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The Effects of Yoga and Aerobic Exercise on Concentration and Feeling-States

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Abstract

The impacts of yoga and aerobic exercise on level of concentration and change in feeling-states were examined in this study. They hypothesis was that concentration and feeling-states would improve over a yoga and aerobic exercise session, but yoga, a combination of exercise and meditation, was expected to produce greater positive changes than aerobic exercise. Participants included 70 students from Roger Williams University, 27 male and 43 female. 34 took part in 30 minutes of yoga and 36 took part in 30 minutes of aerobic exercise. Concentration levels and feeling-states improved significantly over sessions of both yoga and aerobic exercise sessions equally. Results indicate that aerobic exercise and yoga both produce positive changes in concentration, stress, energy, and well-being while only yoga produces improvements in mood and self-satisfaction.

Keywords: aerobic exercise, yoga, concentration, feeling-state

The Effects of Yoga and Aerobic Exercise on Concentration and Feeling-States

A period of exercise often induces feelings of rejuvenation, energy, and alertness. Through examining the causes and effects of these feelings, it has been found that exercise positively influences physical and mental health as well as, mental capabilities as well (Heckler & Croce, 1992; Kubesch, Walk, Manfred, Kammer, Lainburg, Heim, & Hille, 2009; Lichtman & Poser, 1982; Masley, Roetzheim, & Gualtieri, 2009). Yoga is a type of exercise that incorporates deep breathing, the calming voice of an instructor, and holding static positions that work the body's muscles. Yoga has been studied and found to have positive effects on physical fitness, mood, anxiety level, and cognitive functioning (Abadi & Venkatesan, 2008; Berger & Owen 1992; Netz & Lidor 2003; Prakash, Dubey, Abhishek, Gupta, Rastogi, & Siddiqui, 2010; Ross & Thomas, 2010; Streeter, Jensen, Perlmutter, Cabral, Tian, Terhune, & Renshaw, 2007; Subramanya & Telles, 2009). However, findings have been contradictory in both exercise and yoga research, as results have shown both facilitative and inhibitory effects on cognitive functioning and mood among studies (Tomporowski, 2003). In his review of research, Tomporowski (2003) suggested that type of exercise, physical fitness of the participant, and length of exercise may all be factors uncontrolled for among studies that explain the discrepancies in findings. Based on the results of studies analyzed, Tomporowski (2003) asserted that under conditions of ideal type and length of exercise and ideal fitness of participant, exercise assists a person in blocking irrelevant information in the brain, thereby facilitating that person's response speed and accuracy in cognitive processes (Tomporowski, 2003). This conclusion necessitated research to define what types and lengths of exercise facilitate cognitive processes.

Effects of Exercise on Mental Functioning

Some studies found effects from long term exercise, while others discovered effects from short-term. Lichtman and Poser (1982) have found immediate effects of a single exercise session on mental functioning. It was found that participants scored higher on measurements of cognitive functioning and had greater mood improvements (participants reported feeling happier) after an exercise class than after a hobby class. These findings led the authors conclude that short bouts of exercise have a positive effect on cognitive functioning and mood states (Lichtman & Poser, 1982). The findings of this study were directly contradicted by Tomprowski and Ganio (2006) who found both exercise and a control session to produce positive improvements in concentration.

However, Kubesch et al. (2009) reinforced the results of Litchtman and Poser (2006) by finding that participants' scores of attention improved more greatly after a 30 minute aerobic exercise period but not after a 30 minute control period or 5 minute movement break (Kubesch et al., 2009). This study shows that the exercise period must last for a substantial amount of time in order for a positive impact on cognition to be achieved.

Heckler and Croce (1992) attempted to find whether physical fitness and length of exercise may be factors that influence scores on cognitive tasks after exercise. Results of this study showed that less fit women performed well on cognitive tasks after short periods of exercise, but poorly after long periods of exercise (Heckler & Croce, 1992). This demonstrated to Heckler and Croce (1992) that exercise has facilitative effects until endurance is compromised; leading them to conclude that physical fitness of the participant determines the effects of exercise.

Effects of Yoga and Meditation on Cognitive Function and Mood

Yoga is a form of exercise that differs from aerobic exercise because of its meditative component. There have been many studies conducted on meditation and significantly fewer have been conducted on yoga. As will be described below, the positive effects of meditation have been shown to be numerous. Since meditation is a large component of yoga, it is important to investigate yoga further to determine the role that meditation may play in producing positive effects during yoga.

Prakash et al. (2010) conducted a study to test the long-term effects of practicing Vihangam yoga meditation. The researchers examined experienced yoga meditators by measuring attention levels after meditating. It was found that attention scores were significantly higher for participants after a mediation session than for participants who had not taken part in a meditation session (Prakash et al., 2010). The authors postulated that because yoga meditation requires focusing on a specific point, the individual learns to control conscious thought and keep it focused (Prakash et al., 2010). This study shows the long term benefits for concentration that can be produced by meditation.

The effects of short-term mindfulness meditation practice on mood, anxiety, and cognitive function were studied in an experiment conducted by Zeidan, Johnson, Diamond, David, and Goolkasian (2010). The researchers found that negative mood, fatigue, and anxiety were reduced and performance on cognitive tasks was improved after a session of meditation (Zeidan et al., 2010). This shows that short bouts of meditation can produce improvements in cognition.

Kumar and Telles (2009) conducted a thorough study of meditation by examining the effects of four different states of meditation on attention and concentration measured by a letter-

cancellation task. Results showed a significant increase in attention and concentration from before to after meditation when participants were in a meditative focusing state compared to other states of meditation and the control group (Kumar & Telles, 2009). The authors concluded that meditative focusing may be the state of meditation that increases attention processes, while other states of meditation may not have the same effect (Kumar & Telles, 2009). The study mentions that meditative focusing is often the "default" state of meditation used during yoga, accounting for the positive effects of meditation found in combination with yoga (Kumar & Telles, 2009). The following study illustrates the benefits of long-term yoga.

Abadi and Venkatesan (2008) studied the effects of yoga on children with ADHD in reducing their distractibility and improving their symptoms. It was found that yoga produces positive changes in the children after 8 weeks of yoga practice (Abadi & Venkatesan, 2008). This study indicated that yoga has an impact on reducing distractibility and possibly improving ability to concentrate (Abadi & Venkatesan, 2008).

In contrast, an experiment by Kimbrough, Balkin, and Rancich (2007) found that certain yoga poses had no effect on some cognitive functions. The researchers tested the effects of inverted yoga positions on short-term verbal memory (Kimbrough et al., 2007). No results indicating an effect of yoga on cognitive function were found (Kimbrough et al., 2007). This study only looked at specific yoga poses, and not a cohesive yoga session including meditation.

Subramanya and Tells (2009) conducted a study comparing yoga with meditation to see whether their effects on memory and anxiety would differ. Yoga was found to be associated with improvement on a cognitive task of attention and concentration (Subramanya & Telles, 2009). From the results, the researchers concluded that yoga has a greater positive effect on attention than simply meditating for the same amount of time (Subramanya & Telles, 2009). These

findings indicate that yoga produces greater improvement on attention and memory scores when compared meditation (Subramanya & Telles, 2009).

