
| 5-7 hours per week | 7.4 | 5.7 | 9.5 |
| 7+ hours per week | 6.3 | 3.8 | 9.5 |
| How have you practiced aerobics in the past? | | | |
| Class | 52.6% | 49.1% | 57.1% |
| Video | 23.2 | 18.9 | 28.6 |
| Self-Guided | 31.6 | 34.0 | 28.6 |
| Personal Aerobic Instruction | 6.3 | 3.8 | 9.5 |
| Other | 9.5 | 7.5 | 11.9 |
| When was the last time you practiced aerobics? | | | |
| Within the past week | 38.9% | 30.2% | 50.0% |
| One week | 4.2 | 5.7 | 2.4 |
| 2-4 weeks | 6.3 | 1.9 | 11.9 |
| 1-2 months | 7.4 | 11.3 | 2.4 |
| 3-6 months | 7.4 | 11.3 | 2.4 |
| 7 months-1 year | 2.1 | 1.9 | 2.4 |
| 1-2 years | 3.2 | 1.9 | 4.8 |
| 3-5 years | 1.1 | 1.9 | 0.0 |
| 5+ years | 1.1 | 0.0 | 2.4 |

Procedure

Recruitment. Participants were recruited from classes run by two campus recreation organizations, the Honors Program, and a yoga class organized by the researchers. The study was advertised through e-mails, LISTSERVs, and flyers (Appendices A, B, & C). The researchers also made announcements about the study in-person at targeted classes (Appendix D).

In an initial attempt to recruit participants from one of the campus recreation organizations, researchers composed an email message advertising the study, highlighting the \$10 incentive, to be sent to potential participants informing them about the study (Appendix A). The facility administrators forwarded this email to all individuals registered for its beginner-level yoga, hip-hop dance, belly dancing, and cycling classes before their classes began. The researchers then attended these targeted classes and, with the permission of the instructor, made an announcement promoting the study at the end of the class (Appendix D). This announcement explained all of the requirements of the study and advertised the incentive available to participants who fulfilled these requirements. The same announcement procedure was employed at the classes held by the other campus recreation organization and at the yoga sessions run by the University Honors Program. However, these later organizations did not send out an email to their participants prior to the first week of classes.

In addition to the recruitment methods mentioned above, the study was advertised in numerous university LISTSERVs (Appendix B) and through flyers distributed on campus. The written advertisement used on the flyers and LISTSERV

emails was similar to the script of the speech used for recruitment in the targeted exercise classes. These recruitment methods were conducted in an effort to reach more potential participants. Anyone who was interested in participating in the study was instructed to contact the researchers by email. Once contacted, the researchers provided these respondents with information about the different yoga and aerobic classes from which the team was collecting data. These individuals had the option of joining any yoga or aerobic class targeted by this study. Participants only completed recruitment procedures once they had enrolled in their self-selected class. A primary difference among the classes used in this study was that while all of the aerobics classes required fees, only some yoga classes required payment.

During the recruitment session, participants were informed about the procedure of the study and the incentive that they would receive upon completion. Participants did not receive specific details about what the study was measuring. In order to participate in the study, participants were asked to read and sign a consent form (Appendix E). By signing the consent form participants verified that they understood the parameters of the study and that their participation in the study was completely voluntary. Researchers collected the completed consent forms and assigned each participant a unique identification number to ensure anonymity in the data. This identification number was used instead of participants' names to match participants' surveys with their testing materials. After signing the consent form participants completed a demographic survey (Appendix F) containing fifteen questions related to their previous experiences with yoga and aerobic exercise. Participants who wished to receive personalized reminders about upcoming

measurement sessions were given the option of providing the researchers with their preferred contact information. This information was used solely to remind participants about the time and location of their next measurement session and was kept completely separate from all data.

Participants were either recruited in the weeks before their initial measurement session or, in some cases, in conjunction with their first measurement session. Participants who were recruited prior to their first measurement session were verbally reminded by researchers to arrive 30 minutes before their next class in order to complete the first step of data collection. The recruitment methods employed in this study targeted people who had previously signed up to take these courses before hearing of the study.

Measurements. Each participant attended two measurement sessions. Following the pre-test, post-test design, the researchers conducted data collection sessions immediately before one class and immediately after the next class participants attended. When participants arrived at the first data collection session, they each received a writing utensil and a copy of the behavioral survey (Appendix G). The researchers followed a pre-written script to explain the survey and guide participants through completing it (Appendix H). Once all participants had completed the survey, the researchers distributed a copy of the d2 Test of Attention (Appendix I) with the practice side facing upward. The researchers administered the d2 Test to the participants, continuing to use the prepared script (Appendix H). The behavioral survey was used to collect information regarding the habits and activities of the participants, while the d2 Test was used to obtain a baseline attention score. At

the end of the assessment session, administrators reminded participants that the next data collection session would take place directly after their next class and would take no longer than 30 minutes. Following this initial assessment, participants took part in their respective yoga or aerobics classes.

Participants who previously provided researchers with their contact information received a personalized e-mail 2 days prior to their next class, reminding them to attend their second data collection session immediately after the next class they attended. These emails served to increase participant retention rates. Both yoga and aerobic group participants attended a second measurement session directly following their class. During the second measurement session, the behavioral survey (Appendix G) and d2 Test of Attention (Appendix I) were administered to both groups using the same scripted instructions as in the first measurement session. Upon completion of these measures, participants from both groups completed a form in order to receive their \$10 incentive (Appendix J). The information provided by participants on the incentive form was used solely to ensure that participants received their incentive for completing the study and was kept completely separate from all data.

Generally, measurements were taken during consecutive weeks. However, some measurements were taken with gaps of two or more weeks between data collection sessions. Since this study specifically examined the immediate effects of short-term yoga practice, it was not critical for the classes to be attended on consecutive weeks, but required only that the second administration of the d2 Test of Attention occur directly after participation in the class. The d2 Test of Attention has

extremely high test-retest reliability. Numerous studies conducted in the United States have demonstrated that no learning curve exists five hours after completing the test (Brickenkamp & Zillmer, 1998, p. 18). Therefore, since measurement sessions were separated by at least one week, it was assumed that any changes in the scores on the d2 Test were due to any intervention that took place and not due to familiarity with the test.

Interventions

All of the classes used in this study employed some form of repeated physical activity. For the purposes of this study physical activity is broadly defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Shephard & Balady, 1999, p. 963). The classes targeted by this study were held on a weekly basis and participants were instructed to refrain from partaking in any instructional exercise classes outside of the study. Although various on-campus programs offered the classes used in this study, all of the yoga classes were beginner level classes, based on the Ashtanga style of yoga. Ashtanga yoga has provided the basis for mainstream yoga practice in the United States (Shaver, 2007). The National Institute of Health (NIH) defines yoga as a combination of physical postures, breathing exercises, meditation, and a distinct philosophy (NIH NCCAM, 2009). For the purpose of this paper, yoga is defined as a combination of the asanas (postures), pranayama (regulated breathing) and dyhana (meditation) (Salmon, et al., 2009). The descriptions of each of the yoga classes targeted by this study focused on various different components of Ashtanga yoga. One program described their classes as incorporating held postures, breathing exercises, and relaxation techniques

(McEachern, 2007). The yoga classes offered by another campus recreation facility taught yoga for strength, flexibility, and relaxation (Art and Learning Center, 2008). The yoga class offered by the Honors Program, Yoga Plus, was a beginner-level class that focused on basic yoga techniques (Hebert, 2009). In addition, in an effort to recruit more participants, the researchers organized a free weekly yoga class. This class was taught by a certified yoga instructor, Dr. Brecken Swartz, and included a fusion of basic yoga styles based in Ashtanga yoga, similar to that of the other yoga classes. All of the yoga classes used in this study focused on breathing, poses and stress release. In addition, all classes involved a mindfulness meditative aspect.

