# Effects of Dubstep Music on Physiological Measures of Stress Induced by Test Anxiety

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## Abstract

**Background.** Test anxiety is a common psychological phenomenon that manifests itself through the activation of the sympathetic nervous system. These physiological responses to a stressful test can have negative effects on the individual's performance. Listening to music is a common practice students use while studying or completing assignments. However, different types of music may evoke different physiological effects in individuals. **Objective.** This study examines the physiological effects of dubstep music on the stress response of individuals taking a stressful five minute IQ test. **Methods.** Blood pressure, heart rate, and galvanic skin response measures were obtained over the five minute testing period to determine sympathetic arousal. Data from a control group, exposed to no dubstep, and an experimental group, were compared. (n=20). **Results.** No significant difference in physiologic response was seen between groups. **Conclusion.** No results were statistically significant (p-value < 0.05), therefore dubstep music does not induce an increased stress response compared to baseline. Future studies of the effects of dubstep should be considered using a larger sample size and better control for confounding variables.

## Introduction

Test anxiety is a common psychological experience that can impose numerous negative effects on an individual. Traditionally, it has been widely accepted that test anxiety is composed of emotionality and feelings of worry. These emotions are capable of inducing various psychosomatic responses, which includes increased sweating, dizziness, nausea, and panic (Cassady and Johnson, 2002). Test anxiety can also manifest physiologically through the activation of the sympathetic nervous system, producing elevated cardiovascular responses such as heart rate and blood pressure, and increased electrodermal activity (Conley 2010, Reinhardt 2012). The physiological effects resulting from test-related anxiety also pose the possibility of interfering with psychomotor processes that are used during complex problem solving (Deffenbacher, 1986). Individuals who experience high levels of cognitive test anxiety have

been shown to perform significantly poorer during exams, particularly when placed under highly evaluative situations (Hancock, 2010). However, a moderate level of increased physiological response correlates with better test scores, so a certain level of heightened sympathetic nervous system activity may be necessary for optimal performance (Cassady and Johnson, 2002).

Anxiety is a negative influence on both psychological and physical health, and students take measures to combat short-term and long-term stress. Listening to music is a common practice students engage in while studying or completing assignments. In numerous studies, music has been found to reduce physiological signs of stress in a wide range of situations which invoke negative emotions (Watkins, 1997). Upon listening to a Mozart orchestral piece, participants reported feelings of being more at ease, rested, and refreshed, resulting in psychological relaxation and stress reduction (Smith and Joyce, 2004). Hospitalization is a measurable inducer of anxiety and stress for many. Music therapy prior to surgery has been shown to lower reported anxiety (Wang et al, 2002). It has also been reported to reduce both heart rate and systolic blood pressure, physiological values associated with a stress response (Hamel, 2001).

However, a large majority of research has revolved around classical music and its calming effects, excluding other types of music. Dubstep is a relatively new and distinctive genre, thus little research has been done regarding its potential effects on anxiety. This genre began in UK South London almost ten years ago and has only recently made headway into US mainstream market and has since gained a popularity. This genre is characterized by the use of heavy bass, fast tempos, percussion patterns, and intense electronic sounds (Gaerig, 2012). These descriptors are quite the opposite of a typical classical selection. Therefore if classical music is consistently shown to induce a calming response, dubstep music may also elicit a

response. This response may be of concern or relative importance, considering its rising popularity, especially amongst those of schooling age. The purpose of this study is to examine the potential physiological effects of dubstep music on the stress response of individuals taking an IQ test. The IQ test is designed to be unreasonable in its expectations, in order to induce anxiety among participants. Dubstep is not generally considered calming, therefore it may be expected to have the opposite effect as classical music does. It is hypothesized that a significantly increased physiological stress response will be seen in subjects exposed to dubstep while taking the IQ test compared to subjects taking the test in silence.

