Power and Stature: Analysis of the Human Physiological Response to Stress

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Physiology 435, Spring 2016

Lab 603, Group 10

Keywords: Anxiety, Power Pose, Stress

Word Count: 2939

Abstract

Academic responsibilities for university students lead to higher levels of stress and anxiety on a daily basis. These stressors can be categorized as acute stressors, and have been found to lead to a release of hormones that influence the cardiovascular system and initiate a stressed emotional response. It has been found that mindfulness-based approaches, such as a power pose, can be used to decrease feelings of acute stress. A power pose manipulates the body into an open, wide stance that helps increase feelings of power and dominance. If an individual engages in a power pose stance, their blood pressure, pulse, and respiratory volume values should decrease and deviate less from the baseline, suggesting a more controlled physiological response during an acute stress situation. After having participants engage in a spontaneous business pitch, we found no significant differences in blood pressure, pulse or respiratory volume measurements for participants engaging in power pose stances compared to those not engaging in power pose stances. Confounding variables, such as location and friendships, may have contributed to participants' level of acute stress and led to the insignificance of our data. In the future, further experimentation should be done to evaluate the conditional requirements of a successful power pose.

Introduction

University students frequently endure many stressors due to various academic responsibilities that lead to higher levels of stress and anxiety on a daily basis (Conley et al., 2012). Stress and anxiety can be induced not only during academic evaluation, but also during presentations and the common interview process. Academic challenges that prompt stress and anxiety can be classified under "acute academic stress" or "anticipatory academic stress." "Acute academic stress" is the act of experiencing the actual stressor, such as taking an exam or giving a presentation. "Anticipatory academic stress" can take place during long-term events that influence a major goal, such as studying for an exam in order to do achieve a high grade. In this study, we will be focusing on acute academic stress.

During an incidence of acute academic stress, it has been found that there is an increase in systolic blood pressure (Loft et al., 2007). The change in systolic blood pressure can be attributed to cardiovascular and neuroendocrine physiological adjustments, in which acute stressors have been found to produce substantial, maintained cardiovascular and endocrine responses. Upon introducing the acute stressor, cortisol, an important hormone tied to physiological, psychological, and physical health regulation, is released. Through the use of a power pose, levels of cortisol release are reduced. The release of cortisol is associated with an increased pulse, systolic and diastolic blood pressure, as well as an increased respiratory volume (Sudsuang et al., 1991). Because it poses a great social and evaluative threat, public speaking is a significant acute stressor that leads to a release of hormones that influence the cardiovascular system and initiate a stressed emotional response (Al'Absi et al., 1997).

Due to the fact that a majority of university students experience emotional stress and anxiety when experiencing acute academic stress, an effective coping mechanism is sought to help decrease these responses that could pose future health risks. It has been found that the most successful approaches in reducing stress fall into three categories: cognitive, behavioral, and mindfulness-based. Of those three, the mindfulness-based approach works to reduce acute stress through awareness of the body (Regehr et al., 2013). One mindfulness-based approach includes the use of a power pose, which is characterized by having an open, wide stance that maximizes the total amount of space an individual assumes. By manipulating the body into expansive, high-power pose for a total of two minutes, feelings of power and dominance, testosterone levels, and risk-taking increase while stress, cortisol levels, and anxiety decrease (Carney et al., 2010). In addition to such changes, the individual is more likely to exhibit enthusiasm and be more proactive and positive about future endeavors (Cuddy et al., 2012). Through a simple and minimal amount of manipulation, the physiology and psychology of an individual can be significantly transformed so that they are able to successfully complete their goals.

Associated with higher levels of power, dominance, testosterone and lower levels of cortisol, a power pose may be used to alleviate oncoming stress and anxiety during an acute academic stress experience, such as public speaking. Factors that help indicate acute stress and anxiety are blood pressure, pulse, and respiratory volume measurements that deviate significantly from the baseline. During times of high acute stress and anxiety, an increase in all three of these measurements is also the consequent physiological response (Spielberger et al., 2013). While prior research on power poses has focused on serum cortisol and total protein level measurements, the connection between cortisol and the physiological measurements chosen in this experiment are clear. This information helped formulate the question and hypothesis for this study. If an individual engages in a power pose stance, will their blood pressure, pulse, and respiratory volume values decrease and deviate less from the baseline? If so, this will indicate that a power pose can help an individual have a more controlled physiological response than someone who does not perform a power pose before the exposure to an acute stressor that is associated with a high stake, stressful social situation.