The aerobic courses used in this study included several dance styles such as ballroom dancing, hip-hop, belly dance, nightclub, and jazz, as well as a cycling class. These classes were offered by both campus recreation facilities and had required participation fees. All aerobic classes concentrated on teaching coordinated exercises and maintaining physical movement. The aerobic classes targeted by this study did not involve any exercises in meditation. All of the classes used as interventions in this study, with the exception of the Yoga Plus class offered by the Honors Program and the yoga class organized by the researchers, required the payment of a fee to participate.

In the context of this study, it is imperative to address the concept of dance as an aerobic activity. Research has demonstrated that, not surprisingly, high-impact, high-intensity dance routines yield the greatest benefits for aerobic fitness. Williford, Blessing, Olson, & Smith (1989) analyzed the required energy expenditure for four

different dance routines, each with a unique combination of intensity and impact (high-impact, high-intensity; high-impact, low-intensity; etc.). Though the high-impact, high-intensity routine required the highest energy expenditure and, therefore, provided the greatest aerobic benefits, the low-impact, low-intensity routine may have been too temperate to yield any significant cardiovascular fitness rewards. The study ultimately concluded that low-impact aerobic dance class must be performed at a high level of intensity in order to apply the same amount of energy as a traditional aerobics class (Williford, et al. 1989). A separate study reached a similar conclusion, asserting that moderate to high-intensity aerobic dance exercises place sufficient stress on the cardiovascular and respiratory systems to produce the effects normally associated with aerobic fitness (Igbanugo & Gutin, 1978).

Measures

Demographic Survey. A demographic survey was administered before the intervention to obtain information about participants' age, gender, and previous experience with yoga (Appendix F). This survey was used to describe the sample and to compare the control and experimental groups prior to analysis of results.

Behavioral Survey. A behavioral survey was administered at each measurement session to obtain information from participants about specific behaviors in the week prior to each measurement session. This survey requested participants to report on certain behaviors in the week prior to each measurement session. The specific behaviors participants were asked to provide information about included hours of sleep, days that alcohol and drugs were consumed, and perception of stress (Appendix G). These questions were asked because sleep deprivation, (Millman,

2005), consumption of alcohol or drugs (Lundqvist, 2005; Pope & Yulegard-Todd, 1996; Levin, et al., 1998; Abrams, Gottlob, & Fillmore, 2006), and stress levels (Braunstein-Bercovitz, 2003) have been shown to affect attention. This survey was used to control for these behaviors as possible confounding variables.

Attention. This study used the d2 Test of Attention (Appendix I) to measure the selective attention and mental concentration of participants. The d2 Test of Attention handbook defines selective attention and mental concentration as the “continuous and focused selection of stimuli” (Brickenkamp & Zillmer, 1998, p. 3). A major aspect of selective attention and mental concentration is the ability to acknowledge certain stimuli correctly and quickly within a task while ignoring others (Goldstein, 2007; Ashcraft, 2005). The test was originally designed to measure driving efficiency in Germany and has been widely used in Europe for many types of attention-based studies and clinical applications. In recent years, the d2 Test has been increasingly employed as a measure of attention in studies conducted in the United States (Brickenkamp & Zillmer, 1998).

The d2 Test of Attention has been demonstrated to be a valid and reliable test of attention. A study by Zillmer and Hong found that the test has a Cronbach’s alpha of .96 in 18 to 37 year olds in the United States (Brickenkamp & Zillmer, 1998). Cronbach’s alpha is a coefficient of internal consistency and reflects how well the test measures the construct it claims to measure (in this case, selective attention and mental concentration). The higher the coefficient, the stronger the relationship is; the highest possible alpha is 1.0 (Liu & Zumbo, 2007). Other studies by Brickenkamp also asserted that the test has strong test-retest reliability in adults after

a five-hour interval (Brickenkamp & Zillmer, 1998). This means that no learning curve exists five hours after the test has been taken so any changes in d2 scores after five hours can be attributed to the interventions and not the fact that participants had previously taken the test.

The d2 Test of Attention was an appropriate measure of the selective attention and mental concentration for the study design. The test has been used most successfully on participants between the ages of 18 and 35 (Brickenkamp & Zillmer, 1998), into which this study's target population fits. It can be administered to a single participant or a large group of participants by a single proctor. The test and manual were easily and inexpensively attained from Psychological Assessment Resources (PAR). Additional supplies necessary to administer the test include writing implements, a stopwatch, and clipboards. The script used in this study to administer the d2 Test was adapted from the test's manual (Brickenkamp & Zillmer, 1998).

The d2 task involves discriminating and crossing out target symbols from non-target symbols in a timed, 20-second interval. Two d2 score calculations, which both measure selective attention and mental concentration, were examined. The first score calculated, TN-E, is a measure of response inhibition. According to Posner (2004), response inhibition is an attentional process of deterring behavioral tendencies or responses that are impulsive and incorrect in context. Response inhibition scores are calculated by taking the total number of items processed and subtracting both types of error: errors of commission (crossing out incorrect items) and errors of omission (failing to cross out correct items). The second score, Concentration Performance (CP) measures the coordination of speed and accuracy of

performance (Brickenkamp & Zillmer, 1998). Concentration performance is a measure of the total number of correct symbols crossed out correctly minus any errors of commission. Concentration performance is considered a slightly more accurate judge of attention as it compensates for various phenomena that can occur during the test, such as a participant skipping an excessive number of target stimuli. This leads to a heightened sensitivity to performance accuracy, when compared with the response inhibition score. The response inhibition score gives a more quantitative measure of selective attention and mental concentration whereas the concentration performance score provides a more qualitative measure of selective attention and mental concentration (Brickenkamp & Zillmer, 1998).

Chapter 4: Results

Statistical analysis was performed on the d2 Test of Attention scores obtained from the yoga experimental group and aerobic control group to compare selective attention and mental concentration of each group. A preliminary analysis was conducted on participants' responses to the behavioral survey (Appendix G) to determine if any statistically significant differences existed between the participants in the yoga and aerobic groups. These variables were compared using one-way Analyses of Variances (ANOVA). The results from these analyses demonstrated that there were no statistically significant differences between groups regarding the possible confounds that were tested (alcohol, $F(1,93) = 0.56$, $p = .46$; prescription medication, $F(1,93) = 1.16$, $p = .28$; marijuana use, $F(1,93) = 2.62$, $p = .109$; other controlled substances, $F(1,93) = 0.97$, $p = .33$; cigarettes, $F(1,93) = 0.84$, $p = .36$; outside aerobic activity, $F(1,93) = 2.05$, $p = .16$; outside meditation, $F(1,93) = 0.23$, $p = .62$).