The research indicates that exercise and meditation have positive effects on cognitive functioning and mood. Because yoga is a combination of exercise and meditation, it seems possible that yoga would produce a greater positive change in concentration and mood than either of the two alone. It is known from the last mentioned study that yoga produces improvements greater than meditation alone, but now must be compared to exercise to see whether it produces greater results.

Comparisons of Yoga and Aerobic Exercise

Ross and Thomas (2010), in an extensive review of the literature, found that yoga has had equal and often superior health benefits on individuals when compared to other forms of exercise (Ross & Thomas, 2010). In many studies, the physiological effects have been observed even after a period of yoga or exercise. Although both types of exercise have positive effects on mood, physiological differences in stress levels exist between the two (Ross & Thomas, 2010). Exercise has been shown to increase levels of the stress hormone, cortisol, while yoga has been shown to cause the levels to decrease (Ross & Thomas, 2010). Other physiological effects have been observed in the practice of yoga, and the authors asserted that further research must be conducted to compare how benefits differ between exercise and yoga (Ross & Thomas, 2010).

The specific changes produced by yoga were studied by Streeter et al. (2007) in an experiment looking at Gamma-Amniobutyric Acid (GABA) levels in the brain during and after yoga practice. Past research has shown that low GABA levels in the brain are associated with mood disorders such as depression and anxiety (Streeter et al., 2007). Results showed that GABA levels in the brain increased by about 27% over the session of yoga (Streeter et al., 2007).

This showed that yoga produced a physiological change associated with a subjective mood change, in at least one psychological state.

The physiological changes brought on by yoga are mirrored in participants' subjective experiences of mood and stress level. Not only is it known that yoga produces physiological changes that affect mood and stress levels, participants in studies also have reported improvements in mood and decreased stress over a session of yoga. Berger and Owen (1992) compared yoga to aerobic swimming and found that both produce about equal improvements in reported mood.

A later study by Netz and Lidor (2003) also compared yoga to aerobic exercise to observe the subsequent effects on psychological states. Results showed scores of lower anxiety and higher subjective well-being in the yoga and swimming participants compared to aerobic dance and control participants (Netz & Lidor, 2003). The authors inferred that swimming and yoga induce similar mental states, due to the nature of them both being isolated, personal forms of exercise where one focuses inward, rather than outward (Netz & Lidor, 2003). Yoga and swimming were shown by this study to produce positive changes in mood, just as Berger and Owen (1992) discovered. From the findings, Netz and Lidor (2003) concluded that yoga produces a greater positive effect on psychological states than aerobic dance.

Past research has clearly shown that both short and long term bouts of aerobic exercise can produce positive changes in cognitive functioning (Heckler & Croce, 1992; Kubesch et al., 2009; Lichtman & Poser, 1982; Masley et al., 2009).Research on meditation shows that both long and short term periods of meditation can increase a person's ability to inhibit irrelevant stimuli and concentrate on cognitive tasks (Kumar & Telles, 2009; Prakash et al., 2010; Zeidan et al, 2010). Exercise and yoga have been compared on many levels of health, but not on the

impact on cognition. Yoga has been shown to produce greater positive changes in mood than exercise, and has been shown to produce greater improvements in cognition than meditation. Yoga and exercise have yet to be compared in their effects on cognitive function and some feeling-states (such as self-satisfaction and motivation).

In the present study, the effects of yoga on concentration level and subjective feeling-states were compared with the effects of aerobic exercise; scores were interpreted by performance on a cognitive task and subjective assessment of feeling-states. Because past studies have examined cognitive outcomes of exercise, yoga, and meditation separately, it was seen as important to compare yoga and exercise to see whether one has a stronger effect. Since yoga is a combination of physical movement and meditation, and has been shown to produce stronger effects on cognitive functioning than meditation alone, it was expected that its effect on cognitive performance would be stronger than exercise alone. The hypotheses of this study were that concentration and feeling-states would increase over a session of yoga and a session of aerobic exercise, but improvements would be greater over a session of yoga than a session of aerobic exercise.

Method

Participants

70 undergraduate students (27 men, 43 women) at Roger Williams University participated in the study. The average age of participants was 19.5 and 88.5% of participants identified themselves as white. All participants were enrolled in introductory Psychology and Core courses and took part in the study to fulfill course requirements and receive a $5 gift card to the campus book store, Barnes and Noble. The participants were informed upon registering that they would be taking part in physical activity and should wear appropriate clothing, including

comfortable pants and sneakers. Participants were assigned to the yoga or aerobic exercise group depending on the time they registered for the study.

Materials

Materials used in this study were a projector with DVD capabilities, the instructional yoga video: "Shiva Rea Daily Energy Vinyasa Flow Yoga" (Eckstein, 2009), the instructional aerobic exercise video: "The Biggest Loser: The Workout Cardio Max" (Pozo, 2007), an exercise habit questionnaire, a feeling-state assessment, and a letter cancellation task, derived from the meditation study by Kumar and Telles (2009). One video was used per experimental group. Yoga participants followed the energizing flows through yoga postures and calming, meditative movements of Shiva Rea's video in a 30 minute session (Eckstein, 2009). A more detailed description of the video can be viewed in Appendix B. Aerobic exercise participants followed high intensity physical movements of the Biggest Loser video in a 30 minute workout (Pozo, 2007). Please see Appendix C for a more detailed description.

Procedures

Before participants arrived to the study, the researcher cleared space by moving desks and chairs to the back of the room and against the walls. When participants arrived to the study, they were given a consent form (see Appendix A). The consent form included a statement saying that participants should not take part in the study if they have a health condition that would be affected by exercise, to stop any movement or come out of any position that feels uncomfortable, and that they are free to discontinue participation in the study at any time. These points were reiterated in a verbal statement before the video began (see appendix G for full script). After consent forms were signed, participants were given the letter cancellation task, face down. The following instructions were given to the participants: "You will have 90 seconds to complete this

task. There are six letters at the top of your page; you must cross out each of these six letters every time they appear in the box below. Please work row by row from the top to the bottom in the box of letters." After instructions were given, the researcher told participants to flip their papers over and pressed start on the timer. The researcher stopped participants after exactly 90 seconds and collected the letter cancellation tasks. Once the letter cancellation tasks were completed and collected, participants were handed the questionnaire (with demographics and the exercise habit survey) (Appendix D), and the feeling-state assessment (Appendix E). Once both were completed and collected, participants were told to spread out around the room, making enough space for them to hold their arms straight out to their sides without making contact with others. The researcher pressed play on the video which was already cued to the intended start point. One set of lights were turned off in the room for both experimental groups.

The yoga group followed one of the 20 minute yoga sessions in Shiva Rea's video, which was entitled "Earth", followed by a five minute session of forward bend stretches, and ending with a five minute session of "Shavasana" for meditation (Eckstein, 2009). The aerobic exercise participants followed a 20 minute cardio level one session, and a ten minute cardio level two session from the Biggest Loser workout (Pozo, 2007). Both sessions lasted 30 minutes.