Methods

Participants

Twenty-six participants completed this study, male (14) and female (12). All participants were students enrolled at the University of Wisconsin-Madison.

Materials

The physiological variables that were measured throughout this study were blood pressure, pulse, and respiratory volume. Blood pressure was measured using a 10 Series Upper Arm Blood Pressure Monitor (BP791IT, #2014004275LG, Omron Healthcare Co., Ltd., Lake Forest, IL, USA) fitted on each participant's non-dominant arm. Pulse readings were measured by a Pulse Oximeter (#9843, Nonin Medical, Inc., Plymouth, MN) with a finger clip sensor (#8000K2, Nonin Medical, Inc., Plymouth, MN) assembled on each participant's index finger on their non-dominant hand. Respiratory volume were gathered using a BSL Respiratory Effort Xdcr (SS5LB, #13116897, BIOPAC Systems, Inc., Goleta, CA, USA), or respiratory belt, centered at each participant's sternum and wrapped around around their chest region. The respiratory volume data was displayed by the BIOPAC BSL 4.0 MP36 software on a computer provided by the laboratory. A survey was given to each participant during the study to assess their confidence level, which was obtained using a randomly generated survey from "The Confidence Code" website. This survey helped account for the personality differences among the participants, which were then controlled during the statistical analysis of the final results.

Procedure

Each researcher was assigned a task. Researcher 1 read a written script, giving consistent directions to each participant throughout the study. Researcher 2 recorded the pulse readings. Researcher 3 recorded the blood pressure measurements. Researcher 4 worked the BIOPAC software on the computer, which displayed the respiratory volume measurements. Researcher 5 was the only group member informed of the randomized assignment of treatment to the participants in order to ensure a double-blinded study.

The study began with an introduction given by Researcher 1. Then, the participant read and signed a consent form. Afterwards, Researcher 5 helped the participant be fitted with the equipment: blood pressure monitor on participant's non-dominant arm, pulse oximeter with finger clip sensor on participant's index finger on non-dominant hand, and respiratory belt centered at the participant's sternum and wrapped around around their chest region. The participant was then prompted to complete a survey consisting of questions that assess his or her overall confidence level. While completing the survey, the participant's baseline blood pressure, pulse, and respiratory volume were measured using the equipment and BIOPAC software provided by the laboratory.

Once the survey and measurements were recorded, the equipment was removed from the participant. Then, the participant stayed in the room with Researcher 5 while the other group members left. According to a randomized list, Researcher 5 instructed each participant to either sit in their chair (control) or perform a "super-man" power pose (experimental) for two minutes. For the "super-man" power pose, participants were asked to stand-up, place their hands on their hips and look straight ahead at the other side of the room. Following the instructions, Researcher 5 left the room and started a timer for two minutes. The assignment of the control and experimental poses were based on a random number generator that outputted “1” (control) and “2” (experimental) at equal probabilities to effectively remove any bias for treatment selection.

After two minutes, all five researchers returned. Researcher 5 helped reassemble the equipment on the participant. Meanwhile, Researcher 1 instructed the participant to prepare a business pitch to market a plain wooden board with wheels. Following the preparation, the participant would have to present their pitch in front of the lab group. This was an applied acute stressor meant to cause a change to the physiological variables for each participant. During the preparation time, the participant’s blood pressure, pulse, respiratory volume were measured again. Once measurements were recorded, the participant was thanked for his or her time and the individual experiment was finished. All the data representing the physiological changes in blood pressure, pulse, and respiratory volume before and after the applied acute stressor were recorded in a spreadsheet. See timeline (Figure a).

Positive control data

Figures b-e represent the positive control data (with the addition of data gathered from a participant who performed a power pose), serving as evidence that changes in blood pressure, pulse, and respiratory volume were measurable before and after the stressful event.

Date Analysis

The collected data within this study was analyzed using the ANOVA statistical test to assess for significance.

Results

For all three physiological variables, respiratory volume, pulse, and blood pressure, the mean change between the measurements made before and after the stressor was found to be not significant (p-value > 0.05). There were twelve participants randomized into the control group (no pose) while there were fourteen participants randomized into the treatment group (power pose). The ANOVA analysis controlled for the participants' gender and confidence report on the survey.

