Short Term Physiological Effects of Yoga on Relieving Acute Stress Induced by Task-Anxiety

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Abstract

Acute stress accumulated over time can lead to chronic stress resulting in many health problems, such as heart disease and depression. Through substantive evidence, it has been shown that physical exercise and meditation can reduce stress levels. Previous studies have focused on alleviating existing stress symptoms using yoga in the long-term. However, in this study, the purpose is to reduce the symptoms of acute stress induced through task anxiety, thereby reducing the development of chronic stress. All participants were asked to perform a five minute yoga session or to wait for five minutes, followed by a timed multiplication test to induce stress. We hypothesized that individuals who participated in a brief yoga session will have reduced stress levels during the test as measured by heart rate (HR), respiration rate (RR), and blood pressure (BP). However, we found that -- while there were increased levels of HR, RR, and mean arterial pressure (MAP) after taking a multiplication test -- there were no significant differences in physiological response to strongly support our hypothesis. It can be concluded that a brief session of yoga had little effect on reducing acute stress induced by task anxiety, therefore, longer periods of yoga may help to show stronger differences.

Introduction

Anxiety disorders are the most common type of mental illness in the United States, affecting eighteen percent of the adult population (Kessler, 2005). Moreover, the consequences of stress negatively alters one's feelings, behaviors, and mind. Research shows that 49 percent of the public report that they have had a stressful event or experience in the past year (Hensley & Hurt, 2014). When the body is under acute stress, the sympathetic nervous system signals the "fight or flight" response, and releases hormones such as cortisol and norepinephrine that cause

heart rate, respiration rate, and blood pressure to rise. One of the major forms of acute stress is task anxiety, defined as feelings of stress and changes in the body's homeostasis while completing a task, such as an exam, performance, or competitive event (Staal, 2004). Prolonged exposure to acute stress can lead to chronic stress, which has been shown to contribute to lowered immunity, heart disease, depression, anxiety, hypertension, diabetes, and other serious conditions (Pruthi, 2013). Taking measures to cope with stress can prevent harmful effects. Physical activity and meditation may be an easy way to prevent stress induced by task anxiety.

An activity that incorporates both physical activity and meditation is yoga. Yoga is increasingly used in clinical settings to combat the effects of stress on physical and mental health (Riley, 2015). According to *The Journal of Psychiatric Research,* about 1.44 million Americans were prescribed yoga by their doctor in 2011 as a form of stress management (Pascoe, 2015). Studies show that all types of yoga have been beneficial in reducing the risk of adverse health outcomes, including heart disease and high blood pressure (Pruthi, 2015). One study examined the effects of a 26-session integrated yoga program as a secondary treatment for patients with hypertension, and found a significant reduction in both systolic and diastolic blood pressure among the patients in the study group (Roche, 2014). Another study measured anxiety status using Spielberger's Anxiety Scale among medical students on the day of exams (Spielberger, 1983). The study found that on exam days, students showed reduced anxiety scores after practicing yoga. The researchers concluded that, due to yoga, there was a significant decrease in basal levels of anxiety, as well as a decrease in anxiety during stressful events (Malathi, 1999).

Previous studies have shown that yoga treatment is beneficial in alleviating general stress symptoms, but it is yet to be determined if yoga is capable of reducing stress symptoms incurred during stressful situations. The major form of acute stress incurred during stressful situations is

task anxiety. Reducing task anxiety will reduce acute stress and ultimately negate the development of chronic stress. The aim of this study was to determine the short term physiological protective impacts of a short yoga session on acute stress.

Materials and Methods

Participants

This study was conducted at The University of Wisconsin-Madison under the supervision of the Physiology 435 laboratory faculty and staff. Participants (n=30) were randomly selected from a convenience sample of students at the UW-Madison campus. Prior to participation, subjects were given a consent form with a clear description and risks associated with the experiment. Sex and age demographics were also collected during this time. A normalized script was read to each subject before any testing.