At the completion of 30 minutes, participants had two minutes to move from the center of the room and sit at a table or desk in order to complete the posttest measures. When the two minutes were up, participants were administered a different form of the letter cancellation task, face down (see Appendix F). The same procedure was followed as the first administration of the letter cancellation task. Once the letter cancellation tasks were completed and collected, participants were re-administered the feeling-state assessment. Once all of the assessments were completed and collected, participants were verbally debriefed. The researcher explained that the

study was to examine how different types of exercise affect change in concentration and feeling-states. The researcher then thanked the volunteers for participating in the study, and presented participants with $5 gift cards to Barnes and Noble.

Measures

Two letter cancellation tasks, as used by Kumar and Telles (2009), were used to measure the level of concentration in participants before and after the 30 minute experimental period (see Appendix F). The two letter cancellation tasks were counterbalanced so that half of the participants in each experimental group received one task first and the other second, and the other half received them in opposite order. The task consisted of a block of randomly placed letters in 14 columns and 22 rows with six assigned letters listed at the top of the page which participants were required to cancel within the block in 90 seconds. Scores of concentration on the Letter Cancellation Task were calculated by counting the number of correctly cancelled letters within the grid (Kumar & Telles, 2009). This score represented the speed and accuracy of the participants' completion, and therefore their concentration level (Kumar & Telles, 2009).

The questionnaire, which can be viewed in Appendix D, consists of demographics and a 9-question exercise habit survey which consisted of inquires about how often participants participate in exercise and yoga.

The 22-item feeling-state assessment (Appendix E) measured the participant's subjective well-being. The feeling-state assessment scores were measured on a 5-point Likert scale from that ranged from strongly disagree (1) to strongly agree (5). The feeling-states of stress, mood, motivation, and energy were derived from Netz and Lidor (2003), Berger and Owen (1992), and Zeidan et al. (2010) who assessed feeling-states in their own studies. Three to four statements were included for each of the following categories: mood, stress, energy, concentration, self-

satisfaction, and motivation; all of which were combined to produce a score of overall subjective well-being (Appendix E). Participants indicated their agreement with statements such as "I feel happy" (mood), "I feel anxious" (stress), "I feel tired" (energy), "My mind feels foggy" (concentration), "My body is in a condition that I am satisfied with" (self-satisfaction), and "I want to accomplish something important today" (motivation). For positive statements like "I feel energized", scores were entered exactly how participants indicated on the assessment; if they selected "5", "5" would be entered. Responses to negative statements like "I am upset" were reversed scored. Thus, higher numbers represented positive feeling-states while low numbers represented negative ones. For example, if a person had a high overall score for stress level, this would indicate that the person did not report feelings of stress; their high score represented positive responses to the statements regarding stress.

Results

A series of paired-samples t-tests were conducted to determine whether significant changes from before to after the experimental session were reported. It was found that scores of concentration, reported levels of mood, stress, energy, concentration, self-satisfaction, and well-being improved significantly from before to after a session of yoga. Scores of concentration, reported levels of stress, energy, concentration, motivation, and well-being improved significantly from before to after a session of aerobic exercise (see *Table 1*). Detailed results are reported below.

Concentration

Scores of concentration on the letter cancellation task improved significantly ($t(33) = -4.16$, $p = .000$) after a session of yoga. Scores of concentration on the letter cancellation task also improved significantly ($t\ (35) = -2.67$, $p = .01$) after a session of aerobic exercise. To compare

the magnitude of change in the yoga and aerobic exercise conditions, change scores were calculated for yoga (mean change = 14.73) and aerobic exercise (mean change = 8.92). An independent samples t-test showed that there was no significant difference in the magnitude of change between the two groups (see *Table 1* and *Figure 1).*

After a session of yoga, reported concentration level had improved significantly ($t(33) = -2.51$, $p = .017$). Reported concentration level also improved significantly ($t(35) = -2.14$, $p = .04$) after a session of aerobic exercise. There was no significant difference in the amount of change in the yoga and aerobic exercise groups (see *Table 1* and *Figure 2*). Measured concentration level was found to be positively correlated with self-reported concentration ($r(69) = .247$, $p = .039$), such that if a person's score on a letter cancellation task increased from before to after the experimental period, so did their reported level of concentration (see *Table 2*).

Self-Report of Feeling-States

Reported mood level showed significant improvement ($t(33) = -2.85$, $p = .008$) after a session of yoga. Mood did not improve significantly after a session of aerobic exercise (see *Table 1*and *Figure 3*). Reported stress level improved significantly ($t(33) = -6.70$, $p = .000$) after a session of yoga. Reported stress level also improved significantly ($t(35) = -2.91$, $p = .006$) after a session of aerobic exercise (see *Table 1* and *Figure 3*). Reported energy level improved significantly ($t(33) = -2.81$, $p = .008$) after a session of yoga. Energy level also improved significantly ($t(35) = -4.01$, $p = .000$) after a session of aerobic exercise (see *Table 1* and *Figure 3*). Reported self-satisfaction improved significantly ($t(33) = -3.13$, $p = .004$) after a session of yoga. However, self-satisfaction did not improve significantly after a session of aerobic exercise (see *Table 1* and *Figure 3*). There was no significant improvement in motivation level after a session of yoga. Motivation level improved marginally ($t(35) = -1.83$, $p = .076$) after aerobic

exercise (see *Table 1* and *Figure 3*). Overall subjective well-being improved ($t(33) = -4.39$, $p=.000$) after a session of yoga. Overall subjective well-being also improved ($t(35) = -3.86$, $p = .000$) after a session of aerobic exercise (see *Table 1* and *Figure 3*).

Effectiveness of Yoga Compared to Aerobic Exercise

To compare the magnitude of change in the yoga and aerobic exercise conditions, change scores were calculated for yoga and aerobic exercise for each of the dependent variables. A series of independent samples t-tests explored whether the yoga or exercise conditions were more effective. Results revealed no significant differences between yoga and exercise in their changes produced in concentration, stress, energy, self-satisfaction, motivation, and wellbeing. An independent samples t-test revealed a marginal significance ($t(68) = -1.76$, $p = .08$) of group on mood change, such that yoga participants' moods improved slightly more ($M = 0.18$, $SD = 0.36$) than aerobic exercise participants' after a session ($M = .04$, $SD = 0.28$) (see *Figure 3)*.

Participants' Fitness Level

A series of correlations explored relationships between participants' fitness level and change in feeling-states. Participants who had conducted aerobic exercise before the experimental period that day had scores negatively correlated with reported change in mood after the exercise period ($r(69) = -.212$, $p = .024$), such that people who had done aerobic exercise earlier in the day reported decreased mood after the yoga or aerobic exercise period. There were no significant correlations between whether or not participants exercise regularly and change in mood scores (see *Table 2*).

Since the effect of fitness of participant has been analyzed in past research on exercise, the effect of regular exercise (presumed to indicate fitness) was examined in the present study to determine its effects on exercise and yoga. Participants' fitness levels and change in feeling-

states were analyzed through a series of 2 (fitness level: regular exercise; not regular) x 2 (exercise condition: yoga, aerobic exercise) ANOVAs. There was a marginally significant interaction effect of conducting regular aerobics by experimental group on change in stress level ($F(3,38) = 3.94$, $p = .051$). Regular exercisers who took part in yoga experienced slightly greater improvement in stress level ($M = 0.78$, $SD = 0.71$) than regular exercisers who took part in aerobic exercise ($M = 0.28$, $SD = 0.86$). People who do not regularly exercise and took part in the aerobic exercise group reported slightly greater improvements in stress level ($M = 0.77$, $SD = 0.85$) than people who do not regularly exercise who took part in yoga ($M = 0.52$, $SD = 0.31$) (see *Figure 4*).