Respiratory Volume

The mean change in respiratory volume (mV) from the baseline measurements in response to the applied stressor within the study for the control group was approximately -0.134 mV, while the mean change for the treatment group was approximately 0.044 mV. The negative mean value for the control group suggests that there was on average a decrease in respiratory volume (mV) from baseline measurements. The positive mean value for the treatment group suggests that there was on average an increase in respiratory volume (mV) in the treatment group in response to the applied stressor. The control group had a larger absolute value, indicating a greater change from baseline. However, for both the control (no pose) and treatment (power pose) groups, this data was found to be statistically not significant (p-value=0.4945). The overlapping standard error bars in Figure 1 also show this.

Blood Pressure

The mean systolic, diastolic and arterial pressure (mmHg) before and after the stressor for treatment and control groups were calculated along with standard deviations. For each pressure measure, there was very little difference in change, if any at all, from baseline to after the stressor was introduced. The data was found to be statistically not significant (p-value: 0.254). Overlapping error bars further indicate this finding as seen in Figure 2.

Pulse

The mean change in pulse (beats/min) from the baseline measurements in response to the applied stressor within the control group was approximately 7.77883 beats/min, whereas the mean difference within the treatment group was 8.20154 beats/min. Though these values show that the control group had less of a pulse spike than the treatment group, a difference of only 0.42271 beats per minute between the two groups, as well as a calculated p-value of 0.156, show that the data obtained was not significant. The overlapping error bars in Figure 3 further confirm this fact, showing little to no significance between power pose treatments and pulse.

Discussion

The experiment showed no significant changes in physiological responses after requiring a participant to hold a power pose prior to an applied acute stressor - a spontaneous business pitch. While no statistical significance was found, the data collected from this study reflected general trends that support our hypothesis. According to Figure 1, the mean change in respiratory volume (mV) for the treatment group, which performed the power pose, was smaller in comparison to the mean change for the control group, which did not perform the power pose. The lack of significant results may be accredited to potential shortcomings in our experiment. The location of the testing facility likely impacted our findings. During the data collection process, the study took place in a large laboratory serving as the connection point to a number of different rooms. As a result, groups of students unintentionally interfered with the testing process by entering the room while a participant was performing a power or control poses in private. This occurred for a number of trials. Friendships between the participants and members of the research team may have reduced the amount of stress triggered during the study as well.

Respiratory Volume

Data shows that there was a greater absolute mean change in respiratory volume from baseline in response to the applied stressor for the control group than the treatment group. Unlike for the treatment group, however, the mean change was negative (Figure 1) for the control group, indicating an average decrease in respiratory volume when the stressor was applied. This data was surprising because previous studies suggest that minute respiratory volume increases when an individual is experiencing anxiety or stress (Spielberger et al., 2013). Such an increase in minute respiratory volume was rather seen in the treatment group, in which the participants performed the power pose. While this study suggests that the performance of a power pose could help control the change of respiratory volume in an individual who will shortly experience a stressor, it also shows there will be an increase in the measurements. The opposite results were seen in participants who did not perform the power pose. Regardless, this data was found to be statistically insignificant. To provide significant data regarding the effect of power poses on the regulation of human respiratory volume in stressful situations, future research should consider extending the treatment time. The resulting data may then reflect an even smaller mean change and a decrease in respiratory volume from baseline in response to an applied stressor for the participants who performed a power pose, as hypothesized.

Blood pressure

Data results show that after the applied stressor, there was a slightly larger positive mean change in systolic and diastolic pressure, and thus a larger mean change in mean arterial pressure, from baseline in the treatment group than in the control group. Blood pressure measurements in the control group showed little to no change in systolic pressure after the stressor, no change in diastolic pressure, and little to no change in the mean arterial pressure. The calculated p-value of 0.254 denotes that the data lacked significance.

Possible sources of error that could have accounted for the lack of significance within the data are proper placement of blood pressure measurement device. This includes adequate fastening and complete raising of sleeves if the participant was wearing long sleeve clothing.

Pulse

The pulse measurements taken for each group before and after the stressor revealed that introducing the stressor showed no statistical significance ($p=0.156$). Although a difference was evident between the average changes in pulse between the two groups, the difference was so minute (0.42 bpm) that it could be attributed to random error during data collection rather than a significant correlation between the two.