Design

In order to determine the effects of yoga on task anxiety, changes in three physiological responses were measured, including heart rate (HR), blood pressure (BP), and respiration rate (RR). Each variable was measured twice: once before the experiment to determine individual baseline values, and once afterwards, during the proctored task. Measurements of all physiological responses were taken using noninvasive equipment provided through the class. Participants were assigned to control and experimental groups using a random binary generator, which produced a random string of zeroes and ones. Any subject who received a zero was assigned to the control group; those who received ones were assigned to the experimental group.

Subjects in the experimental group left the room and completed a five-minute yoga/stretching exercise following baseline measurements of heart rate, blood pressure, and

respiration rate. The exercise included low intensity yoga, deep breathing, and stretching (Yoga with Adriene, 2014). Because the study was double blinded, participants in the control group that were not subjected to any exercise also left the room for five minutes.

Following the yoga or five minutes of rest, subjects were asked to take a timed multiplication test. Although the participants were told otherwise, completion of the task was unfeasible due to a time constraint of thirty seconds, which induced anxiety. HR and RR were measured again while each participant took the test. BP was measured immediately after testing. See Figure 1 for a measurement timeline.

Materials

Heart rate was measured using a pulse oximeter (Nonin Medical Inc. Minneapolis, MN. Model#9834). Blood pressure was examined using a 10 series automatic blood pressure cuff (Omron Healthcare Co., Ltd. Lake Forest, IL. Model#BP791IT). Respiration rate was indexed using a respiratory transducer (BioPac Systems, Inc. Goleta, CA. Model#55SLB). The timed test, obtained from www.math-aids.com, consisted of 60 multiplication questions on paper.

Procedure

The participant was seated at a desk next to three experimenters and, after signing a consent form, was given instructions from a normalized script. Baseline heart rate and respiration rate were measured simultaneously. The pulse oximeter was clipped onto the subject's index finger on their non-dominant hand to measure heart rate. Four bpm values were recorded for duration of thirty seconds - one at zero, ten, twenty, and thirty seconds. Respiration rate data was

gathered using a respiratory transducer. The transducer, a flexible belt, was strapped above the subject's nipple line and the depth of each breath was measured. One interval was collected per ten seconds of data. The pulse oximeter was removed after HR and RR were recorded. Immediately following, the BP cuff was strapped onto the subject's right upper arm, above the elbow to measure BP. Both systolic and diastolic pressures were measured.

After baseline data collection, one experimenter led the participant into the hallway to either do a short yoga exercise or sit with the experimenter for five minutes. Once the participant was led into the hallway, the experimenters that stayed in the lab calculated the average HR across all four measurements using Microsoft Excel, and calculated the average RR manually using three peak-to-peak intervals distributed evenly throughout the thirty second collection period.

After five minutes in the hallway, the participant was directed back into the same chair in the lab with the same three experimenters. The respirometer and pulse oximeter were reapplied to the participant in the same manner as it was during baseline measurements. The participant was then given instructions for taking the test. Participants were informed that they had thirty seconds to complete as many problems as possible; they could skip problems if needed, and that their score was relevant to the data collection. As soon as the test began, heart and respiration rates were recorded in the same way as the baseline measurements. The three experimenters in the room continuously verbally pressured the participant to go faster, insisted that they had problems wrong, and counted down outloud for the last five seconds of the test. This was meant to add stress to the environment during the test. Immediately following the thirty seconds, BP was recorded. The participant was then thanked and dismissed once all equipment was removed.

All heart rates and respiration rates were entered into Microsoft Excel after the participant was dismissed. Averages for HRs were determined using an automated equation in Excel, while average RRs were calculated manually and entered into Excel. The mean arterial pressure (MAP) was calculated at the end of the study.

Data Analysis

Differences from baseline physiological responses were calculated for each individual. Acute stress was measured using levels of task anxiety. Increases in anxiety was defined for each variable. For mean arterial pressure (MAP), any positive value was considered to be an increase in anxiety. Negative MAP values indicated a decrease in anxiety. MAP was calculated using the following equation: MAP= DS+(⅓ x PP), where DS is diastolic pressure and PP is pulse pressure (systolic minus diastolic).