**Materials and Methods**

Physiologically relevant measurements were taken to measure the response to dubstep music exposure included heart rate, blood pressure, and galvanic skin response. Galvanic skin response was measured via the BIOPAC student lab software, which included placing two electrodes on the index and middle finger of the subject's non-dominant hand. Heart rate was measured with a pulse oximeter placed on the ring finger of the same hand fitted with the GSR electrodes. Blood pressure was recorded with an automatic cuff placed around the wrist. These physiological measurements were chosen to measure the level of stress and sympathetic nervous system activation in our participants. In times of increased stress, the sympathetic nervous system increases the amount of sweat secreted by the body, which affects the electrodermal conductance and manifest itself in the GSR data. In addition to increased sweat production, activation of the sympathetic nervous system stimulates cardiovascular activity, measurable with increased heart rate as well as blood pressure in the human body. Recording these variables in research participants provides insight into the stress level and sympathetic activity of participants listening to dubstep music and in the control.

Upon initiation of evaluation, the subject was placed in a quiet room to limit distractions and attempt to omit confounding variables. They were seated at a table, facing away from the computer. The equipment necessary to measure physiological response was then applied to their body. Initially, baseline measurements for the variables were recorded to obtain average, resting values (see Figure 1.). The subject was then informed that they would be taking an IQ test that will last a duration of five minutes and can be completed in this time period. The IQ test serves the purpose of inducing a stress response, which was measured by increased heart rate, blood pressure, and GSR. The test was unreasonable in its design and expectations, because there are more questions than can be completed within the time limit. They were also considered to be challenging to the average individual because they were selected from sample questions that are asked to be admitted into a high-IQ organization. A timer counting down the time remaining was placed in view of the subject to attempt to further increase the anxiety experienced by the individual. The group that took the test without listening to music is the negative control; this is expected to be the average stress response. Another test group completed the IQ test while listening to dubstep music. This group served as the positive control; an effect was expected. The chosen song to be representative of this genre was "Woo Boost (Subskrpt Remix)" by Rusko, a dubstep DJ and record producer. The song is characterized by a fast tempo, use of bass, and electronic sounds.

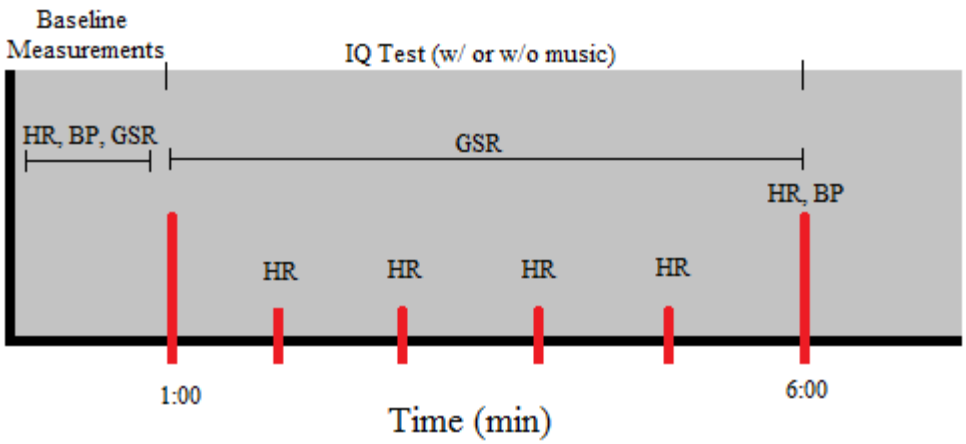


**Figure 1.** Timeline of measurements obtained during the study process. Baseline measurements include heart rate (HR), blood pressure (BP), and galvanic skin response (GSR). The initial red line indicates the start of the IQ test, which lasts five minutes. Heart rate was taken at one minute intervals during the test. Further measurements are taken at the corresponding points on the chart.

During the test, GSR was recorded throughout the entire duration because of its minimal invasiveness and constant measurement on the BIOPAC software. Heart rate was measured off the pulse oximeter at one minute time intervals during the test. Blood pressure was recorded immediately upon completion of the test. Recording blood pressure may have served as a distraction to the subject and is invasive, so it was not taken during the test. Once all the physiological data had been recorded and the test has been concluded, each test subject was given a short survey concerning their music listening habits. Each subject's survey was correlated to their data through their subject number. This serves to gather data on the subject's own psychological response and interpretation of the study which can be compared to the physiological effect.