One possible source of error during data collection includes the possibility that the pulse oximeter lacked sensitivity and was unable to give accurate outputs of pulse in real time, reducing the number of values obtained outside of an outlier range in the given 30 second period. In the future, this problem can be resolved by either extending the treatment time to increase the quantity of values recorded or potentially utilizing a device with increased accuracy.

Though there were no physiological significant differences between the power pose group and control group, prior studies suggest power poses are capable of improving an individual's psychological power and therefore executive function (Smith et al, 2008). By taking control of one's executive function, the ability to prepare for impromptu events increases, thus increasing the participant's confidence levels during the actual business pitch. Taking this into consideration, it is necessary to perform future experimentation evaluating an individual for his or her final performance. Documenting physiological measurements both before and during this performance would be insightful in determining if holding a preparatory power pose significantly impacts the participant during the final presentation. Thus, making it possible to conclude whether a power pose holds only preparatory or absolute effects.

A recent publication by Ranehill sought to recreate and evaluate the robustness of the original experiment was released last year and reported no statistical significance in relation to hormonal levels or behavioral task performance. Statistical significance existed solely in relation to the participant's self-reported feelings of power (Ranehill et al, 2015). Learning from this, is important to acknowledge that while the power posing effects have been documented, it is also situational. In this experiment, it is possible that the experimental situation was not supportive of yielding significance in relation to the power pose effects. In previous studies, providing subjects with the preliminary knowledge that their performance will be analyzed led to significant results. In contrast, leaving out such information led research to conclude results were insignificant. Moving forward, further experimentation should aim to decipher the psychological conditional requirements of successful power posing.

Acknowledgments

We would like to thank Dr. Andrew Lokuta, Jessica Abrams and Alan Sayler for their continued support of our work.

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Figures and Legends

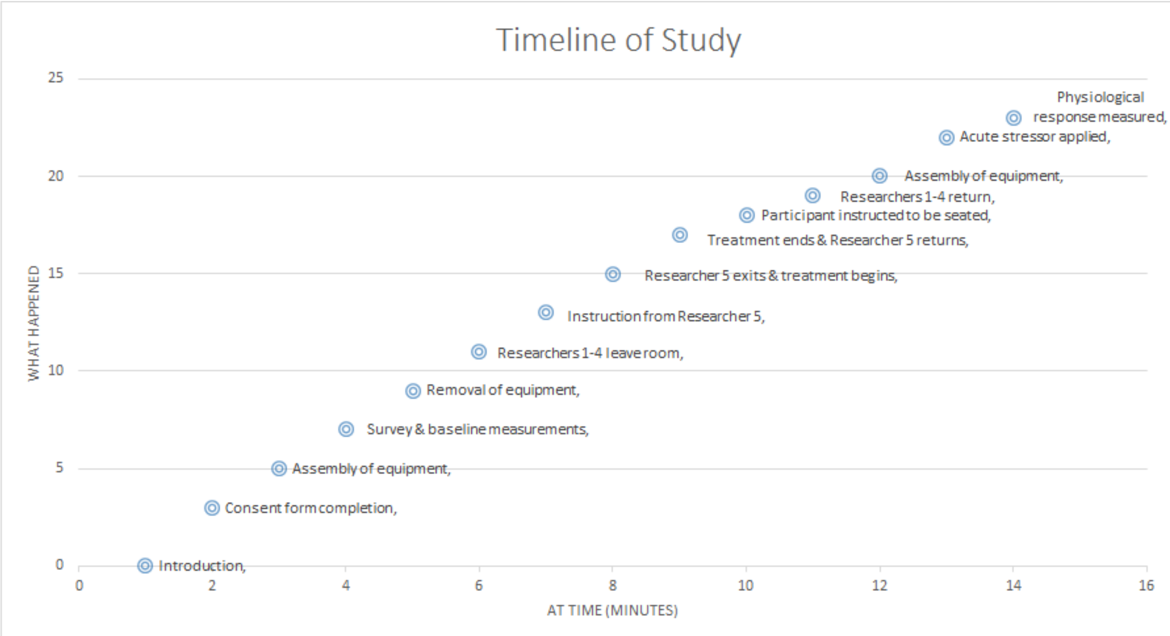

Figure a. This figure describes the chronological order of all the events within this study.