We chose to define a heart rate increase above five beats per minute when compared to baseline as an increase in anxiety. In addition, respiration rates with increases of seven breaths per minute above baseline indicated anxiety. If the subject exhibited significant increases in two out of the three variables, they exhibited acute stress. The data was then analyzed using two sample T-tests in Rstudio.

Results

Heart Rate

Average changes in HR in beats per minute between the baseline and testing values in different sexes were calculated (Figure 5). All four groups: male yoga, male control, female yoga, and female control groups, showed an increase in HR from baseline during testing, with the male control group showing the greatest increase. However, these values were determined to be statistically insignificant.

Mean Arterial Pressure

For average change in MAP (mmHg), there were slight increases in the female yoga and control groups from baseline (Figure 6). The male control group had a bigger increase in average change in MAP, but the male yoga group had a decrease in average change. Despite these trends, the results were not statistically significant.

Respiratory Rate

Average change in RR (breaths per minute) among males and females in both the control and experimental groups showed increases from baseline (Figure 7). Once again the p-values in each case were not determined to be statistically significant.

Summary

Our initial hypothesis was that participants who completed a five-minute yoga routine before a test would show little or no increase in HR, BP, and RR, compared to the individuals who did not do yoga before the test. After applying two sample t-tests to our data, we found that there was not a significant change in average HR, BP, or RR among all individuals that did yoga versus all individuals that did not ($p>0.05$). A two sample t-test was then applied to groups according to sex. Males who did yoga before the test did not show a significant change in any of the average measurements compared to males who did not do yoga ($p>0.05$). The same was true among females. The most significant test finding was the difference in average RR among all

individuals who did yoga compared to those who did not (p=0.085); however, this result was still not conclusive enough to support our hypothesis.

We ran a linear regression for all three parameters with sex as a covariate to ensure that it was not a confounding variable. There was no significant difference in physiological response between the treatment and control groups.

Discussion

Task anxiety, a form of acute stress, has been known to cause the release of cortisol and norepinephrine, both of which contribute to the rise of heart rate, respiration rate, and blood pressure. Given previous research on the long-term effects of yoga, we hypothesized that doing a five-minute yoga session before a timed test would reduce task anxiety as measured by heart rate, blood pressure, and respiration rate. We predicted that participants who engaged in a short yoga routine would show either decreases or significantly smaller increases in HR, RR, and BP during the test, compared to the control group.

We made a number of assumptions when initially designing the experiment itself. One major assumption was that all participants had the same amount of experience with yoga. Realistically, participants with more yoga experience may have been more comfortable with the exercise video and exhibited long-term physical benefits of yoga (Ross & Thomas, 2010). Additionally, the method of transportation that participants used prior to the experiment (e.g. walking, biking, driving) may have altered the physiological factors to be higher or lower than normal due to differing levels of physical exertion. Furthermore, we assumed all subjects were under similar levels of stress prior to participation. However, participants may have experienced different levels of stress while completing the anxiety-inducing task, thus confounding the HR, RR, or BP data. It is possible that other outside stressors may have contributed to atypical results

in physiological measurements as well. In order to account for these assumptions in future research, participants should be given a survey to assess their stress level prior to the study, and taking longer baseline measurements should increase accuracy by accounting for the variance in participants' activities both before the test and their lifestyle choices.

During data analysis, three data points from respiratory measurements needed to be excluded from calculations. Errors in these measurements were due to participants laughing, talking, or improper fitting of the respiratory transducer. These sources of error ultimately led to inaccurate respiratory rates for these individuals. Furthermore, distractions in the participants' environment during the yoga exercise greatly reduced the effectiveness of the yoga due to the public nature of the setting.