Upon subsequent compiling of data, they were analyzed to determine if there is a significant effect of listening to dubstep on the stress response. Results were compared in

Microsoft Excel using paired t-tests assuming unequal variance to determine statistical significance between the control and experimental groups to reach a conclusion that confirms or rejects the hypothesis.

## Results

All participants were young adults enrolled in Physiology 435 at the University of Wisconsin-Madison. Both control and experimental groups had the same population size (n=10), and there were 11 females and 9 males. .

### *Galvanic Skin Response*

The galvanic skin response, measured in microsiemens, was taken for each subject throughout the five minute testing period. The mean GSR value was calculated for each subject (see **Figure 2.**). Upon revision of the data, it was discovered that two files could not be opened for unknown reasons, and one data recording appeared to have been taken from a poorly placed electrode. This required the removal of three data points from the experimental group. In order to perform a paired t-test comparison between the two groups, three randomly selected GSR values were also removed from the control group. A paired t-test assuming no variance was performed on the subsequent data compilation between the control and experimental group mean GSR values. The critical p-level, or alpha level, was set at $p<.05$. There is no statistically significant difference between the groups (p=0.317011) (see **Table 1.**).

| | p-value |
|---|---|
| Diastolic P | 0.283784 |
| Systolic P | 0.068812 |
| MABP | 0.168047 |
| Heart Rate | 0.159033 |
| GSR | 0.317011 |

**Table 1.** Calculated p-values from paired t-test comparisons measuring the difference in stress response between the

experimental and control groups.

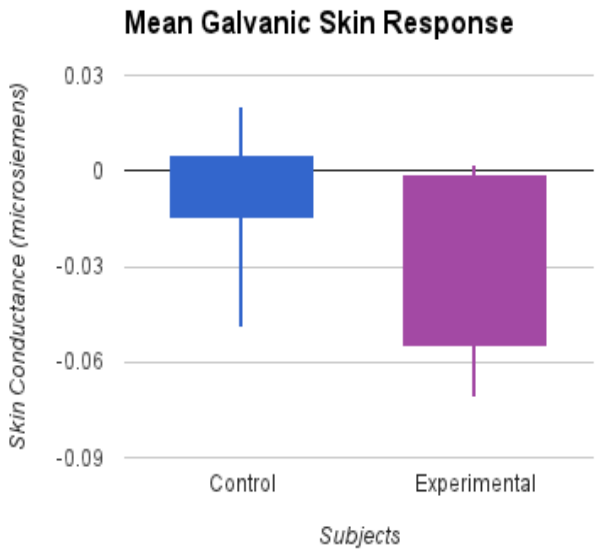


**Figure 2.** Box and whisker plot representing the distribution of mean GSR values for both the experimental and control groups.

***Blood Pressure***

Blood pressure was measured as systolic(SP)/diastolic(DP) readings in mmHg. These values were used to calculate Mean Arterial Blood Pressure(MABP) via the formula DP+1/3(Pulse Pressure)=MABP(see **Figure 3.**). Pulse Pressure(PP) was calculated as SP-DP=PP. The blood pressure values for resting and post-IQ test were subtracted from each other to measure the disparity. A paired t-test assuming unequal variance was performed between the control and experimental group for these differences. The critical p-level, or alpha level, was set at $p<.05$. There was no significant difference found in MABP, systolic or diastolic blood pressure (see **Table 1.**).

| MABP | Mean Control | ± SD | Mean Experimental | ± SD |
|---|---|---|---|---|
| Pre IQ test | 92.87 | 11.41 | 88.43 | 9.59 |
| Post IQ test | 94.17 | 10.17 | 97.57 | 17.89 |
| Post-Pre IQ test | 1.3 | 5.10 | 9.13 | 15.99 |

**Table 2.** Table representing mean and standard deviation values for the data from both the experimental and control groups for MABP.