The same pattern was found when change in reported concentration level was analyzed ($F(3,38) = 11.47$, $p = .001$). People who exercise regularly and took part in the yoga group experienced greater improvements in concentration level ($M = 0.59$, $SD = 0.72$) than people who exercise regularly and took part in the aerobic exercise session ($M = 0.08$, $SD = 0.79$) and people who do not regularly exercise and took part in the aerobic exercise session experienced greater improvements in concentration level ($M = 0.75$, $SD = 0.61$) than non-exercisers who took part in the yoga session ($M = -0.02$, $SD = 0.76$) (see *Figure 5*).

Discussion

The hypotheses of this study were that concentration and feeling-states would show improvement from before to after a session of yoga and a session of aerobic exercise, but levels of concentration and feeling-states would increase more greatly over a session of yoga than a session of aerobic exercise. Collected and analyzed data showed that improvement in measured and self-reported concentration was produced equally over a session of yoga and a session of aerobic exercise. Both yoga and aerobic exercise caused improvements in the reported feeling-

states of stress, energy, and well-being. Additionally, yoga produced improvements in the reported feeling-states of mood and self-satisfaction.

Results of this study have replicated those of past studies and furthered the knowledge-base by analyzing how yoga and aerobic exercise compare in their effects. Kubesch et al. (2009), and Litchman and Poser (1982) had found that a single session of exercise can improve concentration level, Prakash et. al (2010), and Zeidan et al. (2010) had found that meditation improves concentration level over a session, and Abadi and Venkatesan (2008) had found that a session of yoga improves concentration level. Because of these results, it was thought that yoga, as a combination of exercise and meditation, would produce a greater improvement than exercise alone. Results of this study did agree with those of the studies mentioned above; however, current results did not show that yoga produced superior effects when compared to aerobic exercise.

In this study, yoga has yielded more numerous significant results than aerobic exercise. Not only does yoga challenge and exercise the muscles of the body and the pumping of the heart, it activates neuro-chemical centers in the brain to produce calming, positive effects including happiness, feelings of self-worth, reduced stress, and increased concentration. Streeter et al. (2007) has found that chemical levels of Gamma-Amniobutyric Acid (GABA) in the brain increase substantially over a session of yoga, producing increased positive mood. This same measure should be applied to aerobic exercise in the future to discover the differences in brain chemistry producing mood changes between yoga and aerobic exercise.

According to participant reports in this study and evidence from past studies, aerobic exercise helps to reduce stress, induce concentration, and boost the body's energy level, but does not seem to tap into the person's emotional well-being. Yoga bears this extra result possibly as a

consequence of its meditation component, the calming rather than stimulating or even intimidating voice of the instructor, and the relaxing and stretching of the muscles.

Yoga was not found to produce significantly greater improvements in concentration and feeling-states than aerobic exercise, and this may be because the meditation component did not have its intended impact. Participants in this study were not experienced meditators or yoga practitioners as they were in studies by Prakash et al. (2010), and Kumar and Telles (2009) who found meditation to produce improvements in concentration level. Without meditation experience or specific instructions to meditate during the yoga session, participants may not have experienced the benefits of meditation during the yoga session. This most likely resulted in the participants only experiencing the yoga session as an exercise period, causing it to yield the same results as the aerobic exercise session.

Frequency of exercise was also investigated in this study, and was found to affect the measures of mood. Participants who had exercised earlier that day before their session of yoga or aerobic exercise tended to report a decrease in mood over the experimental session. Frequency and length of exercise should be investigated further to determine the ideal amount of exercise needed to gain the greatest results. With increased frequency in practicing particular exercises, it is assumed that one will improve in skill level and the exercise will come more easily. Over a long-term yoga practice, one might experience greater effects than those experienced in a single session; it is possible that an experienced yoga practitioner will experience greater improvements over a session than an inexperienced one.

Fitness also impacts the effectiveness of the experimental treatment. It was found that a person who regularly exercises experiences a greater improvement in stress and concentration during yoga than they do during aerobic exercise. Conversely, a person who does not exercise

regularly experiences a greater improvement in stress and concentration through a session of aerobic exercise than through a session of yoga. A possible explanation for this is that aerobic exercise is a familiar activity that does not take a whole lot of mental effort because it consists of every-day upright movements such as running, jumping-jacks, and squats. Many of the participants most likely conducted aerobic exercise in physical education classes during elementary, middle, and high school. The familiarity makes aerobic exercise easy for a person to catch on to especially if that person does not exercise regularly. The positive effects of exercise for a person who doesn't usually exercise are great, allowing them to absorb positive changes in stress and concentration. For these people, who are presumably not physically fit, being introduced to yoga may be quite a challenge. Yoga consists of unconventional, challenging postures and positions that are not easily learned and conducted simultaneously. Repetition of these positions may cause difficulty for people who are unfit and not familiar with yoga.

For a person who does exercise regularly, a short session of aerobic exercise was found to cause very little change in stress and concentration. This could be due to the fact that regular exercisers do these exercises frequently, so the experience is dull. Their muscles are toned so the short session does not cause a drastic impact, and the person may not feel challenged, thus entering a state of boredom and not experiencing positive effects on stress and concentration. For a person who regularly exercises, yoga may act as a challenge in a positive way. Having strong muscles, presumably, the people are able to hold the postures and feel a positive challenge rather than a stressful one. Doing yoga may be less boring and thus more engaging for someone who exercises often. In this way, people who are fit can reap the benefits in stress and concentration of yoga more than those who are not fit. Heckler and Croce (1992) conducted a study to test the effects of physical fitness on cognitive performance after a session of exercise. They found that

less fit women benefit from a short bout of exercise, but not from a long period of exercise. This helps to clarify the above results. Before exercise becomes too copious a challenge, the effects of exercise on an unfit person are positive. However, when the exercise is too challenging, an unfit person does not experience positive changes in concentration and stress.

Results implicate that yoga and aerobic exercise are efficient methods of improving concentration, stress, energy, and subjective well-being. Yoga alone is also an efficient method of producing improvements in mood and self-satisfaction. This indicates that yoga may be a beneficial alternative form of exercise, especially for students, people with stressful lifestyles, or people who just need a mood elevation, motivation, energy, or self-confidence boost.

Future research should include larger sample sizes and more thorough measures of concentration and mood, including both self-reports and physiological measurements. Physical fitness' effects should be examined further as well. More thorough measures should be used to determine fitness and comparisons of long-term yoga and long-term aerobic exercise should be made to discover if there are differences in effects. As muscles become toned to the specific type of exercise over long term, the positive effects from individual exercise periods will likely be capitalized upon. The differences in effects of yoga and aerobic exercise should certainly be investigated further because it seems that both are highly beneficial, but possibly in different ways.