Due to limited lab time, the yoga video in this study was five minutes in duration. One reason yoga was not proven to be helpful in reducing task-anxiety might be that a short video does not adequately relax the participant before completing the task. Along with time constraints, we were also limited in the number of participants we could study. As a result, the sample size for our experiment was 26 participants.

In our experiment we also noted each participant's gender. We believed this would help eliminate any sex-related discrepancies between baseline data; males have been shown to have higher baseline BP as compared to females (Dimkpa, 2008). After analyzing changes in overall physiological responses, we compared changes in each physiological variable in males who did and did not complete yoga. The process was repeated for female participants. After observing the sex-specific data, we found the results to be insignificant. Although inconclusive, studying the correlations between males as well as measurements between females could be an area of study for future replications of our experiment.

Despite inconclusive results, we hope to provide a starting point for future research to further investigate effective stress-relieving activities by studying the relationship between task-anxiety and yoga. The methods used by Köhn and colleagues (2013) provide a good example of how to conduct a yoga study yielding more significant results. In subsequent trials of this experiment, larger sample sizes and longer videos could be implemented. The former will reduce the chance of type I error, while the latter will aid in participant relaxation.

Additionally, a different stress inducing activity could be implemented to ensure all participants experienced the same or similar degree of stress. Future studies could also investigate gender and/or cultural differences and note how yoga affects short-term task anxiety in varying ages in males versus females, or between different cultural groups. The results from this experiment have shed light on a new perspective between yoga and task anxiety. However, any correlation between these two variables could have significant implications for managing acute stress due to test taking and stressful work-related events, which ultimately could improve the quality of life.

Figures and Legends

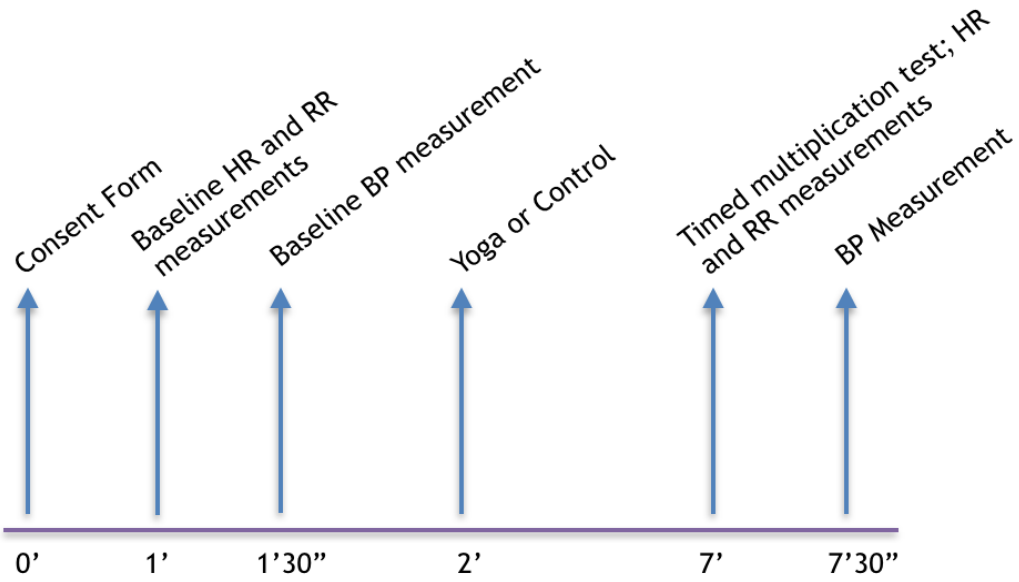


Figure 1. Timeline (in minutes) depicting participant experience and physiological response measurements throughout the study.

	Males	Females	Total
Average Age	21.5	21.5	21.5
Number of Participants	11	15	26

Figure 2. Demographics (sex and average age) of all participants.

Figure 3. Screenshot of baseline respiration of a subject, taken from BioPac Systems, Inc. The highlighted region shows one ten second interval and the corresponding BPM (breaths per minute) value. Respiration rate was calculated by taking the average of three intervals, as stated in Procedures.