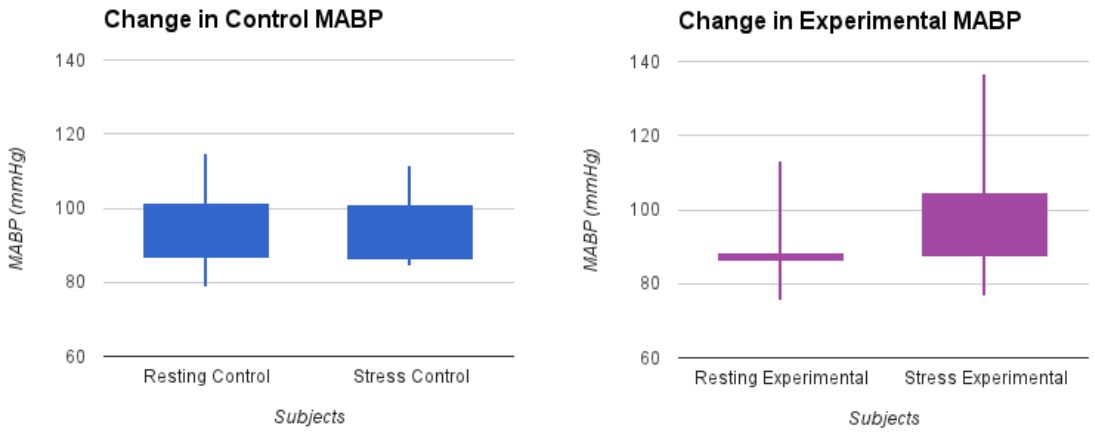


**Figure 3.** Box and whisker plots representing the distribution of data values of MABP for control and experimental groups.

| Systolic | Mean Control | ± SD | Mean Experimental | ± SD |
|---|---|---|---|---|
| Pre IQ test | 121.4 | 16.68 | 117.3 | 9.55 |
| Post IQ test | 121.5 | 11.34 | 126.7 | 20.97 |
| Post-Pre IQ test | 0.09 | 8.41 | 9.40 | 12.50 |

**Table 3.** Table representing mean and standard deviation values for the data from both the experimental and control groups for systolic blood pressure.

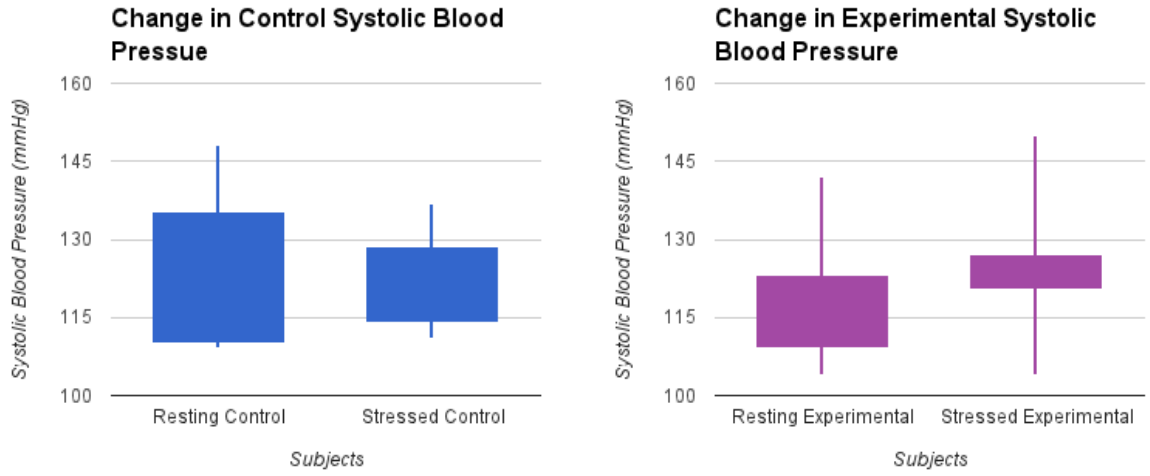


**Figure 4.** Box-and whisker plots representing the distribution of data values of systolic pressure for both the experimental and control group.

| Diastolic | Mean Control | ± SD | Mean Experimental | ± SD |
|---|---|---|---|---|
| Pre IQ test | 78.6 | 10.63 | 74 | 10.47 |
| Post IQ test | 80.5 | 10.77 | 83 | 20.97 |
| Post-Pre IQ test | 1.90 | 5.93 | 9 | 19.02 |

**Table 4.** Table representing mean and standard deviation values for the data from both the experimental and control groups for diastolic blood pressure.

