RUNNING HEAD: Heart rates and breathing pattern - Bush

**LOWERING STRESS LEVELS AT WORK: THE EFFECT OF BREATHING PATTERN ON HEART RATE**

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ABSTRACT

Heart rate. It’s a part of us that most people don’t think about for a second. But, it does matter. Your heart rate is a great indication of your heart health and can easily be measured with two fingers pressed over an artery in your neck. Heart rate changes based on your activity, stress, fear, etc. But could your breathing pattern really affect your heart rate? After pondering on this question, I decided to run a test. I designed an experiment to test if changing your breathing pattern would cause heart rate to change. My results proved my hypothesis to be invalid. After slowing normal breathing to an inhale of 6 seconds and an exhale of 6 seconds, the majority of test subjects’ heart rate increased. Further research and testing is necessary to support this hypothesis.

KEY WORDS: heart rate, stress, breathing pattern, inhale, exhale, Logger Pro®

INTRODUCTION

 Heart rate can be defined as the number of the times the right and left ventricles contract in a unit of time (MedicineNet 2016). In other words, a person’s heart rate is the number of times their heart beats in one minute, the standard measure of time. When heart rate is self-recorded, pushing two fingers down on the artery beneath the jaw, it can be felt in pairs. This pair is the right ventricle contracting, then the left ventricle. This combination happens in less than a second, approximately 100 times in one minute (Stein 2015).

 The “normal” range for heart rate varies, as it can differ from person to person. 60 to 100 beats per minute is considered normal for the average, moderately active adult (Stein 2015). Many factors can affect heart rate. Exercise has arguably the largest impact on heart rate. It has been tested and proven, that during moderate exercise, heart rates will increase. The heart must pump blood to more parts of the body at a faster rate during exercise. Exercising regularly can cause your resting heart rate to be lower, as the heart does not have to work as hard to pump blood (Simon 2013). Also, as the recovery time after exercise of a fit person happens at a lower heart rate than an unfit person (Figure 1). If exercise can greatly impact heart rate, can conscious breathing impact it also?

After months of my swim coach lecturing about how effort, breathing, and heart rate go hand in hand, I decided to test it. To prove his theory valid or invalid, my lab partner and I ran an experiment testing the change in heart rates of people as they breathe normally, inhale 3 second/ exhale 3, and inhale 6/ exhale 6. I hypothesized; If your breathing pattern affects heart rate, then your heart rate will slow down, the deeper the breath, in 10 different people for 30 seconds.

MATERIALS AND METHODS

 To perform this experiment, we relied on the computer software, Logger Pro®. We needed access to a computer with Vernier Logger *Pro®*software, Vernier Lab Quest® Mini with USB cable, the Vernier Heart Rate Hand-Grip Monitor including probe, and Microsoft Excel. We also needed a chair for the test subjects to sit in, a time keeping device (IPhone was used in this experiment), tape to hold the probe down to the lab table, and lab journals to record data from the results. For this experiment, we needed ten test subjects. We asked that they agree to give us up to five minutes of their time to perform three breathing pattern trials. The controls were the time tested, sitting still, and no physical activity being performed. The tested, or dependent variable, was the average heart rate from each trial.

 Before beginning the experiment, we must be logged into Logger Pro®. The heart rate file can be accessed at File Open, Human Physiology with Vernier, 03 Heart Rate Vital Sign. Once the program was open, we hooked the Vernier Heart Rate Hand- Grip Monitor probe to the Vernier Lab Quest® Mini and then into the computers USB port. The probe had to be pointed where the test subject will be sitting, so that it can pick up the direct wireless signal from the Hand- Grip. It did not lay flat on the table, but was held down with a piece of tape. The software was then ready to start the experiment.

 To start, we had the first test subject help us a run a test trial to ensure that our experiment would provide reasonable results. First, they sat down in a lab chair and were handed the Hand- Grip Monitor, with the arrows pointed up and their fingers curled around it as if they were gripping a steering will. (It is important, for the data to be collected, that the arrows were pointed up and that the hand grip was placed in its corresponding hand. Also, all electronics must be placed away from the experiment, as they could interfere with the wireless from the Hand-Grip.) We then asked the test subject to breathe as they normally would for thirty seconds while gripping the Hand-Grip. When we said go, one lab partner pressed the green Collect button on the toolbar on the Logger Pro program and the other partner pressed start the time keeping device. Because of the way the program is set, the heart rate did not start to appear on the software until fifteen seconds into the experiment. Note: This did not have any effect on our experiment, the heart rates from zero to fifteen seconds were still calculated into the average heart rate. After thirty seconds, we asked the test subject to place the Hand- Grip monitor back on the table, as Trial 1 was complete. The average heart rate, shown on screen, was then added to our excel file and lab journal under Test Subject 1, Trial 1 (Table 1).

 For Trial 2, we clicked Data, Undo Data to open a new data collecting table on Logger Pro. All the steps from Trial 1 were copied, except the breathing pattern. For this second trial, we asked the test subject to sit down and change their breathing. They were to inhale for three counts (seconds), then exhale for three. This would be done for thirty seconds and the results were collected and added to the excel file under Test Subject 1, Trial 2.

 For Trial 3, the final trial, the steps were copied from Trial 1, except the breathing pattern was changed. The subject was asked to inhale for six counts, then exhale for six for thirty seconds. The average heart rate was then recorded under Test Subject 1, Trial 3.