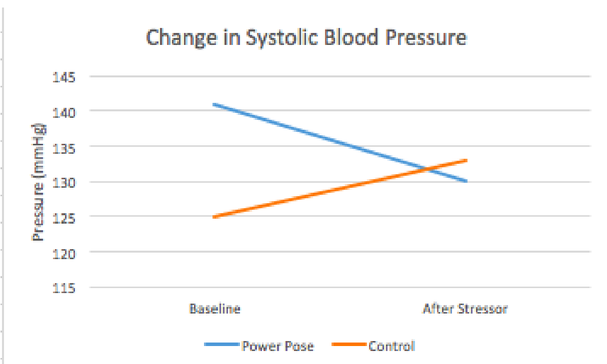

Figure b. This graph represents the change in systolic blood pressure within the positive control from baseline measurement in response to the applied stressor.

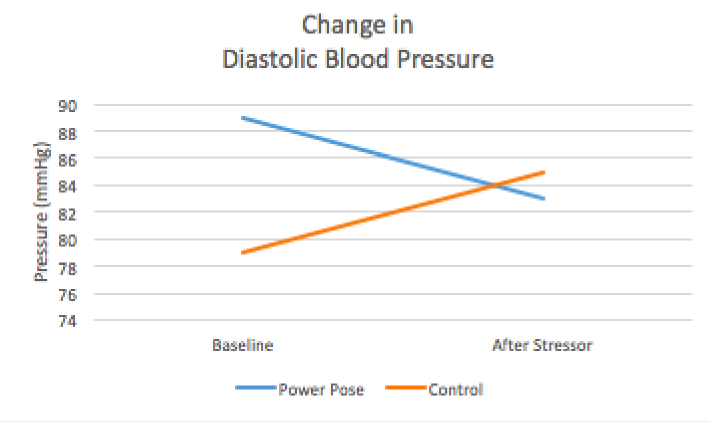

Figure c. This graph represents the change in diastolic blood pressure within the positive control from baseline measurement in response to the applied stressor.

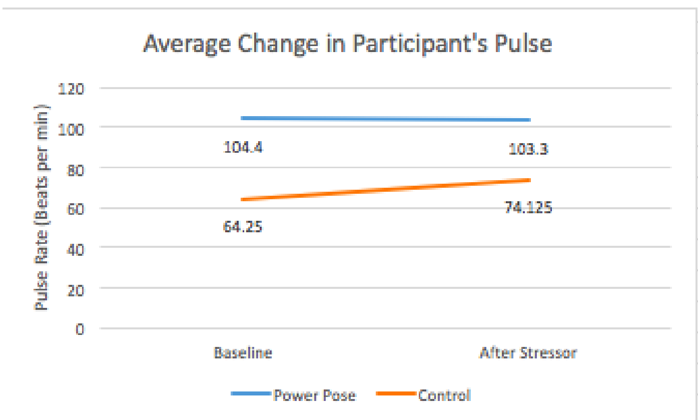

Figure d. This graph represents the change in pulse within the positive control from baseline measurement in response to the applied stressor.

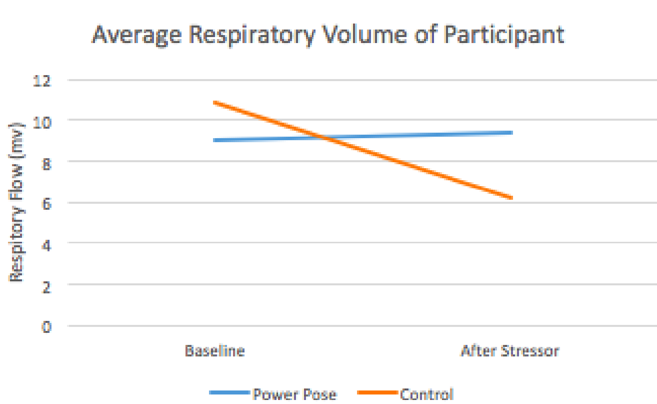

Figure e. This graph represents the change in respiratory volume (mV) within the positive control from baseline measurement in response to the applied stressor.