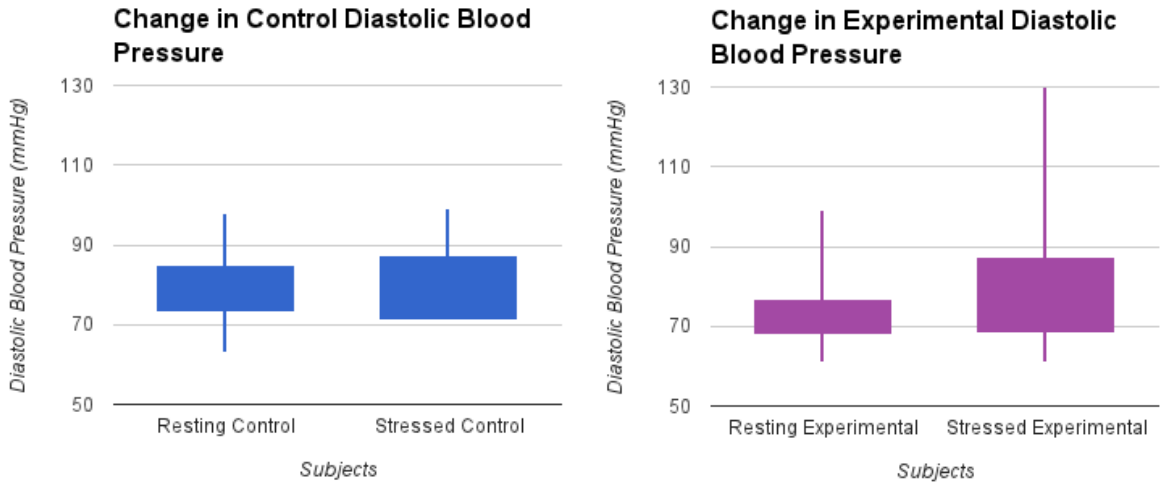


**Figure 5.** Box and whisker plots representing the distribution of data values of diastolic pressure for both the experimental and control groups.

### *Heart Rate*

Heart rate values were measured at one minutes intervals throughout the duration of the IQ-test, and these values were averaged to obtain a mean test-taking heart rate. Resting (pre-IQ test) heart rates were also obtained (see **Figure 6.**). The pre-IQ test values were then subtracted from the mean test-taking heart rate values to find the disparity. A paired t-test assuming unequal variance was performed between the control and experimental group for these differences. The critical p-level, or alpha level, was set a $p<.05$. There is no statistically significant difference in heart rate between the groups ($p=.159033$)(see **Table1.**).


**Figure 6.** Box and whisker plot representing the distribution of mean values of heart rate for both the experimental and control groups.

| Heart Rate | Mean Control | ± SD | Mean Experimental | ± SD |
|---|---|---|---|---|
| Pre IQ test | 77.54 | 14.43 | 67.7 | 12.84 |
| IQ testing | 81.36 | 11.47 | 75.8 | 9.91 |
| testing-Pre IQ test | 3.81 | 7.68 | 8.09 | 4.93 |

**Table 5.** Table representing mean and standard deviation values for the data from both the experimental and control groups for heart rate.

**Discussion**

It was hypothesized that listening to dubstep music while undergoing the IQ test would result in an greater stress response, measured by increased physiological values of blood pressure, heart rate, and electrodermal conductance.

The results of the blood pressure measures did not reveal statistical significance. Although there was a larger increase in systolic and mean arterial blood pressure in our experimental group, the difference was not statistically significant (p=0.283784, 0.068812, 0.168047). It is important to note that blood pressure was taken only twice throughout the test. Once for baseline before the test began, and again at the end of the IQ test. It does not account for variation during the test. Blood pressure readings were recorded using an automatic wrist cuff. Despite readings displaying relatively normal values (120/80), there was the potential that this technology may not reveal accurate blood pressure values. However, the same cuff was used on all subjects so values are accurate relative to each other, and this process replaces error that could otherwise have been caused by human measurements. In addition to potentially inaccurate blood pressure readings, the short duration of the test may not have allowed the body sufficient time to fully adjust its blood pressure to a stressful situation. Systolic blood pressure measures were the only readings to trend towards higher stress in the experimental group, however these results were not significant enough to support our hypothesis.