= .64; sleep, $F(1,93) = 2.09$, $p = .15$; stress, $F(1,93) = 0.44$, $p = .51$). Thus, none of these behavioral indicators were included as controls in the final analysis. Although the behavioral survey asked about drug use, the questions' focus on amount of drugs used instead of what drugs meant that little insight could be gained from an analysis of those numbers. To determine if the groups had pre-existing differences on the initial measure of attention, a one-way ANOVA was conducted comparing the groups' mean scores of selective attention before intervention (time one). There were no statistically significant differences between the groups in either of the attentional scores, TN-E or CP (TN-E: $F(1,93) = 2.656$, $p = .107$), CP: $F(1,93) = 1.092$, $p = .299$).

Table 2

Summary of Observation Point 1 Behavioral Data in the Total Sample and by Group

| Variable | Total (n = 95) | Yoga (n = 53) | Aerobics (n = 42) |
|---|-------------------|------------------|----------------------|
| On how many days in the past week have you consumed alcohol? | | | |
| Mean | 1.16 | 1.24 | 1.05 |
| SD | 1.27 | 1.38 | 1.13 |
| On how many days in the past week have you used prescription medications? | | | |
| Mean | 2.06 | 1.75 | 2.45 |
| SD | 3.13 | 2.99 | 3.29 |
| On how many days in the past week have you used marijuana? | | | |
| Mean | 0.23 | 0.38 | 0.05 |
| SD | 0.99 | 1.30 | 0.21 |
| On how many days in the past week have you used any other controlled substances? | | | |
| Mean | 0.15 | 0.07 | 0.23 |
| SD | 0.80 | 0.43 | 1.10 |
| In the past week, how many cigarettes have you smoked on average per day? | | | |
| Mean | 0.18 | 0.11 | 0.26 |
| SD | 0.79 | 0.58 | 0.99 |
| How many hours in the past week have you participated in any aerobic activities outside of this class? | | | |
| Mean | 2.89 | 2.42 | 3.50 |
| SD | 3.69 | 3.45 | 3.92 |
| How many hours in the past week have you participated in any meditative activities outside of this class? | | | |
| Mean | 0.81 | 0.71 | 0.92 |
| SD | 2.24 | 1.54 | 2.91 |
| In the past week, on average, how many hours of sleep did you get per night? | | | |
| Mean | 6.97 | 7.11 | 6.80 |
| SD | 1.06 | 0.96 | 1.16 |
| How stressed were you in the past week? (Scale 1-5, 5 most stressed) | | | |
| Mean | 2.74 | 2.79 | 2.67 |
| SD | 0.91 | 0.86 | 0.98 |

Table 3

Summary of Observation Point 2 Behavioral Data in the Total Sample and by Group

| Variable | Total (n = 95) | Yoga (n = 53) | Aerobics (n = 42) |
|---|-------------------|------------------|----------------------|
| On how many days in the past week have you consumed alcohol? | | | |
| Mean | 1.04 | 1.17 | 0.88 |
| SD | 1.13 | 1.25 | 0.94 |
| On how many days in the past week have you used prescription medications? | | | |
| Mean | 2.14 | 2.02 | 2.29 |
| SD | 3.10 | 3.01 | 3.24 |
| On how many days in the past week have you used marijuana? | | | |
| Mean | 0.18 | 0.32 | 0.00 |
| SD | 0.82 | 1.09 | 0.00 |
| On how many days in the past week have you used any other controlled substances? | | | |
| Mean | 0.09 | 0.02 | 0.17 |
| SD | 0.73 | 0.14 | 1.08 |
| In the past week, how many cigarettes have you smoked on average per day? | | | |
| Mean | 0.21 | 0.13 | 0.31 |
| SD | 0.92 | 0.59 | 1.22 |
| How many hours in the past week have you participated in any aerobic activities outside of this class? | | | |
| Mean | 2.99 | 2.92 | 3.08 |
| SD | 3.56 | 3.98 | 2.99 |
| How many hours in the past week have you participated in any meditative activities outside of this class? | | | |
| Mean | 0.48 | 0.52 | 0.44 |
| SD | 1.38 | 1.17 | 1.61 |
| In the past week, on average, how many hours of sleep did you get per night? | | | |
| Mean | 6.91 | 7.04 | 6.75 |
| SD | 0.96 | 0.85 | 1.07 |
| How stressed were you in the past week? (Scale 1-5, 5 most stressed) | | | |
| Mean | 2.65 | 2.72 | 2.57 |
| SD | 0.90 | 0.89 | 0.91 |

The primary analysis consisted of comparing scores that measured selective attention and mental concentration using ANOVA procedures. Two ANOVAs were conducted to determine the effect of the intervention on attention scores; one examined differences between groups on response inhibition (TN-E) and one examined differences between groups on concentration performance (CP), which are both scores of selective attention and mental concentration (Brickenkamp & Zillmer, 1998). Response inhibition is an attentional process of deterring the behavioral tendencies or responses that are impulsive and incorrect in context (Posner, 2004). Concentration performance (CP) measures participants' performance accuracy on the test (Brickenkamp & Zillmer, 1998). Mean and standard deviations for the two ANOVAs, broken out by class type, both pre-intervention (time one) and post-intervention (time two), are detailed in Table 4.

An ANOVA was run on the pooled group and broken down by class type for response inhibition scores (TN-E). The pooled group has a statistically significant increase in scores for response inhibition as measured by the ANOVA test on the difference between the mean scores for pre-intervention and post-intervention ($F(1, 93) = 206.00, p = .00$), demonstrating a large effect size ($f = .46$) for both yoga and aerobic interventions (Cohen, 1992). Further, participants in the yoga group had lower attention scores after intervention (time two) than those in the aerobic group, showing a second statistically significant main effect of class type ($F(1, 93) = 4.18, p = .04$), with a small effect size ($f = .23$) (Cohen, 1992). The interaction between class type and test time, however, was not statistically significant ($F(1, 93) = 0.35, p = 0.56$).

Concentration performance (CP) was used for measuring the coordination of speed and accuracy of performance. The pooled group has a statistically significant increase in scores for concentration performance as measured by the ANOVA test on the difference between the mean scores for pre-intervention and post-intervention ($F(1, 93) = 253.70, p = .00$), demonstrating a large effect size ($f = .47$) for both yoga and aerobic interventions (Cohen, 1992). However, neither the main effect of class type ($F(1, 93) = 2.29, p = .13, f = .19$) nor the interaction between class type and test time ($F(1, 93) = 1.32, p = .25$) were statistically significant.