Respiratory Volume

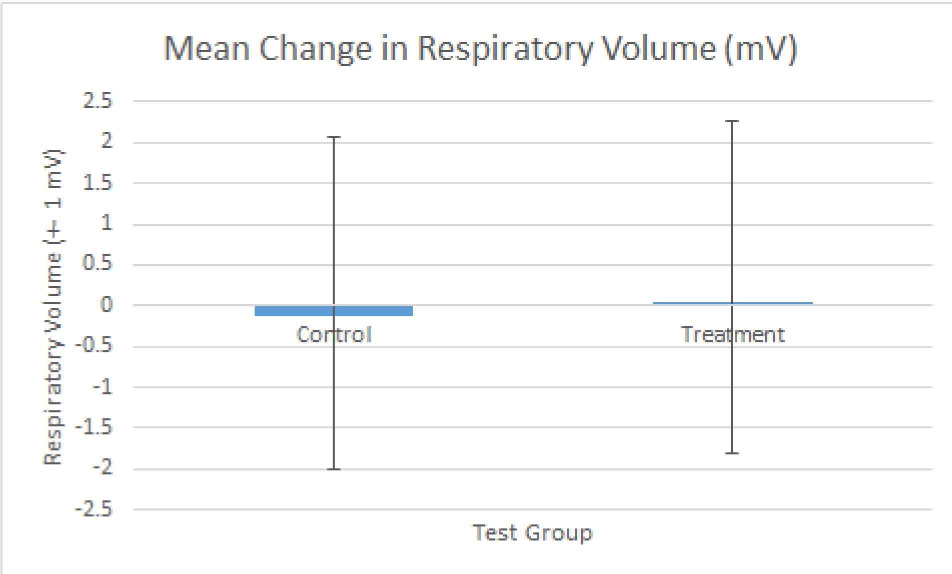

Figure 1. This graph represents the mean change in respiratory volume (mV) from the baseline measurements in response to the applied stressor for both the control (no pose) and treatment (power pose) groups. (control group, n=12, mean standard deviation (S.D.)=3.914, standard error=2.214; treatment group, n=14, S.D.=3.560, standard error=1.865; p-value=0.4945).