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Table 1

Mean Concentration and Feeling-State Scores Before and After Yoga and Exercise

	Yoga			Exercise		
	Before	**After**	**Significance**	**Before**	**After**	**Significance**
Concentration Score	26.18 (19.98)	40.91 (9.66)	$p = .000$	33.47 (17.68)	42.39 (13.75)	$p = .011$
Reported Mood	4.07 (0.71)	4.25 (0.64)	$p = .008$	3.50 (1.66)	3.48 (1.69)	n.s.
Reported Stress	2.96 (0.81)	3.64 (0.74)	$p = .000$	3.06 (1.01)	3.47 (0.77)	$p = .006$
Reported Energy	2.83 (0.82)	3.17 (0.76)	$p = .008$	3.13 (0.72)	3.61 (0.62)	$p = .000$
Reported Concentration	3.37 (0.67)	3.71 (0.67)	$p = .017$	3.33 (0.84)	3.61 (0.71)	$p = .040$
Reported Self-Satisfaction	3.69 (0.77)	3.92 (0.64)	$p = .004$	3.80 (0.67)	3.92 (0.60)	n.s.
Reported Motivation	3.52 (0.84)	3.71 (0.71)	n.s.	3.67 (0.87)	3.77 (0.79)	$p = .076$
Subjective Well-being	3.41 (0.56)	3.73 (0.51)	$p = .000$	3.49 (0.56)	3.71 (0.51)	$p = .000$

Note. Concentration score is based on number of letters correctly cancelled on the letter cancellation task, on a scale of 0-70. All other scores are feeling-state measurements based on a 5 point Likert scale. Standard deviations are in parentheses. (n.s. = non significant)

Table 2

Correlations Between Participants' Reports of Exercise and Change in Feeling-States

	Aerobics today	Exercise Regularly	Concentration Score	Concentration change	Mood change	Stress change	Energy change	Satisfaction change	Motivation change	Well-being change
Aerobics today	-	-	-	-	-	-	-	-	-	-
Exercise Regularly	0.14	-	-	-	-	-	-	-	-	-
Concentration Score	0.032	0.033	-	-	-	-	-	-	-	-
Concentration change	0.006	0.002	.247*	-	-	-	-	-	-	-
Mood change	-0.258*	-0.17	0.018	0.138	-	-	-	-	-	-
Stress change	0.051	0.079	-0.056	0.16	0.006	-	-	-	-	-
Energy change	-0.134	0.113	-0.021	.276*	0.06	0.146	-	-	-	-
Satisfaction change	-0.201	-0.141	0.081	0.232	0.277*	.327**	0.193	-	-	-
Motivation change	-0.06	0.06	0.188	.428***	0.152	0.148	.519***	0.205	-	-
Well-being change	-0.128	0.052	0.138	.724***	.269*	.485***	.671***	.541***	.714***	-

* $p < .05$. ** $p < .01$. *** $p < .001$

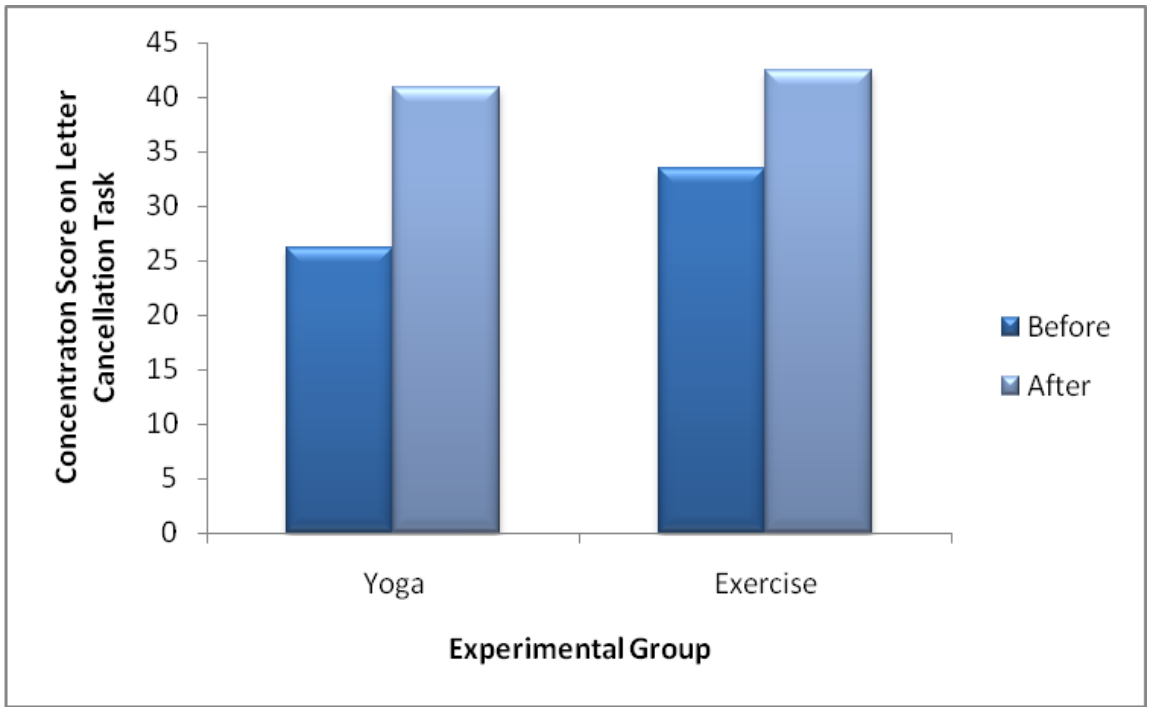


Figure 1. Letter Cancellation Task mean scores pretest and posttest for both groups.

Concentration level improved from before to after the sessions of yoga and aerobic exercise.