Table 4

Means (M) and Standard Deviations (S.) for Total Number minus Errors (TN-E) and Concentration of Performance (CP) for both Yoga and Aerobic Groups pre-test and post-test

| Measure | TN-E | | CP | |
|-----------|-------|-------|-------|-------|
| | M | SD | M | SD |
| Yoga | | | | |
| Pre-Test | 485.7 | 71.04 | 196.0 | 41.04 |
| Post-Test | 550.0 | 61.17 | 234.1 | 37.06 |
| Aerobics | | | | |
| Pre-Test | 509.6 | 70.57 | 205.4 | 46.36 |
| Post-Test | 579.4 | 64.66 | 249.4 | 41.87 |

Since level of stress, alcohol consumption, and hours of sleep are shown by the literature to effect attention, it was possible that these variables might have influenced participants' scores on the d2 Test of Attention. A multiple regression analysis was performed to determine the extent to which these variables may have affected attention scores. In this analysis, predictors included questions from the behavioral survey regarding how stressed a participant felt in the last week, how many hours of sleep they averaged per night, and the number of days in which alcohol was consumed, as well as participation in the yoga or aerobics groups. The criterion variables included scores on response inhibition (TN-E) in the first regression and concentration performance (CP) in the second. Both criterion variables were measured at the second observation point, following participation in the yoga or aerobics classes. Tables 5 and 6 contain the important statistics from the regression analysis for response inhibition and concentration performance respectively.

In the regression model for response inhibition (TN-E) none of the variables considered in the model were statistically significant. Alcohol consumption, stress levels, and average amount of sleep per night were entered at the first step. The only variable that approached statistical significance at this step was average hours of sleep ($\beta = -.18$, $p = .09$). Participation in yoga and aerobic classes was then entered at the second step of the regression equation, and approached statistical significance ($\beta = .20$, $p = .06$), but remained non-significant. As neither step of the equation was statistically significant for response inhibition (TN-E), it was not surprising that the amount of variance explained by the model was low ($R^2 = .08$).

In the regression model for concentration performance (CP) none of the variables tested were statistically significant. As with response inhibition (TN-E), the only variable to approach significance in the first step was hours of sleep ($\beta = -.19$, $p = .08$), while no variables approached statistical significance in the second step. The amount of variance explained by the model was lower for concentration performance than for response inhibition ($R^2 = .04$), which is consistent with the lack of statistical significance.

Table 5

Hierarchical Multiple Regression Results for Total Number minus Errors (N=95)

| Observation and Variable | <i>B</i> | <i>SE B</i> | β | <i>P</i> |
|---|----------|-------------|---------|----------|
| Dependent Variable: Total Number minus Errors (TN-E) | | | | |
| Observation 1 | | | | |
| In past week, have you consumed alcohol? | -2.41 | 5.31 | -0.05 | 0.65 |
| How stressed were you in the past week? | -8.17 | 7.25 | -0.12 | 0.26 |
| In past week, how many hours of sleep on average did you get per night? | -11.08 | 6.36 | -0.18 | 0.09 |
| Observation 2 | | | | |
| In past week, have you consumed alcohol? | -1.17 | 5.27 | -0.02 | 0.83 |
| How stressed were you in the past week? | -6.92 | 7.17 | -0.10 | 0.34 |
| In past week, how many hours of sleep on average did you get per night? | -8.92 | 6.37 | -0.15 | 0.17 |
| Yoga or dance class | 25.45 | 13.27 | 0.20 | 0.06 |

Table 6

Hierarchical Multiple Regression Results for Concentration Performance (N=95)

| Observation and Variable | <i>B</i> | <i>SE B</i> | β | <i>P</i> |
|---|----------|-------------|---------|----------|
| Dependent Variable: Concentration Performance (CP) | | | | |
| Observation 1 | | | | |
| In past week, have you consumed alcohol? | -0.79 | 3.30 | -0.03 | 0.81 |
| How stressed were you in the past week? | -4.49 | 4.50 | -0.10 | 0.32 |
| In past week, how many hours of sleep on average did you get per night? | -7.11 | 3.95 | -0.19 | 0.08 |
| Observation 2 | | | | |
| In past week, have you consumed alcohol? | -0.17 | 3.30 | -0.01 | 0.96 |
| How stressed were you in the past week? | -3.86 | 4.48 | -0.09 | 0.39 |
| In past week, how many hours of sleep on average did you get per night? | -6.01 | 3.98 | -0.16 | 0.13 |
| Yoga or dance class | 12.90 | 8.29 | 0.16 | 0.12 |

Chapter 5: Discussion

Interpretation of Findings

This study compared the effects of participation in yoga and aerobic classes on attention in young adults. The question the researchers asked was whether or not young adults who attended yoga classes would show increased selective attention and mental concentration beyond that of an aerobic exercise control group. The first hypothesis was that participants who took two yoga classes or physical activity

classes would both show increased attention scores. A second hypothesis stated that participants who took two yoga classes would have higher attention scores over those of the participants who took two physical activity classes. Both selective attention and mental concentration scores were statistically significantly higher after class participation for both the aerobic and yoga groups. This suggests that instructional physical activity correlates with an increase in attention immediately following the activity, which supports our first hypothesis. Thus, both yoga and aerobic groups appeared to experience an increase in attention following participation in their respective activity.

Examining the data more specifically, the analysis of the response inhibition (TN-E) score showed that participants of the instructional aerobics class had scores that were statistically significantly higher than those of the participants in the instructional yoga class. Because of this result, it was determined that young adults who attend yoga classes do not show increased selective attention beyond that of an aerobic exercise control group which does not support our second hypothesis. Instead, the instructional aerobic class improved the participant's attention significantly greater than the yoga class.

Although the response inhibition (TN-E) scores discussed above suggest that the scores of the aerobics group significantly increased with respect to the yoga group, this relationship was not seen when looking at the concentration performance (CP) score. Concentration performance is said to be a more reliable measure of attention as it is slightly more sensitive to response patterns which allow one to selectively cross out symbols while ignoring distracters (Brickenkamp & Zillmer,

1998). The results from this test showed that there were no statistically significant differences between the yoga and aerobic groups after participation in their respective classes. In sum, participation in either a yoga and aerobics class results in the same amount of increase in one's attention.

Comparison with Literature Review

The findings of this study are consistent with some of the literature regarding the relationship between yoga and attention. As with this study, Sahasi (1984) found a statistically significant improvement in attention scores after yoga intervention. The guided aerobic fitness group in this study also exhibited increased attention scores, which is consistent with the results found by Budde et. al. (2008). Studies conducted by Valentine and Sweet (1999) and Sarang and Telles (2007) asserted that meditation and yoga-based relaxation techniques would improve attention; these assertions were supported by the findings of the current study as the yoga group produced increased attention scores after participation in the class, but it is unclear how much of an effect meditation had individually on attention. Since the post intervention yoga scores did not surpass those of the aerobic group, it was unclear whether the mechanism that increased attention was unique for yoga.

Although both groups seemed to show significant increase in attention post-intervention, the results did not provide a way to determine the mechanism for this increase. Both meditation and physical activity have been shown to increase attention (Hillman, Castelli, & Buck, 2005; Kratter & Hogan, 1983), therefore it is possible that the two groups' attention scores increased for different reasons. The instructional aspect of the aerobics classes, specifically the dance classes, could have contributed

to the increase in attention since the participants had to actively pay attention, listen, and follow the instructor. This sustained attention throughout the class may have contributed to their improved performance on the d2 test. Also the faster movements in the dance class may have allowed more blood to pump to the brain which may have contributed this group's increased attention scores more prominently than the yoga group's, which is consistent with what Budde, et. al, (2008) said about aerobic activity increasing heart rate. The yoga group may have improved due to a combination of the physical aspects of yoga, paying attention to the instructor for the postures, and the meditative component in yoga. All in all, due to the multiple variables of movement speed, meditation, and guided practice, it is unclear to which particular aspect of these exercises contributed the most to the increase in attention, but it can be assumed that all of these factors contributed to it together.