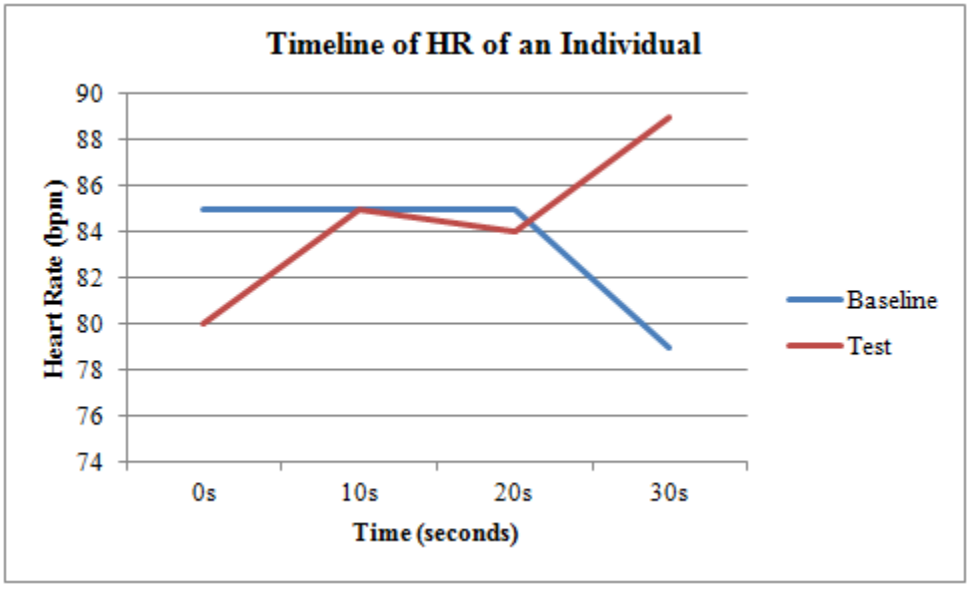


Figure 4. This graph represents a trendline for heart rate during baseline measurements and during the test for one participant. The data depicts an increasing heart rate during the 30 seconds of testing and a gradually decreasing heart rate during the 30 seconds of baseline measurement.

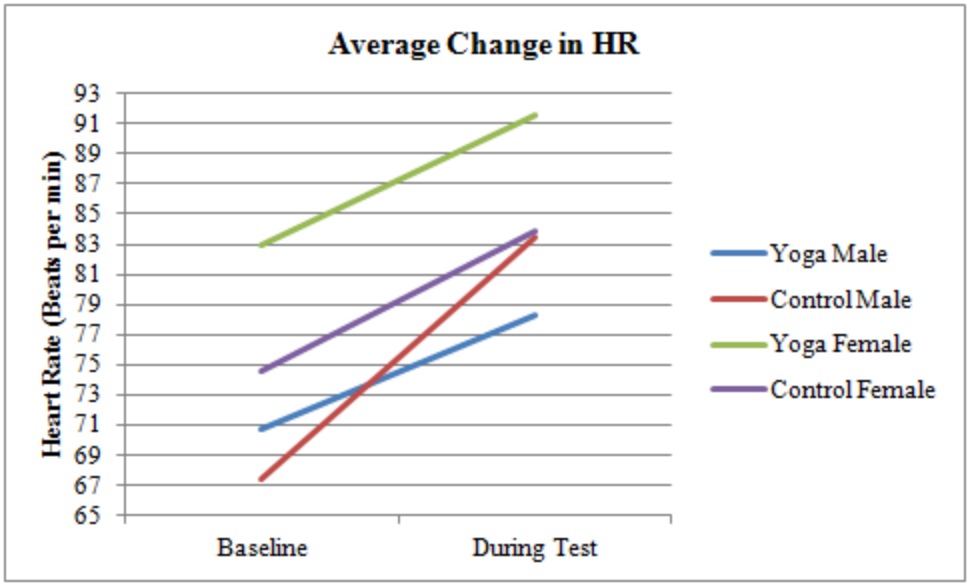


Figure 5. Average change in HR among males and females in each group. Both males and females in the control and experimental groups showed a trend in increased heart rate during testing compared to their baseline averages. The males who did yoga showed a smaller increase in heart rate than males who did not do yoga. ($p>0.05$)