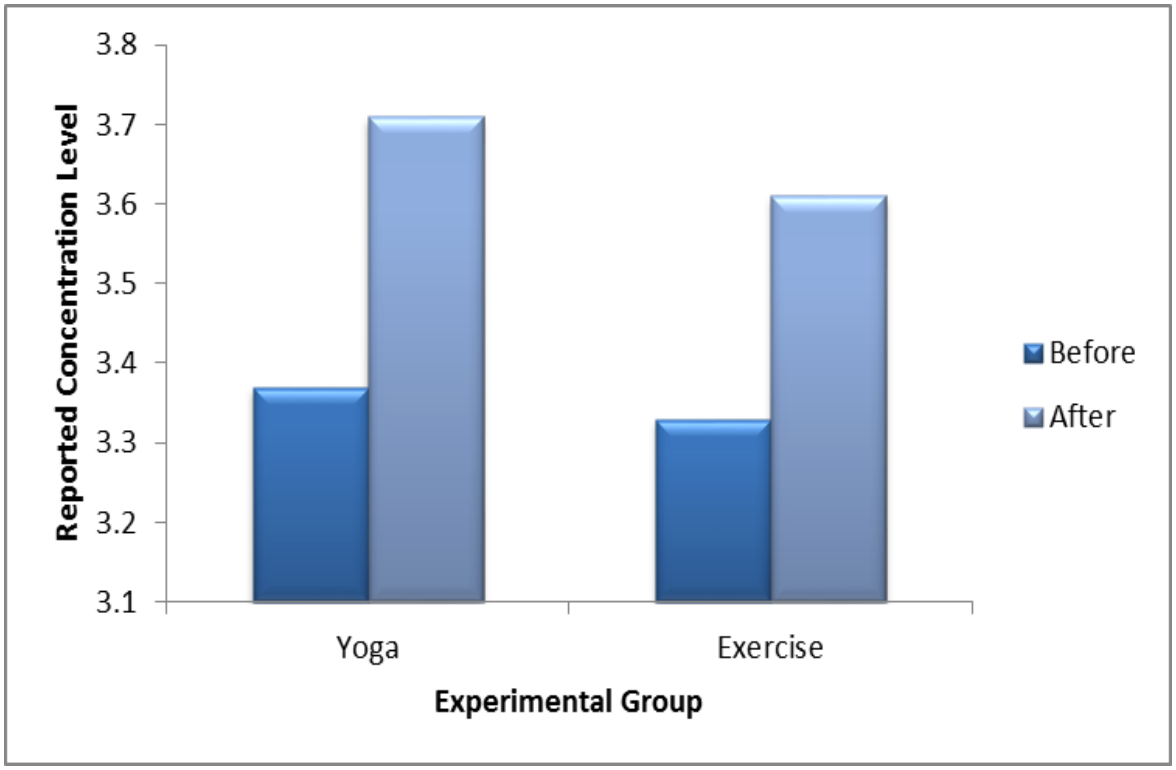


Figure 2. Reported concentration levels for both groups before and after experimental period. Reported concentration levels increased significantly from before to after both sessions.

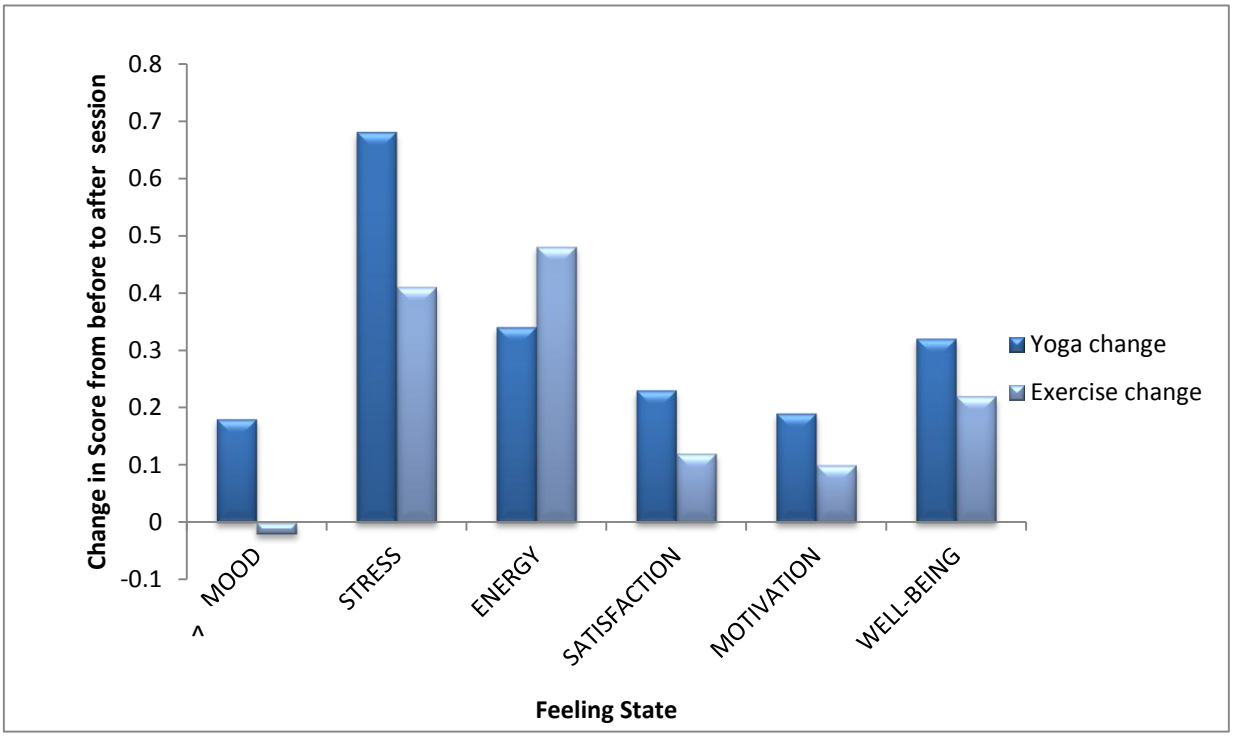


Figure 3. Feeling-State Assessment mean changes from before to after session. Positive numbers indicate improvement from before to after.

^ $p < .10$. A non-significant trend showed mood improved somewhat more in the yoga condition than in the aerobic exercise condition.

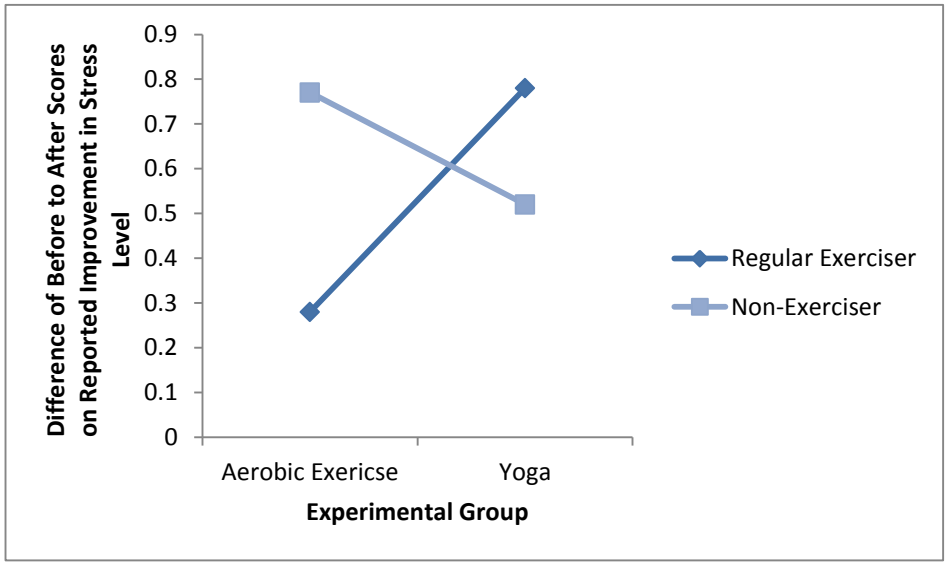


Figure 4. Interaction of regular/non-regular exercise and experimental group on change in stress level over the experimental session.