Since both groups of participants in this study took part in classes requiring physical activity and since both demonstrated increases in their attention scores, physical activity is the most consistent intervention that may have triggered the mechanisms that improve scores of attention. In line with the previous research concerning the cognitive effects of physical activity, such as Budde et. al. (2008) which found that coordinated exercise increases one's attention, this study found that physical activity does correlate with an increase in attention. These results support the hypothesis that short-term practice of yoga and other forms of physical activity has a positive effect on the attention of young adults. Several other studies have found similar results, supporting the argument that physical activity increases

attention and other cognitive functions such as memory and perceptual skills (Hillman, Erickson, & Kramer, 2005; Hillman, Castelli, & Buck, 2005).

Other sources suggest that additional factors may contribute to improved attention. For example, Budde et. al. (2008) suggested that the increased heart rate that occurs during a more strenuous activity may contribute to a greater increase in attention. The mindfulness meditative aspect during yoga practices has been suggested to lower resting heart rates (“Simple Ways to Beat Stress,” 2008). Therefore, it is possible that each group showed an increase in attention for different reasons. The aerobic group may have shown an increase in attention due to increased heart rate, while the yoga group showed an increase due to meditation. In contrast, other studies have found that short-term aerobic exercise lowers resting heart rate following an exercise session (Shephard & Balady, 1999; Fort et. al, 1979). This consistency between lowered resting heart rate for both short-term yoga and short-term aerobic exercise practice offers further insight into the increased attention for both activities that were found in this study.

This study used novice yoga students rather than experienced yoga students. As the attentional benefits of the experienced yoga students may have leveled off over time, it was important to use students who were inexperienced in order to maintain that an increase in attention was due to short-term yoga practice and not to other factors. We focused on mindfulness rather than other more complex meditative practices because effective meditation requires practice that students in beginning classes would not have. More experienced students could be examined in a future study as they are more familiar with postures and techniques of yoga and would

presumably have more skill at attaining a desired meditative state. The newer students, however, would focus much more on simply trying to do the various positions and not have the chance to fully participate in the complex meditation practices. Also, looking at experienced students of yoga would be beneficial to the field as one could see the effects of the deeper levels of meditation on attention. For this study, however, it was practical to look at beginner classes as the average college student is not a well trained yogi, but much more inexperienced. This aspect increases the external validity, or the ability to generalize the findings of this study to a realistic population in the study's age group.

Limitations

While this study resulted in important findings that will contribute to the literature in this area, it is important to address the limitations. First, it is important to consider is that, in the interest of obtaining an adequate sample size, participants were recruited from various yoga and aerobic classes, often led by different instructors. Although numerous instructors, each with their own teaching style, taught the yoga classes, the content and level of these various classes were the same. All of the participants in the yoga group practiced forms of Ashtanga yoga and all participants were enrolled in beginner courses; however, it is possible that the personal styles of the different instructors may have influenced the extent to which meditation was a focus of the different yoga classes. Some instructors employed more meditation and mindfulness exercises than others and the various skill levels of the participants may have hindered some of them from reaching any kind of meditative or mindful state as it takes practice to do so. This issue may have

decreased the study's ability to specifically investigate the effects of mindfulness and rule out confounding variables, as not all of the participants took part in mindfulness meditation either due to the class structure or lack of ability.

Participants in the aerobic group were recruited from a variety of classes, including cycling and different types of dance, a diversity which could have caused unforeseen variations in the results. Many of the classes used for the aerobic control group did not completely fit the definition of aerobic activity. Specifically, all of the classes did not have continuous physical movement; it was interrupted at times due to the instructional component of the class. In the dance classes, for example, the instructor would show the dance move and talk about technique while the participants watched and listened. Only after that would the participants begin trying the movements. Therefore, this class style resulted in non-continuous movement throughout the class. The only class that had continuous movement during the entire length of the session was cycling, but participants from cycling were only a small number of the total aerobics participants used in the study.

The cycling class, which included less instruction, might have lacked the increased attention instruction has been shown to give. At the same time, more aerobic aspects of the cycling might have led to higher heart rates, which have been shown to correlate with higher attention. It is important to better isolate the various mechanisms at play in these classes. This study only looked at the meditative aspect of yoga as the differences between the classes, but looking at how instruction and aerobic activity can affect attention both with and without meditation is also key. Despite these variables possibly decreasing the internal validity of the study, they

may have served to increase its external validity. In a natural setting, it is realistic to expect that there will be different instructors with various teaching styles, teaching different classes. In future studies one could examine and compare more aerobically vigorous classes to less intense classes.

Some discrepancy could also have arisen from the diverse motivations participants had for taking part in this study. The variation in the prices and times of classes may have affected participants' decisions to enroll in a class, a factor that may have impacted the results of this study. Furthermore, given the variety of recruitment methods used, participants may have had different motives for participating in the study, ranging from taking part in a free class to receiving a gift card or, in some cases, simply having an interest in the area of research. The potential impact of this limitation was reduced, however, by demonstrating that there were no statistically significant differences between groups based on the initial measurement of attention and the survey of other potentially confounding variables (e.g., alcohol or drug use, sleep, and stress).

Due to the different times and locations of the classes, the assessment sessions were conducted in a variety of different settings, which may have had different levels of background noise. Noise, could be viewed as an external stimuli, could not be controlled for. Nonetheless, conditions generally remained the same each week for each respective testing session.

Although the demographic survey showed no statistically significant differences between the yoga and aerobic groups on many variables, there were some potentially confounding variables that were not analyzed. The demographic survey

requested information about participants' grade point average (GPA), as it has been previously demonstrated that a high GPA correlates with higher levels of attention (Brickenkamp & Zillmer, 1998). However, there were discrepancies in the way that participants reported GPA. Some participants may have reported their high school GPA, which may not correspond to college-level GPAs. In addition, 17 participants neglected to provide any number for GPA. Due to these inconsistencies in responses, GPA was omitted from the analysis. Future studies could investigate the potential role of GPA in the correlation between physical exercise and attention or, at a minimum, control for potential differences related to GPA. The demographic survey also did not include a questions that asked if the participants had been diagnosed with ADD or ADHD which may have affected the results by decreasing their attention scores (Kratzer, 1982). However, as both groups' d2 score tests at observation 1 were statistically similar, even if some participants had ADD or ADHD, it was assumed that both groups had participants with similar attention capacities or maladies.

In addition, the questions on the behavioral survey regarding the use of drugs or medications were not specific in that the survey did not ask participants to specify which medications they were taking. As a result of the wording on the behavioral survey, participants who were prescribed a non-attention affecting medication could have answered the question the same way as participants who were taking an attention affecting medication, such as Adderall, a prescription drug used to treat ADD. Thus, the possibility of specific medications having a direct or indirect effect on attention should be considered and controlled for when measuring this construct in the future. It was found from the behavioral surveys that the participants' use of

medication were statistically the same at both observation points. Even if participants were taking medication that affected their attention, they took them consistently, meaning that the difference in attention should not be due to medications.