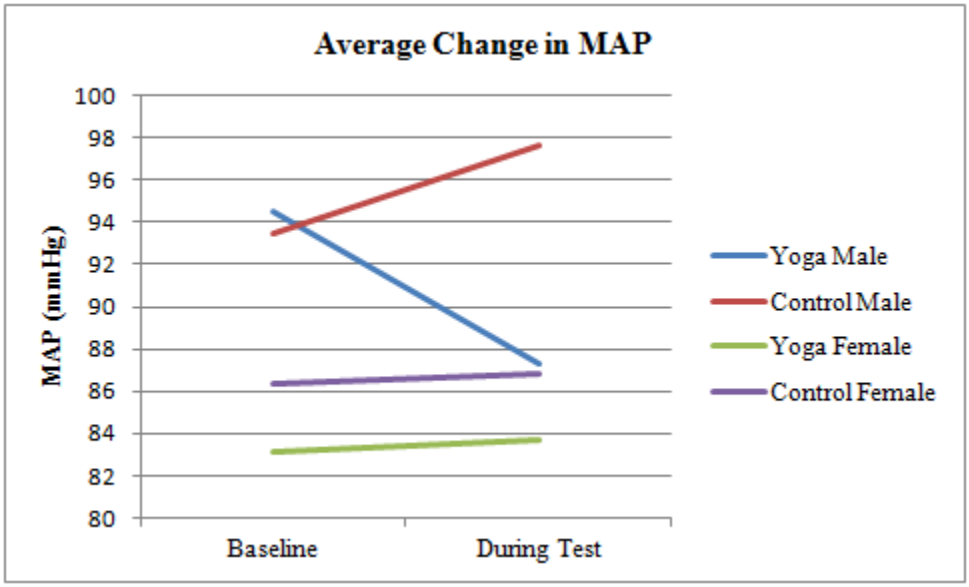


Figure 6. Average change in MAP among males and females in the experimental and control groups. Males who did yoga showed a decrease in average MAP during the test, compared to their baseline values. ($p>0.05$)