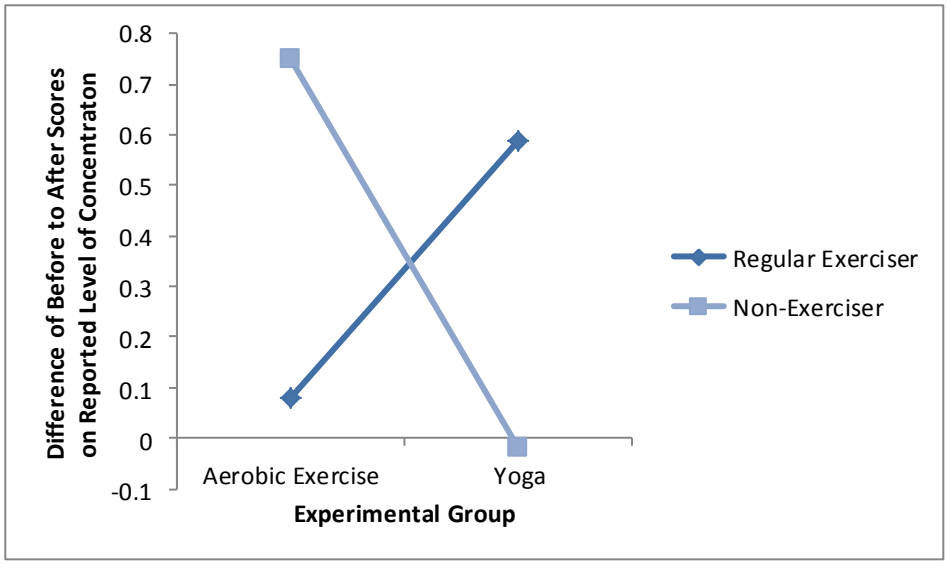


Figure 5. Significant interaction effect of regular/non-regular exercise and experimental group on change in level of concentration over an experimental period. Regular exercisers experience greater improvements in concentration through a yoga session than through an aerobic exercise sesson. Non-exercisers experience greater improvements in concentration over a single aerobic exercise session than over a single yoga session.

Appendix A

CONSENT FORM

Title of project: The Effects of Yoga and Aerobic Exercise

Principal Investigator: Elyse J. Dolde

The purpose of this study is to examine how people are impacted by taking part in physical activity, specifically yoga and aerobic exercise.

If you agree to participate, you will either take part in 30 minutes of aerobic exercise, or 30 minutes of yoga.

The total duration of your participation will be about 1 hour.

Any exercise program comes along with a risk of injury. If you have a health condition that you are concerned will interfere with you taking part in physical activity, please do not participate in the study. If, during the test, you feel any discomfort, discontinue that movement, or come out of that position. Remember that you are free to discontinue participation in the study at any time.

In return for the time invested in this project as a participant, you will receive 2 SONA credits toward a requirement in your Psychology class as stated in the course syllabus or described by your instructor, or given extra credit for the course, as described by your instructor. You will also receive a $5 gift card to Barnes and Noble, the campus bookstore.

Only the researchers and faculty advisor, Dr. Turner, will have access to the records and/or data collected for this study, and all data associated with this study will remain strictly confidential.

Participation is voluntary. There is no penalty for refusal to participate. You may withdraw from the experiment at any time without penalty.

Risks/Discomfort and benefits to the participants- This study imparts risk of injury for participants. Potential benefits are improved health and mood, as well as possibly gaining a better understanding of psychological research. Consistent with the guidelines of the American Psychological Association, data will be stored in the office of the faculty member at least 5 years after the date of a potential publication.

I consent or give permission for my participation as a volunteer in this research study. I have read this form and understand the content. I understand the risks of taking part in physical exercise, and certify that I do not have a health condition that will interfere with safe physical exercise.

_____

Participant's signature Date

This is to certify that I have defined and explained this research study to the participant named above.

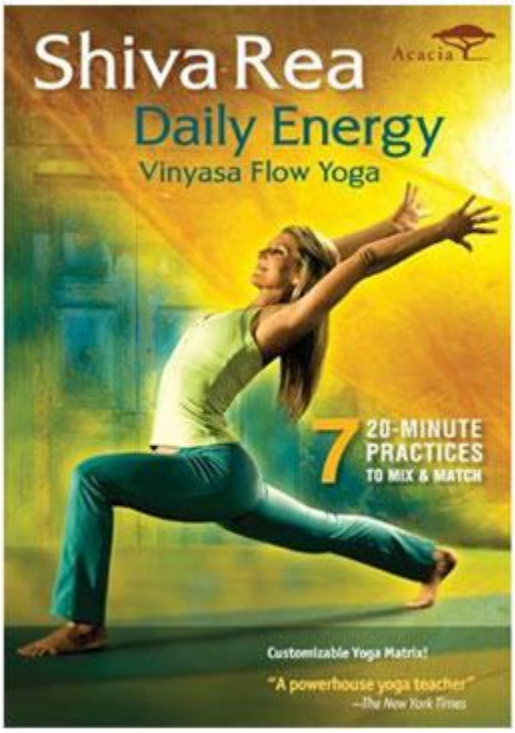
_____

Investigator's signature Date

Appendix B

Shiva Rea Daily Energy Vinyasa Flow Yoga: Earth (Eckstein, 2009)

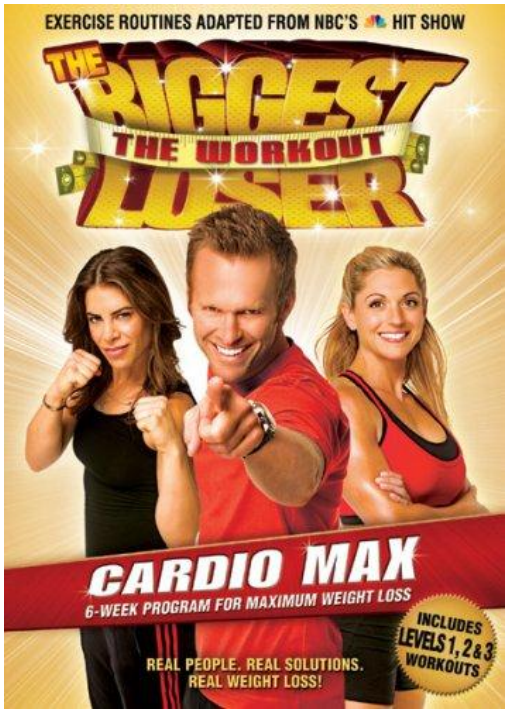
This yoga practice is led by a single instructor who is narrating and conducting every movement. The video encompasses flows through the yoga positions of downward dog, plank, chaturanga (similar to a slow push-up), cobra, upward dog, warrior I, warrior II, lunge, and child's pose. Each movement is associated with a specific breath (in or out), and the rhythm of breath is maintained through the practice. Shiva Rea, the instructor, demonstrates movements clearly and allows for slow progression in learning the positions and movements. The session works the muscles of the arms, shoulders, and legs. The specific practices from this video being used are "Earth", which is 20 minutes of energizing yoga flows, "Forward Bends" which is 5 minutes of various leg stretches, and "Shavasana" which is 5 minutes of meditation.



Appendix C

The Biggest Loser: The Workout Cardio Max (Pozo, 2007)

This aerobic exercise video consists of movements conducted on a single spot, without moving around the room. Movements such as lunges, squats, jumping jacks, and push-ups are conducted and raise the heart rate. An instructor is always describing how and when to conduct each movement. There are several sample participants in the video taking part in the work out at different physical strength levels. The workout encompasses non-stop movement for 30 minutes (comprised of one 20 minute, and one 10 minute session).



Appendix D

Questionnaire

Demographics

Please circle the appropriate answer that best corresponds to you currently.