Another limitation to consider is the fact that the study did not assign participants to their interventions. The participants were recruited to this study from classes in which they were already taking part. In general, the limitation of a quasi-experimental design is that it does not have a random selection of the participants, potentially impacting the internal validity of the study. Alternative explanations of group differences are viable because it was impossible to control for all potential pre-existing group differences.

Chapter 6: Conclusion

Implications for Future Research

The results and limitations of this study demonstrate the need for additional research regarding the effects of yoga on cognitive functions. There are many possible directions in which this research could be taken. In addition to the immediate effects of yoga on cognitive functions which were explored in this study, future research may investigate the long-term effects of practicing yoga. One could look at either long term intervention of a beginner's yoga class and its immediate effects on attention at various points throughout the study. Alternatively, one may want to see if the attentional effects of yoga are still present several days or weeks after the yoga has ended and determine the duration of the effects. Further research could also include doing similar studies on experienced yoga students and experienced aerobic students to see if a difference exists.

Another related research project could include comparing different types of physical activities to each other, in an effort to determine if such variations impact attention differently. For example, aerobic activities such as cycling, ballroom dancing, and kickboxing could be compared to one another to determine if each produces a different effect on attention. The same could be done for different types of meditative yoga. Further studies could compare classes taught by an instructor to unguided individual practice of yoga or aerobic activity. Varying age groups could be considered as well.

It has been mentioned that physical activity has an effect on attention. In the future, researchers could measure physiological factors, such as heart rate to

determine if cardiovascular function increases attention. Physical activity also increases breathing rate, augments blood flow to various parts of the body, and can have impacts on one's metabolism. All of these aspects and more could be investigated to see their affect on attention.

A future study could compare yoga classes to pilates classes to test the effect of meditation on one's attention. A Pilates class includes the postures and movement of yoga, but lacks its meditative aspects, and a comparison of these more similar exercises could help determine if the meditative aspects of yoga are related to increased attention. Because pilates is so similar to yoga in terms of the physical movements that are performed, it would be an interesting study to compare these two exercises as the meditative aspect of yoga could be better isolated as the main difference between the two classes.

In addition, researchers could look at longer term yoga practice. If a participant has become familiar with yoga, then they could be faster at falling into states that induce meditation. Also, practicing yoga for long term may allow a participant to immediately gain greater awareness and mental flexibility. Researchers could investigate these claims regarding these effects of advanced understanding and if it is unique to yoga, or if advanced skills in other practices share the effect. For example, the attention of experienced yoginis could be compared with the attention of experienced dancers to determine if specialization in a particular exercise would produce far more statistically significantly different results.

Further insight regarding the effects of physical activity on attention may be gained by repeating this experiment using a wait-listed control group that performs no

physical activity. The wait-list control would then be used as a baseline to further support the assertion that it was the physically active component of yoga and aerobics that contributed to the increase in attention. If this study is replicated then it would be interesting to see if a complete experimental design including random participant assignment could be implemented. This research design would allow for stronger evidence of the correlation between physical activity and attention and would dispel concerns about how much motivations and interest in the course contributed to an increase in attention. It is also recommended that a higher number of participants be recruited in order to test for a smaller effect size. If more participants are recruited, researchers could determine the size of the effect that yoga has on attention and how it compares with the effect size produced by other forms of physical activity.

Practical Implications

Overall, the results of this study support the recommendation that young adults participate in an instructional class of either aerobics or yoga directly before an activity that would require heightened attention. These activities may include studying, taking exams, interviews, and giving presentations. The findings in this study suggest that physical activity will increase attention and may help improve performance on tasks on which attention is required.

The results of this study have many practical applications. University campuses could use the recommendations of this study to inform the student body of the benefits of physical exercise on attention and create programs to encourage such behavior. Classes at campus recreation facilities or even the counseling center could create a class that has students take part in some physical activity during the class.

Additionally, organizations that cater to young adults may want to have sessions where they facilitate discussion and provide information on how these exercises positively affect attention. These effects would be particularly beneficial to those utilizing learning assistance services on campus. Learning assistance centers and counseling centers could also use these findings to support their implementation of physical activity into their recommended curriculum when students seek assistance.

The researchers are contributing to their own University community by continuing the yoga classes that were initially offered as a part of the study. These free weekly classes are well attended, and may be used by these students to aid their attention in a variety of tasks, including studying, or to introduce yoga to students in the hopes that they will realize the benefits to be derived from its practice.

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Appendices

Appendix A

Notification Emails to Potential Participants

Generic Email to Class Members

Dear [Class Participant],

Would you like to participate in cutting edge cognitive research?

Are you between the ages of 18 and 25?

The members of Gemstone Team Om would like to invite you to participate in our research study examining the relationship between physical activity and mental fitness. Participation involves a simple pencil paper test and a few minutes of your time.

Look forward to seeing a member of Team Om at your next exercise class. If you have any questions, please contact Team Om at gemsteamom@gmail.com.

Sincerely,

Gemstone Team Om

Appendix B

LISTSERV Advertisement for Team Om Study and Free Yoga Classes

If you are between the ages of 18 and 25, the members of Gemstone Team Om would like to invite you to participate in our research study examining the relationship between physical activity and mental fitness. Participation in this cutting edge cognitive research involves attending 2 FREE yoga classes, two surveys and a simple pencil paper test, taking just a few additional minutes of your time. Classes will occur on [date] at [time] in the basement lounge of Anne Arundel.

Please contact Team Om at gemsteamom@gmail.com to participate in this excellent opportunity!

Other LISERSERV Announcement

Would you like to participate in cutting edge cognitive research and go to a free yoga class?

Would you like to get a \$10 gift certificate to a gourmet coffee shop?

Are you between the ages of 18 and 25?

The members of Gemstone Team Om would like to invite you to participate in our research study examining the relationship between physical activity and mental fitness. Participation involves a simple pencil paper test and a few minutes of your time, as well as taking part in an instructed yoga or fitness class.

If this sounds great to you, please contact Team Om at gemsteamom@gmail.com.

Appendix C

Flyer Advertisement

Attend 2 FREE Yoga Classes!



Relieve Stress and Exercise Your Mind!
Participate in Cutting Edge Research!
Earn a \$10 Gift Card for Coffee!

Classes are **month, date, time** and **month, date, time** in
the Basement of **Queen Annes Hall**

Contact
GemsTeamOm@gmail.com
Contact
GemsTeamOm@gmail.com
Contact
GemsTeamOm@gmail.com
Contact
GemsTeamOm@gmail.com
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GemsTeamOm@gmail.com

Appendix D

Recruitment Script

When we first meet with the subjects we will introduce ourselves:

“Hello, we are members of the Gemstone Research Team Om, and we want to thank you for your interest in our study.”

Then we will pass out the consent form and the demographic survey, and go over some main points from the consent form and see if they have any questions about how the study will be conducted:

“We are now passing out a consent form for you to sign and a survey we would like you to fill out to the best of your ability. This study is designed to determine the effects of regular physical activity on attention. At the top of your consent form you should see a number; this number will be used to identify your data. This will serve to keep your personal information confidential, as your name will not be included on the surveys or other collected data. You will be asked to provide contact information so that you can be reminded of your participation. By providing this information you are agreeing to allow us to contact you. If you decide to withhold this information, you will not receive any study reminders.