Blood Pressure

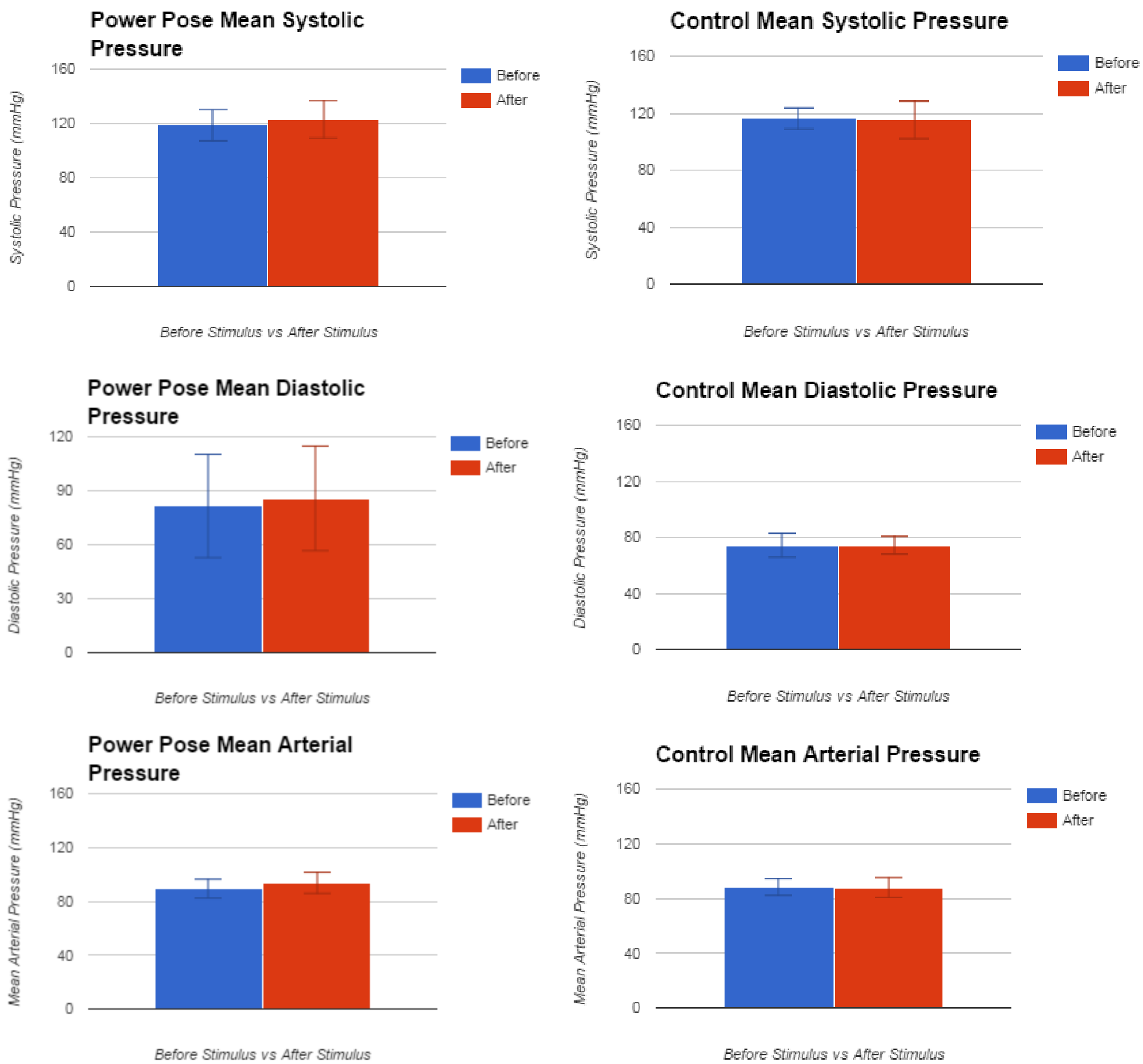

Figure 2. This figure shows the graph of mean systolic, diastolic and arterial pressure measurements (mmHg) in both treatment group (left column, top to bottom) and control group (right column, top to bottom) collected before and after the applied stressor. (treatment group, n= 14, mean standard deviation (S.D): systolic before (SB)=11.506 , systolic after (SA)=13.717, diastolic before (DB)=6.435, diastolic after (DA)=8.03, mean arterial pressure before (MAPB)=7.01, mean arterial pressure after (MAPA)=7.85; control group, n=12, SDSB=7.35, SDSA=13.1, SDDB=8.5, SDDA=6.39, SDMAPB=6.1, SDMAPA=7.31; p-value: 0.254).

Pulse

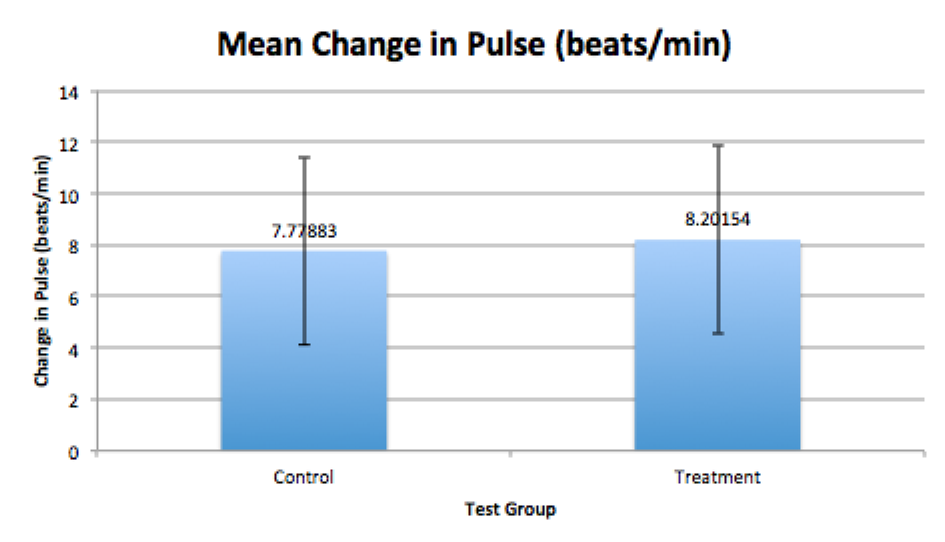

Figure 3. This graph represents the mean change in pulse (beats/min) from the baseline measurements in response to the applied stressor for both the control (no pose) and treatment (power pose) groups. (control group, n=12, mean standard deviation (S.D.)=11.6654, standard error=6.6003; treatment group, n=14, mean standard deviation (S.D.)=13.9634, standard error=7.31449; p-value=0.156).