The results of heart rate measures also did not reveal statistical significance. There was no measurable difference between the control and experimental group (p=0.159033), and the control group on average recorded an increase of almost ten beats per minute, versus a five beats per minute increase in the experimental group. These results do not support our hypothesis and actually trend towards more physiological stress response in our control group. Heart rate

measurements were the most accurate of our three physiological measures, however the data were not completely accurate due to potential error in the pulse oximeter. In addition to potential inherent error in the pulse oximeter, the readings could have been further skewed because the oximeter was placed on the ring finger instead of the index finger in order to allow placement of the GSR probes on the index and middle finger. Heart rate measurements directly contradicted the blood pressure, however they were also less statistically significant. A lack of statistically significant data, in addition to a small sample size makes it difficult to reach a concrete conclusion based on data taken from the heart rates of our test subjects.

The galvanic skin response measurements were difficult to record and to analyze. During testing, several subjects experienced issues with the electrodermal skin receptors sliding off their fingers or not properly registering skin conductance. Due to these errors our data were incomplete for the experimental group. In order to perform t-tests as well as other analysis, data were randomly removed from the control group. In addition to poor data recordings, the graphs of electrodermal activity were difficult to analyze and contained little useful information. Along with errors which contaminated data on specific subjects, the galvanic skin receptors consistently calibrated below a neutral value, and provided negative readings. Electrodermal conductance is also the most variable measure in response to environmental conditions such as temperature and humidity. If there was anything significant to be drawn from the GSR readings, it was on a case by case basis. In some subjects there was a noticeable spike in electrodermal conductance associated with stimulus such as receiving a time warning, or reading a new question on the IQ examination. Overall the galvanic skin response provided little usable data to either support or reject the hypothesis.

To account for confounding variables of individuals who frequently listen to dubstep music, each subject in the experimental group was administered a survey post-IQ test. Subjects were asked five questions pertaining to listening to music while studying, the type of music, and their opinion toward dubstep music in particular (see **Figure 5.**).

| Question | Average Response |
|---|---|
| 1. On average how frequently do you listen to music while studying? (Never=1, Always=5) | 3.1 |
| 2. On average how frequently do you listen to Dubstep? (Never=1, Always=5) | 2.6 |
| 3. How frequently do you listen to Dubstep while studying? (Never=1, Always=5) | 1.2 |
| 4. How much do you like Dubstep? (Hate=1, Love=5) | 2.6 |
| 5. How do you feel about Dubstep while studying? (Relaxing=1, Annoying=5) | 4.3 |

**Table 6.** Experimental group post-test survey results. Responses were tallied and assigned numerical values (1-5).Total response scores were averaged for the 10 subjects to obtain mean response values.

Results of the survey indicated 7/10 subjects in the experimental group reported that they listen to music while studying. However 8/10 subjects reported never having listened to dubstep while studying. 8/10 subjects rated dubstep music to be either mildly annoying or annoying, and no subjects rated dubstep as relaxing or mildly relaxing. These findings suggest that a majority of the subjects found the dubstep annoying, despite the lack of physiological response. The survey results support the idea of further study into this experiment to determine if this irritation is manifesting in a physiological change not measured by this study.

Methodological limitations must be considered when viewing results of the study. Due to lack of approval from the Institutional Review Board permitting human subject testing, subjects had to be selected from a small, nonrandomized population of students. All subjects attended the University of Wisconsin-Madison, were enrolled in Physiology 435, and were in the age range of approximately 20-25 years. In addition, time constraints and available lab time also restricted the number of subjects able to be recruited for testing. Further variables that were uncontrolled for in the study include: medications, beverages, and food consumed prior to testing. Such variables

may have had an effect on  the physiological parameters measured from the subjects chosen for the study.