In addition to the exercise classes for which you are registered, we ask that you commit a maximum of 30 minutes for data collection. This is split between two administrations. The initial administration should take place next week before your class and will take at most 15 minutes of your time. The second administration, which will take place immediately after your following class after the next (in two weeks), will also take at most 15 minutes.

After completion of the study you will be eligible to receive [an incentive of a \$10 value]. You will be asked to provide your home address and UID or SSN in order to receive the incentive in the mail. All identifying information will be kept separate from your data, and you are not required to give this information if you are not interested in receiving [the incentive.] Does anyone have any questions?”

Appendix E

Consent Form

Page 1 of 2

Initials _____ Date _____

CONSENT FORM

| | |
|---|--|
| Project Title | <i>Physical Activity and its Effect on Mental Fitness</i> |
| Why is this research being done? | <i>This research project is being conducted by Dr. Christa Schmidt and Gemstone Team Om at the University of Maryland, College Park. We are inviting you to participate in this research project because you are taking an instructional yoga or aerobics course affiliated with the University of Maryland and you are between the ages of 18 and 25. The purpose of this research project is to determine the relationship between physical and mental fitness in young adults between the ages of 18 and 25.</i> |
| What will I be asked to do? | <i>The procedure involves attending 2 consecutive classes in the course you are taking; you will be asked not to participate in any other instructor-led yoga or aerobics practice during the study. After you sign this consent form, you will be asked to complete a short demographic questionnaire, and to provide Team Om with your contact information for reminder purposes. Provision of contact information is voluntary and the decision not to disclose this information will not exempt you from participation in the study. This initial session should take approximately 5 minutes. The first series of measures will be administered before one of your exercise classes. The second will be administered after your next weekly class. At each session you will be asked to complete a short measure that involves finding and crossing out target symbols with a pencil and a short behavioral survey, which includes questions about your drug and alcohol consumption. We ask that you complete all measures to the best of your ability and as honestly as possible. These sessions will take approximately 15 minutes each. At the end of data collection, you will receive an incentive of a \$10 value provided you completed all parts of our study and fill out an incentive information form, which will ask for your contact information, UID or SSN, and mailing address. Disclosing this information is voluntary, but necessary in order to receive the incentive. It will only be shared with the Gemstone financial coordinator. Overall, you will be asked to participate in approximately 2-3 hours of instructional exercise and approximately 35 minutes of testing sessions. The research will take place in University of Maryland affiliated facilities.</i> |
| What about confidentiality? | <i>We will do our best to keep your personal information confidential. To help protect your confidentiality: (1) your name and contact information will be kept separate from any collected data; (2) you will receive a personal identification number that will be used to identify all collected data; and (3) only the researchers will have access to the identification key and contact list. The release of contact information is voluntary and optional. We will store this information in a locked filing cabinet in a locked office at University of Maryland, College Park within 24 hours of obtaining the information and at all times except when it needs to be referenced during data collection. We will destroy all hardcopy data at the completion of our project. We will make and keep an electronic copy of the contact information and the identification key. If we write a report or article about this research project, your identity will be protected to the maximum extent possible. Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law. Information collected for the purpose of receiving the incentive will be disclosed to the financial administrator of the Gemstone program.</i> |

| | | |
|--|---|--|
| Project Title | <i>Physical Activity and its Effect on Mental Fitness</i> | |
| What are the risks of this research? | <i>There are no known risks associated with participating in this research project beyond the risks associated with exercise which were outlined in your contract with the course's facility.</i> | |
| What are the benefits of this research? | <i>This research is not designed to help you personally, but the results may help the investigator learn more about the effects of physical activity on mental fitness. We hope that, in the future, other people might benefit from this study through improved understanding of the correlation between mental and physical fitness.</i> | |
| Do I have to be in this research? May I stop participating at any time? | <i>Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be eligible to receive the incentive offered at the end of the study.</i> | |
| Is any medical treatment available if I am injured? | <i>The University of Maryland does not provide any medical, hospitalization or other insurance for participants in this research study, nor will the University of Maryland provide any medical treatment or compensation for any injury sustained as a result of participation in this research study, except as required by law.</i> | |
| What if I have questions? | <p><i>This research is being conducted by Dr. Christa Schmidt of the Department of Psychology at the University of Maryland, College Park in conjunction with Gemstone Team Om. If you have any questions about the research study itself, please contact Dr. Schmidt at: 1125 Shoemaker Building, University of Maryland, College Park, Maryland, 20742; (e-mail) schmidtc@umd.edu; (telephone) 301-314-7656</i></p> <p><i>If you have questions about your rights as a research subject or wish to report a research-related injury, please contact: Institutional Review Board Office, University of Maryland, College Park, Maryland, 20742; (e-mail) irb@deans.umd.edu; (telephone) 301-405-0678</i></p> <p><i>This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.</i></p> | |
| Statement of Age of Subject and Consent | <p><i>Your signature indicates that:</i></p> <p><i>you are between the ages of 18 and 25;</i></p> <p><i>the research has been explained to you;</i></p> <p><i>your questions have been fully answered; and</i></p> <p><i>you freely and voluntarily choose to participate in this research project.</i></p> | |
| Signature and Date | NAME OF SUBJECT | |
| | SIGNATURE OF SUBJECT | |
| | DATE | |

Appendix F

Demographics Survey

Demographics Survey for All Participants

1. ID Number _____

2. Age: _____

3. Gender: male ___ female ___

4. Cumulative GPA : _____

5. Why did you decide to take this class? (please check all that apply)

enjoy yoga or dance _____ recovery/injury _____ socially/with a friend _____

health benefits _____ relaxation/stress management _____

class recommended _____ other (please fill in) _____

6. Have you ever practiced yoga before?

yes _____ no (skip to question 11) _____

7. If yes, for how long have you been practicing yoga?

Less than one month _____ 1-2 months _____ 3-6 months _____

7 months-1 year _____ 1-2 years _____ 3-5 years _____ 5+ years _____

8. How regularly do you practice yoga?

I do not practice yoga regularly _____ 0-1 hour per week _____

2-4 hours per week _____ 5-7 hours per week _____ 7+ hours per week _____

9. How have you practiced yoga in the past? (please check all that apply)

Class _____ Video _____ Self-Guided _____ Personal Yoga Instruction _____

Other (please fill in) _____

(Continues on reverse)

10. When was the last time you practiced Yoga?

Within the past week _____ One week _____ 2-4 Weeks _____
1-2 months _____ 3-6 months _____ 7 months-1 year _____ 1-2 years _____
3-5 years _____ 5+ years _____

11. Have you ever practiced dance before?

yes _____ no (skip to end) _____

12. If yes, for how long have you been practicing dance?

Less than one month _____ 1-2 months _____ 3-6 months _____
7 months-1 year _____ 1-2 years _____ 3-5 years _____ 5+ years _____

13. How regularly do you practice dance?

I do not practice dance regularly _____ 0-1 hour per week _____
2-4 hours per week _____ 5-7 hours per week _____ 7+ hours per week _____