1.) Gender
- a.) Male
- b.) Female
- c.) Transgender

2.) Age
- a.) 18
- b.) 19
- c.) 20
- d.) 21
- e.) 22 and above

3.) Year
- a.) Freshman
- b.) Sophomore
- c.) Junior
- d.) Senior
- e.) Other _____

4.) Race:
- a.) White, non- Hispanic
- b.) African American
- c.) Hispanic
- d.) Asian Pacific Islander
- e.) Native American
- f.) Other_____

Exercise Habit Survey

Please circle the appropriate response.

1. Have you exercised today?

Yes No

2. Did you take part in aerobic exercise today?

Yes No

3. If so, for how long?

Less than 30 minutes 30-60 minutes 1-2 hours more than 2 hours

4. Do you participate in aerobic exercise regularly?

Yes No

5. Did you do yoga today?

Yes No

6. If so, for how long?

Less than 30 minutes 30-60 minutes 1-2 hours more than 2 hours

7. Do you participate in yoga regularly?

Yes No

8. How many times each week do you exercise?

Every day 5-6 times per week 3-4 times per week 1-2 times per week

Not on a weekly basis never

9. On the days that you exercise, how long do you exercise for?

Less than 30 minutes 30-60 minutes 1-2 hours more than 2 hours

Appendix E

Feeling-State Assessment

Please respond to the following statements by selecting your level of agreement from strongly disagree (1) to strongly agree (5).

1. I feel happy.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2. I feel Sad.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

3. I feel angry.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

4. I am upset.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

5. I am overwhelmed.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

6. I feel stress-free.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

7. I feel anxious.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

8. I feel tired.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

9. I want to take a nap.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

10. I feel energized.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

11. I feel lethargic.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

12. I feel focused.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

13. My mind feels foggy.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

14. My mind is clear.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

15. I feel distracted.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

16. I feel healthy.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

17. I am satisfied with my life.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

18. My body is in a condition that I am satisfied with.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

19. I want to accomplish something important today.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

20. I feel as if I could be productive right now.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

21. I want to be lazy for the rest of the day.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

22. I have no motivation to do homework or a project right now.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Appendix F

Letter Cancellation Task (Kumar & Telles, 2009)

The box consists of 14 columns and 22 rows of randomly placed letters. The task is designed to measure concentration level by how many letters the participant correctly crosses out in 90 seconds, working from top to bottom.

S, D, J, B, L, Y

O	X	Q	Y	B	T	D	M	D	G	V	D	M	A
A	W	P	A	N	I	V	W	Y	E	L	H	A	V
A	X	U	Q	L	M	I	O	A	L	T	B	R	F
X	I	C	U	W	O	H	P	Y	T	E	Y	T	H
W	D	H	C	B	G	N	K	J	O	C	D	D	D
K	A	X	L	P	A	M	J	T	S	Q	S	Q	F
E	M	Q	O	B	K	W	I	W	Z	B	R	V	U
L	X	O	N	R	M	H	C	E	L	P	D	L	P
N	P	A	B	O	P	B	R	X	X	I	Q	M	H
G	R	E	E	Y	R	I	O	Q	Z	Z	G	F	C
L	K	F	G	V	U	Y	J	V	I	K	A	G	T
T	W	C	X	T	E	K	E	B	L	E	B	O	F
Q	J	W	N	F	Q	Y	B	I	Y	A	S	P	B
J	F	V	Q	C	U	E	X	O	L	D	U	D	M
T	M	Q	T	E	M	K	P	R	C	K	S	K	M
N	D	S	Y	N	Z	I	Y	K	U	H	H	U	F
V	Z	S	J	C	B	Z	H	S	U	N	T	P	O
S	N	R	G	F	Y	S	G	V	M	I	J	F	S
J	G	H	K	K	C	H	U	C	R	V	E	Z	C
S	W	I	X	H	Z	S	R	G	F	G	J	Z	Q
N	L	G	P	R	N	F	O	J	N	J	A	T	L
R	X	J	U	W	Z	U	P	V	Z	I	V	D	W

P, A, E, R, F, K

O	X	Q	Y	B	T	D	M	D	G	V	D	M	A
A	W	P	A	N	I	V	W	Y	E	L	H	A	V
A	X	U	Q	L	M	I	O	A	L	T	B	R	F
X	I	C	U	W	O	H	P	Y	T	E	Y	T	H
W	D	H	C	B	G	N	K	J	O	C	D	D	D
K	A	X	L	P	A	M	J	T	S	Q	S	Q	F
E	M	Q	O	B	K	W	I	W	Z	B	R	V	U
L	X	O	N	R	M	H	C	E	L	P	D	L	P
N	P	A	B	O	P	B	R	X	X	I	Q	M	H
G	R	E	E	Y	R	I	O	Q	Z	Z	G	F	C
L	K	F	G	V	U	Y	J	V	I	K	A	G	T
T	W	C	X	T	E	K	E	B	L	E	B	O	F
Q	J	W	N	F	Q	Y	B	I	Y	A	S	P	B
J	F	V	Q	C	U	E	X	O	L	D	U	D	M
T	M	Q	T	E	M	K	P	R	C	K	S	K	M
N	D	S	Y	N	Z	I	Y	K	U	H	H	U	F
V	Z	S	J	C	B	Z	H	S	U	N	T	P	O
S	N	R	G	F	Y	S	G	V	M	I	J	F	S
J	G	H	K	K	C	H	U	C	R	V	E	Z	C
S	W	I	X	H	Z	S	R	G	F	G	J	Z	Q
N	L	G	P	R	N	F	O	J	N	J	A	T	L
R	X	J	U	W	Z	U	P	V	Z	I	V	D	W

Appendix G

Script:

(While passing out consent forms)

"Thank you for volunteering to participate in this study. You will participate in 2 letter-cancellation tasks, fill out 2 surveys, and participate in 30 minutes of yoga/aerobic exercise. Please do not sign the consent form if you have a health condition that may be affected by physical exertion; there is no penalty for withdrawing from the study. If you agree to participate, please sign your name and date at the bottom of the consent form."

(Collect consent forms and pass out letter cancellation tasks, face down)

"You will have 90 seconds to complete this task. There are six letters at the top of your page; you must cross out each of these six letters every time they appear in the box below. Please work row by row from the top to the bottom in the box of letters. You may flip over your papers and begin."

(Collect letter cancellation tasks, pass out surveys)

"Please complete this survey by answering the questions as directed."

(Collect surveys)

"Please spread out around the room so that you have space on all sides of you if you stretch your arms out. Remember that if any position feels uncomfortable, please come out of it and if any movement is painful, please stop or modify it."

(Begin video)

(Once video has finished)

"You have two minutes to make your way back to your seat."

(While passing out letter cancellation tasks, face down)

"You will have 90 seconds to complete this task. There are six letters at the top of your page; you must cross out each of these six letters every time they appear in the box below. Please work row by row from the top to the bottom in the box of letters. You may flip over your papers and begin."

(Collect letter cancellation tasks, pass out surveys)

"Please complete this survey by answering the questions as directed."

(Collect surveys)

"Thank you for participating in this study, your data will contribute to research that I am conducting on the effects of yoga and aerobic exercise on concentration level and feeling-states. If you have any concerns or questions, feel free to email me at: edolde165@g.rwu.edu."

(Hand out gift cards)