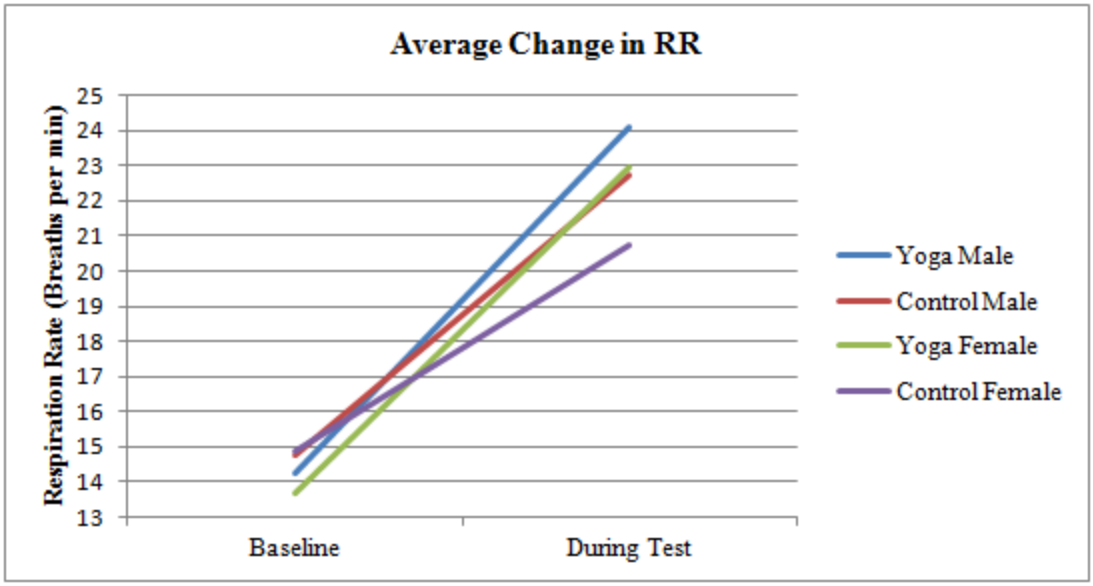


Figure 7. Average change in respiratory rates among males and females in both the control and experimental groups. All participants showed an increase in average respiration rates. ($p>0.05$)

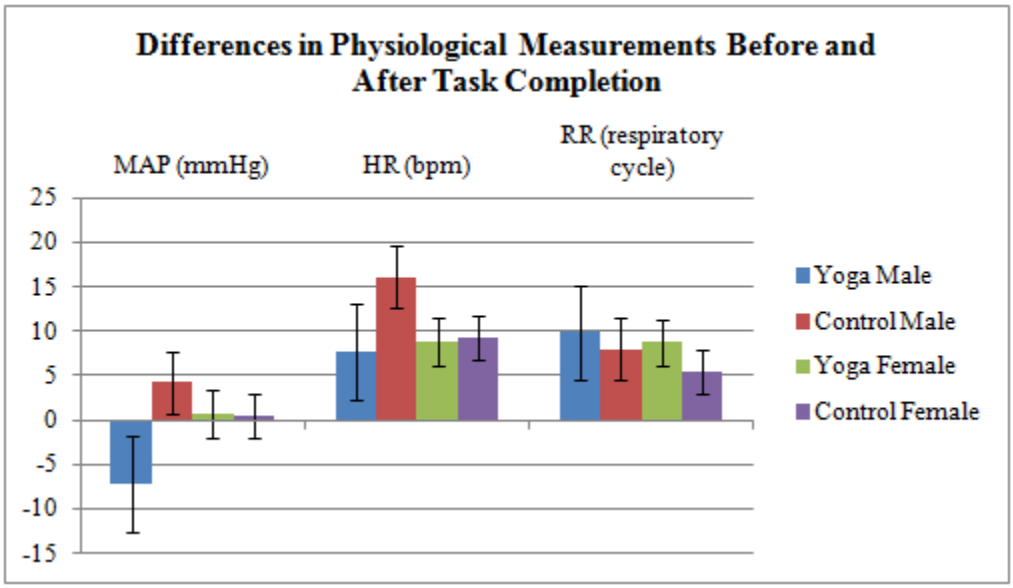
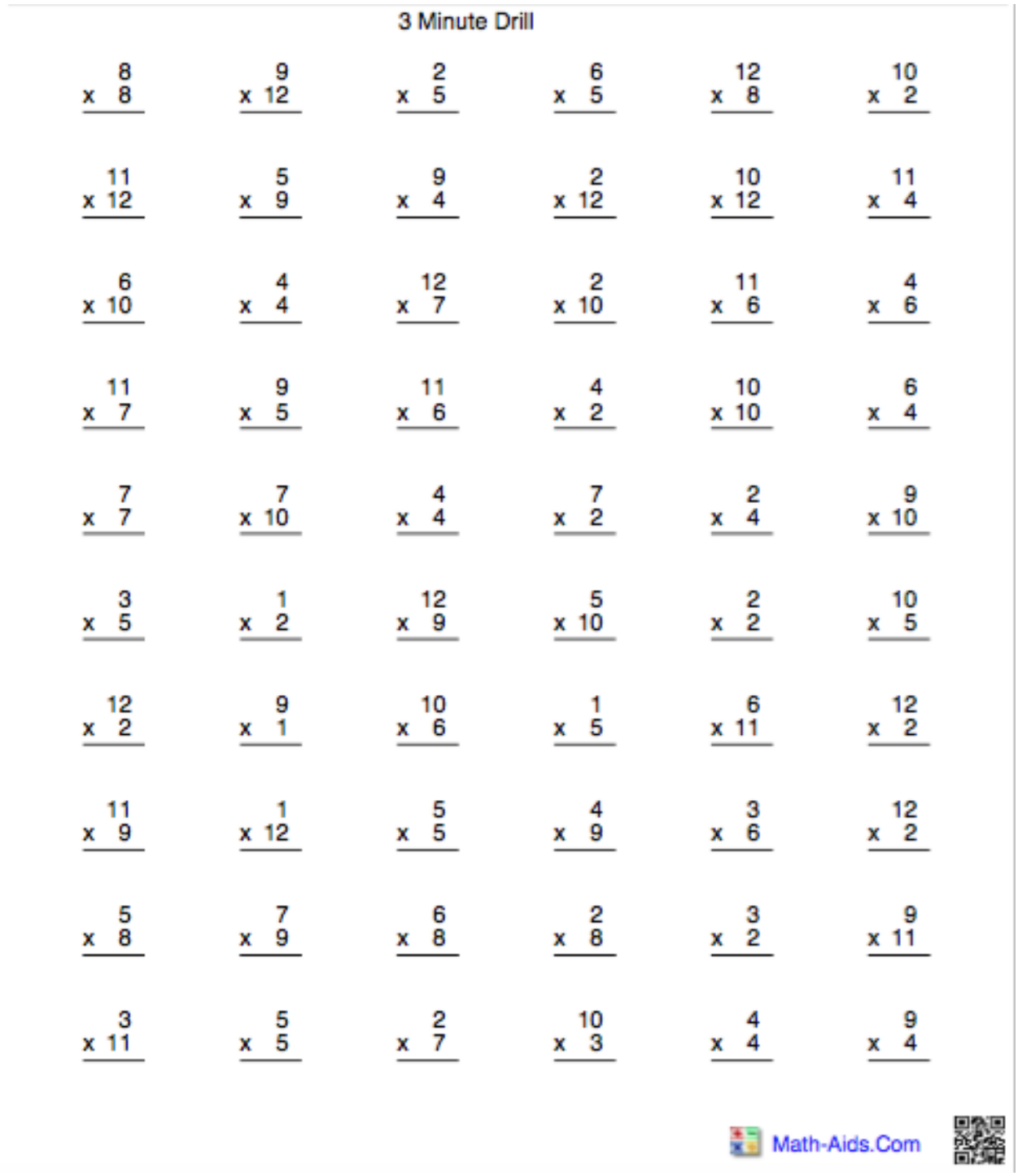


Figure 8. The graph above depicts differences in MAP, HR, and RR before and after task completion in both control and experimental groups. Negatives (-) and positives (+) refer to decreases and increases in the gradient between baseline and after-task measurements, respectively.

Appendix



3 Minute Drill

8 x 8	9 x 12	2 x 5	6 x 5	12 x 8	10 x 2
11 x 12	5 x 9	9 x 4	2 x 12	10 x 12	11 x 4
6 x 10	4 x 4	12 x 7	2 x 10	11 x 6	4 x 6
11 x 7	9 x 5	11 x 6	4 x 2	10 x 10	6 x 4
7 x 7	7 x 10	4 x 4	7 x 2	2 x 4	9 x 10
3 x 5	1 x 2	12 x 9	5 x 10	2 x 2	10 x 5
12 x 2	9 x 1	10 x 6	1 x 5	6 x 11	12 x 2
11 x 9	1 x 12	5 x 5	4 x 9	3 x 6	12 x 2
5 x 8	7 x 9	6 x 8	2 x 8	3 x 2	9 x 11
3 x 11	5 x 5	2 x 7	10 x 3	4 x 4	9 x 4

Math-Aids.Com

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