14. How have you practiced dance in the past? (please check all that apply)

Class _____ Video _____ Self-Guided _____ Personal Instruction _____
Other (please fill in) _____

15. When was the last time you practiced dance?

Within the past week _____ One week _____ 2-4 Weeks _____
1-2 months _____ 3-6 months _____ 7 months-1 year _____
1-2 years _____ 3-5 years _____ 5+ years _____

Appendix G

Behavior Survey for Yoga and Dance Group Members

Behavioral Survey for All Participants

ID Number: _____

1. On how many days in the past week have you consumed alcohol?

circle one: 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7

2. On how many days in the past week have you used prescription medications?

circle one: 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7

3. On how many days in the past week have you used marijuana?

circle one: 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7

4. On how many days in the past week have you used any other controlled substances?

circle one: 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7

5. In the past week, how many cigarettes have you smoked on average per day?

fill in answer: _____

6. How many hours in the past week have you participated in any aerobic activities outside of this class?

fill in answer: _____

7. How many hours in the past week have you participated in any meditative activities outside of this class?

fill in answer: _____

8. In the past week, on average, how many hours of sleep did you get per night?

fill in answer: _____

9. How stressed were you in the past week? (circle one)

Not Stressed - Slightly Stressed - Moderately Stressed - Very Stressed - Extremely Stressed

Appendix H

Administrative Script

Script for the Administration of the surveys and d2 Test of Attention

When we first meet with the subjects we will introduce ourselves:

“Hello and welcome to our study. We are members of the Gemstone Research Team Om, and we want to thank you for your participation.”

Then we will pass out the consent form and surveys, and go over some main points from the consent form and see if they have any questions about how the study will be conducted:

“This study is designed to determine the effects of regular physical activity on attention. You should find your ID number labeled at the top of your d2 test and survey. This ID number will serve to keep your personal information confidential, as your name will not be included on the surveys or any other collected data. In addition to the exercise class you are taking, we ask that you commit approximately 30 minutes for data collection. This is split between two administrations. **To be read at initial administration only:** [This initial administration should take at most 15 minutes of your time. The following administration, which will take place immediately after your class next week, will also take at most 15 minutes.] Does anyone have any questions?”

After the subject receives a recording blank with the front page on top and two soft pencils without erasers, the examiner will briefly explain the general purpose of the test:

“With the help of the following task, I would like to see how well each of you can concentrate on a particular assignment. Please do not turn the page over until you are instructed to do so.

“Now, please fill in your ID number, today’s date, age, sex, handedness, years of education, and occupation. K-12 counts as twelve years plus any higher education. For example, if you are a college sophomore, you have 12 years of grade school plus two years of totaling 14 years of education.”

When they are finished, the examiner will continue with:

“Please pay attention. After the word ‘Examples’ on your recording blank you see three small letters marked with dashes. These are the letter ‘d’ as in ‘dog,’ and each is marked with two dashes. The first ‘d’ has two dashes above it, the second ‘d’ has two dashes below it, and the third ‘d’ has one dash above it and one dash below it, still making two dashes all together. Please cross out every

letter 'd' that has two dashes, regardless of where the dashes are, by making a single line through the letter. Try doing this first with the three examples, then try the practice line. You are not supposed to cross out any of the other letters. Thus, a 'd' which has more than two dashes or fewer than two dashes should not be crossed out, and the letter 'p' as in 'pig' should never be crossed out, no matter how many dashes it has. Do you have any questions right now?"

Any questions arising at this moment will be answered. To assess whether all the subjects have in fact understood the instructions and have marked their answer sheets according, the examiner will continue with:

"Now please look at whether you have crossed out all the correct letters. Every one of the letters in the practice line has a number underneath it. I'll slowly read out the numbers that correspond with the letters which you were asked to cross out. You can see whether you have overlooked any of the letters, or whether you have perhaps crossed out too many. For example, you were expected to cross out the first letter because it is a 'd' with two dashes above it, and then the third letter because it is a 'd' with one dash below and one dash above it. Then you were expected to cross the letter that corresponds with the numbers 1, 3, 5, 6, 9, 12, 13, 17, 19, and 22. Did you cross out all these numbers? Did anybody cross out more letters or few ones? If you have crossed out a letter which you were not supposed to while taking the test, you can correct this mistake by crossing the letter out with a second line. Are there any questions?"

Any questions arising at this moment are answered, and then the following instructions will be given:

"Please do not turn your recording blank over yet. Please put your pencils down for a moment and listen carefully now. Without turning your recording blank over, I will now explain the format of the test. On the other side of your recording blank you will see 14 lines with the same letters you have worked on in the practice line. At the beginning of the test, you should start with the first line, reading from left to right and crossing out each 'd' that has two dashes. This is exactly the same task you did in the practice line. After 20 seconds from the beginning of the test, I'll say: 'Stop, next line' and you will be asked to stop working on the first line and immediately start working on the second line. After another 20 seconds I'll say 'Stop, next line' and you will immediately start working on the next line. If you happen to finish any of the lines before I say 'Stop, next line' please patiently wait until I say to begin the next line to continue the test. We ask you to *work as quickly as you can without making mistakes.*" Are there any last questions?"

The last sentence will be given with equal emphasis on "as quickly as you can" and on "without making mistakes" so that speed of work (and thus the quantity of

performance) and degree of carefulness (avoiding errors) are equally highlighted. If there are no questions at this point, the instructions will continue with:

“Now, please turn the page over, so that the first line is on top. In the upper left hand corner you will see an arrow pointing to where you should start working on the first line.”

As soon as all participants have turned over their test forms according to the instructions, they will be told:

“Pick up your pencil and when I give the order start working on the first line. Ready! Set! Go!”

The stop watch will be started at “Go!” and after 20 seconds the examiner will call “Stop, next line” which will be repeated every 20 seconds until the test is complete, at which point timing will be stopped.

Team Om members who are present will then collect the recording blank and pass out the behavioral survey.

“We are now passing out a behavioral survey. Please fill it out as honestly as possible and to the best of your ability.”

Team members will collect the behavioral surveys.

Only at first session:

“This completes this phase of our study. Thank you again for your participation. We will see you again next week, immediately after your class.

Only at second session:

Team members will hand out the incentive information form.

“To receive your incentive, please fill out this form.”

Team members will collect the incentive information form.

“Thank you again for your participation.”

| TN | E ₁ | E ₂ | CP |
|----|----------------|----------------|----|
| 1 | " | " | " |
| 2 | " | " | " |
| 3 | " | " | " |
| 4 | " | " | " |
| 5 | " | " | " |
| 6 | " | " | " |
| 7 | " | " | " |
| 8 | " | " | " |
| 9 | " | " | " |
| 10 | " | " | " |
| 11 | " | " | " |
| 12 | " | " | " |
| 13 | " | " | " |
| 14 | " | " | " |



Appendix J

Incentive Information Form

“In appreciation for participating in the project for the Gemstone Team Om, I acknowledge receipt of [incentive of \$10 value] for my participation.”

Please check here if you are an employee of the University:

Name:

Student UID # (or Social Security #): _____ - _____ - _____

Home Address: _____

City _____, State _____

ZIP _____

Signature: _____

Date: _____