 In total, ten test subjects were tested, each for three trials. The test subjects were 14-15 year old students in our class who willingly agreed to be a subject. We repeated the steps on Trials one, two, and three for every test we ran. All of our results from the experiment can be found in Table 1.

RESULTS

The results for this experiment were recorded in heartbeats per minute. We tested ten subjects, for three, thirty second trials. While we did test three trials, Trial 1 was a normal breathing exercise. Therefore, for comparison, we focused more on Trials 2 and 3.

Out of the ten people tested, five had an increase in heart rate between Trial 2 (in 3/ out 3) and 3 (in 6/ out 6). This was seen in Test Subject 9. For Trial 2, their heart rate was 112 BPM (beats per minute). In Trial 3, their heart rate rose to 114 BPM. A similar pattern can be seen in test subjects 2, 6, 7, and 10.

Out of the ten people tested, four had a decrease in heart rate between Trial 2 and 3. This can be seen in Test Subject 1. Their heart rate decreased from 115 BPM to 94 BPM. A similar pattern can be seen in Test Subjects 3, 4, and 5.

Out of the ten people tested, one had no change in BPM between Trial 2 and 3. This was seen in Test Subject 8. Their heart rate stayed at a consistent 82 BPM (Table 1).

For Trial 1, normal breathing, the average heart rate was 92 BPM. The heart rates ranged from 75 to 103 BPM.

For Trial 2, inhale 3 seconds/ exhale 3, the average heart rate was 93.5 beats per minute. The range was 70 to 115 BPM.

For Trial 3, inhale 6 seconds/ exhale 6, the average heart rate was 89.9 BPM. The heart rates ranged from 69 to 114 beats per minute.

DISCUSSION

 Before the testing of the experiment was started, I made a hypothesis that I would test to for validity. My hypothesis was; If your breathing pattern affects heart rate, then your heart rate will slow down, the deeper the breath, in 10 different people for 30 seconds. After testing ten test subjects, my hypothesis was proven invalid because majority saw an increase on Trial 3. However, the overall average (Figure 2) saw a decrease in heart rate. It was a 4:5:1 ratio that proved it invalid. For four people, their heart rate decreased from the in 3/out 3 to in 6/ out 6. For five people, their heart rate actually increased. For one individual, their heart rate stayed the same.

I believe that the increase could have been because of the lack of control we have over the test subjects breathing. For some of them, they may not have been able to hold a full six second exhale, even causing panic and their heart to race. Also, technology is not 100% reliable. We experienced many technical difficulties throughout the experiment. Technical difficulties included the Heart- Grip monitor not picking up on the subject’s heart rate and random spikes in heart rate (30+ more beats per minute).

While our experiment proved our hypothesis invalid, this does not mean other research does not prove it valid. This experiment and similar ones must be conducted and recorded to continue to test the hypothesis. One similar test was run, by a collaborative effort between Bar-Ilan University (Israel), and the Martin-Luther University and the Philipps University (both in Germany, to analyze the correlation between breathing and heart rate during sleep. “The researchers conclude, for one thing, that the breathing rate affects the heart rate but not the other way around (American Institute of Physics 2007)”. This study, while not directly linked with the one I conducted, was done to prove that breathing can affect heart rate. Therefore, this study proves my hypothesis valid.

This experiment was conducted to test the theory that breathing can have an effect on heart rate. We decided to take the approach of testing breathing pattern and made a hypothesis that the slower the breath, the lower the heart rate. If tested valid, our results from this experiment could go to help others in their everyday life. For me personally, I can take slow breaths during swim practice to slow my racing heart rate down. It can also be used to help maintain calmness during the school or work day. Whenever the body is experiencing stress, it reacts. A natural reaction is an increased heart rate. “…One effect of an increased heart rate is increased respiration, or breathing rate. In fact, when people are stressed, they tend to take faster, more shallow breaths, in accordance to increased heart rate (Basis 2013).” It has been tested valid that what when a person is stressed, their heart rate increases, causing a feeling of panic. To decrease this negative feeling, a person can take deeper breaths and heart rate will decrease (Table 1). I believe, based on other research, that our experiment is not reliable due to our multiple difficulties.

In conclusion, our experiment supports the hypothesis that breathing pattern can affect heart rate. However, for our experiment, the slower the breath, actually increases heart rate in the case of this experiment.

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**Figure 1**: Shows the difference in heart rate after recovery time after exercise in a fit and unfit person (ENotes 2015).

**Figure 2**: Data from our experiment. Average heart rate compiled from all test subjects, for each trial.

**Table 1**: Results from our experiment. Ten subjects tested, three trials each.

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| Heart Rate Affected by Breathing |
| Test Subject | Inhale/ Exhale |
|   | normal | in 3/out 3 | in 6/ out 6 |
| 1 | 98 | 115 | 94 |
| 2 | 94 | 90 | 95 |
| 3 | 102 | 70 | 69 |
| 4 | 88 | 92 | 90 |
| 5 | 75 | 114 | 77 |
| 6 | 86 | 89 | 104 |
| 7 | 80 | 76 | 78 |
| 8 | 102 | 82 | 82 |
| 9 | 103 | 112 | 114 |
| 10 | 92 | 95 | 96 |

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