Future studies should use a larger, randomized sample. They should also use more accurate testing measurements, such as using a program that measures GSR that is easy to manipulate.  Future studies should consider using more measurements, such as respiratory activity, to determine physiological stress. The experimental design of future studies could be improved by using the same test subjects for both the control and experimental groups. A group of subjects would take the test in silence, and then, after a significant waiting period, take a comparable test while listening to dubstep.  A second group would do the tests in reverse order, by listening to music first, then in silence.  The reverse accounts for variation caused by the testing order.  By using each subject as their own control, the experiment would then be controlled for physiological variations per subject. Overall, results of this study do not support the hypothesis that listening to dubstep music while undergoing the IQ test results in an greater stress response.

## Appendix

| Date | Subject/Gender | Baseline BP | HR0 | HR1 | HR2 | HR3 | HR4 | HR5 | Final BP | Mean GSR |
|---|---|---|---|---|---|---|---|---|---|---|
| 3/12/2013 | 1/F (C) | 142/87 | 63 | 72 | 90 | 85 | 85 | 94 | 131/88 | 0.005 |
| 3/12/2013 | 2/M (C) | 146/91 | 102 | 100 | 101 | 106 | 105 | 100 | 137/99 | 0.005 |
| 3/12/2013 | 3/F (C) | 109/76 | 70 | 87 | 91 | 91 | 86 | 86 | 114/77 | 0.005 |
| 3/12/2013 | 4/F (C) | 112/74 | 61 | 70 | 68 | 75 | 67 | 72 | 121/85 | -0.049 |
| 3/12/2013 | 5/M (C) | 113/73 | 60 | 71 | 76 | 70 | 69 | 70 | 122/75 | 0.02 |
| 3/12/2013 | 6/F (C) | 109/77 | 50 | 53 | 54 | 54 | 58 | 59 | 114/71 | -0.011 |
| 3/12/2013 | 7/M (C) | 148/98 | 75 | 82 | 80 | 79 | 87 | 79 | 134/96 | -0.015 |
| 3/12/2013 | 8/F (C) | 110/63 | 74 | 70 | 73 | 70 | 72 | 72 | 111/71 | |
| 3/12/2013 | 9/M (C) | 115/68 | 67 | 86 | 75 | 84 | 77 | 78 | 120/71 | -0.038 |
| 3/12/2013 | 10/F (C) | 110/79 | 55 | 64 | 70 | 73 | 74 | 67 | 111/72 | -0.007 |
| 4/2/2013 | 1M/M (E) | 142/99 | 96 | 93 | 96 | 94 | 95 | 98 | 150/99 | |
| 4/2/2013 | 2M/M (E) | 124/64 | 64 | 67 | 70 | 67 | 67 | 70 | 120/71 | -0.051 |
| 4/2/2013 | 3M/M (E) | 121/70 | 74 | 77 | 80 | 82 | 80 | 74 | 122/70 | 0.0007 |
| 4/2/2013 | 4M/M (E) | 114/77 | 96 | 96 | 96 | 103 | 97 | 101 | 122/77 | -0.012 |
| 4/2/2013 | 5M/F (E) | 104/61 | 70 | 83 | 79 | 83 | 81 | 82 | 127/61 | -0.06 |
| 4/2/2013 | 6M/F (E) | 108/76 | 66 | 81 | 87 | 71 | 79 | 85 | 104/63 | |
| 4/2/2013 | 7M/M (E) | 116/74 | 71 | 72 | 76 | 74 | 83 | 95 | 150/130 | |
| 4/2/2013 | 8M/F (E) | 109/78 | 79 | 77 | 87 | 87 | 87 | 87 | 120/84 | -0.003 |
| 4/2/2013 | 9M/F (E) | 126/67 | 74 | 78 | 71 | 82 | 78 | 82 | 125/77 | 0.002 |
| 4/2/2013 | 10M/F (E) | 109/74 | 68 | 64 | 67 | 69 | 65 | 73 | 127/98 | -0.071 |

**Table 7.** Raw data recorded for heart rate, blood pressure, and galvanic skin response.

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