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Variability in Heart Rate and Biofeedback with No Instructions to Attenuate Heart Rate

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VARIABILITY IN HEART RATE AND BIOFEEDBACK WITH NO INSTRUCTIONS TO ATTENUATE HEART RATE

by

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Submitted in Partial Fulfillment of the Requirements for the
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CHAPTER 1

INTRODUCTION

Biofeedback is any method of feedback given to participants concerning their physiological functioning. This may include variables such as heart rate, blood pressure, or oxygen consumption, and may be given to participants using various methods, both at rest and during exercise. Researchers working in the area of biofeedback and exercise specifically state that, if participants are able to control their physiological functioning with biofeedback, this may help with performance enhancement (Hatfield, Spalding, Mahon, Slater, Brody, & Vaccaro, 1992) and in the treatment of angina pectoris (Goldstein, Ross, & Brady, 1977). Some researchers have used heart rate for biofeedback (Goldstein et al., 1977; Inoue & Sadamoto, 2002), while others have used respiration (Hatfield et al., 1992) or a combination of feedback measures (Lo and Johnson, 1984). All of these studies required participants to attempt to attenuate heart rate or respiration with the chosen method of biofeedback. Because lower heart rates and blood pressure at rest or at a given workload during exercise are indicative of a higher level of cardiovascular fitness, being able to control such measures with biofeedback may mean individuals may be able to achieve higher workloads than they would without biofeedback.

Most studies conducted previously have used steady-state exercise along with biofeedback to determine if attenuation is possible (Goldstein et al., 1977; Hatfield et al., 1992; Lo & Johnson, 1984). Two of these studies that used steady state exercise

showed an ability of participants to lower heart rate during exercise (Goldstein et al., 1977; Lo & Johnson, 1984), but the workrate utilized was uniform across participants and did not account for fitness level. Therefore, it is impossible to discern if control of heart rate was related to the relative workload for each participant. Hatfield et al. (1992) accounted for relative workload by having each participant work just beneath ventilatory threshold for 36 minutes. Participants were able to lower minute ventilation with feedback, but were unable to lower mean oxygen consumption, carbon dioxide release, or heart rate. What these studies have demonstrated is that physiological variables are controllable during steady state exercise, and that heart rate may be easier to control at lower relative workloads.

Only one study used an incremental training protocol along with biofeedback with instructions for attenuation of heart rate (Inoue & Sadamoto, 2002). In this study, participants went through a bicycle protocol, which took participants from 30% of their VO_{2max} to 75% over a 13-minute time span. Heart rate flashed every 6 seconds and control and biofeedback trials were given in the same session separated by 45 minutes. Out of a 35 participants, 17 were able to lower their heart rate significantly during the biofeedback condition, while 18 participants could not. Those who were unable to lower their heart rate actually had significantly higher heart rates during biofeedback than without. This finding suggests that some form of mental stress associated with biofeedback during exercise may elicit elevated heart rates in some participants, as mental stress has been shown to increase heart rate during exercise in other protocols (Acevedo, Dzewaltowski, Kubitz, & Kraemer, 1999; Acevedo, Webb, Weldy, Fabianke, Orndorff, & Starks, 2006; Szabo, Péronnet, Gauvin, & Furedy, 1994).

Because of the potential of biofeedback to affect heart rate, some researchers have controlled for this by concealing physiological data from participants during exercise (Eston, Faulkner, Mason, Parfitt 2006; Faulkner, Parfitt, & Eston, 2007). This is not an exhaustive list of all research that controls for this variable, but these studies serve as examples as how this belief (that biofeedback can alter physiologic measures) influences some researchers' methods.

Heart rate, one of the most widely used forms of biofeedback, is used as both marker of cardiovascular health (resting heart rate) and to help compute an estimate of $V0_{2max}$. The YMCA cycle ergometer protocol, for example, utilizes heart rate to determine the workloads for the rest of the test duration, as well as in the estimation of $V0_{2max}$ (Canadian Society for Exercise Physiology, 2003/2010). Part of the protocol requires that heart rate stabilize within the last two minutes of each workload in order to continue to the next stage. If a participant has high heart rate variability, it may be more difficult to advance the participant into the subsequent stage. Additionally, because the heart rates in the last two workloads are used in the estimation equation, a high level of variability in the last two workloads will influence the estimated $V0_{2max}$ by changing the slope of the line used to estimate fitness level.

Currently, no research exists that examines how biofeedback affects physiologic measures without instructions to lower heart rate. Though we know that heart rate can effectively be attenuated during steady state and incremental exercise for some participants, we do not know how biofeedback would affect their heart rate without these instructions. Therefore, taking the extra precaution to hide this data from participants in other studies may be unnecessary. There is also the possibility that knowledge of heart

rate could potentially contribute to variability in heart rate measurements that could theoretically impact both exercise test protocol and results.

1.1 Statement of Purpose

The purpose of this investigation was to determine if heart rate biofeedback altered variability in heart rate measurements in comparison to not having the biofeedback both at rest and during exercise. A secondary purpose for this study was to determine if exercise workload or fitness level affected variability in heart rate measurements.

1.2 Hypothesis

We hypothesized that variability in heart rate measurements would not be affected by biofeedback during exercise, and that resting heart rate would also not be altered with biofeedback. We also hypothesized that workload and fitness level would affect variability in heart rate measurements, because the protocol used in this study (YMCA bike test) increases workload according to the heart rate observed in the first three minutes of exercise testing.

CHAPTER 2

METHODS

2.1 Participant recruitment

Twenty-six healthy male adults who had no major illnesses or impairments were asked to volunteer for this study. Only males were recruited because of the potential for the menstrual cycle to affect heart rate variability in women (Bai, Li, Zhou, & Li, 2009). One participant failed to attend his second lab session; therefore, data from 25 males was used in the analysis. Participants were recruited in kinesiology classes at Southern Illinois University Carbondale by the primary investigator.

2.2 Study criteria

Participants attended two lab sessions lasting approximately thirty minutes each. Each session was separated by at least 48 hours to ensure adequate recovery time between sessions.

All participants completed an informed consent form before participation that stated they understood the test protocol and the inherent risks associated with exercise. Participants also completed a Physical Activity Readiness Questionnaire (Par-Q; see appendix); any “yes” answer excluded the participant from the study. No recruited individuals fell into this category; thus, all participants who consented continued with the testing protocol. The SIUC Human Subjects Committee approved this study.

2.3 General protocol for lab sessions

All participants recorded their food, drink, and activity levels for the 24 hours preceding their first lab visit, and they were asked to replicate this as closely as possible in the 24 hours prior to their second lab session. They were instructed to refrain from drinking caffeine or exercising three hours before either session because the heart rate may be elevated more than normal in these situations (Yeragani, Krishnan, Engels, & Gretebeck, 2005). Upon arrival at the first session, participants read and signed the consent form and the Par-Q, as well as a Perceived Stress Scale (PSS), which consisted of 10 questions concerning stress levels over the past month (see appendix). Participants also were weighed on a digital scale during their first lab session.

Each participant was randomly assigned a testing order for the two sessions. The testing sessions were identical except that during the Known Heart Rate (KHR) condition they could see their heart and during the Unknown Heart Rate (UKHR) condition, they could not. Before the start of the second lab session, participants again filled out the PSS and they were also verbally asked whether or not any major emotional disturbance had occurred in the past 48 hours that may affect their anxiety levels or heart rate. No participant indicated any such event, and no major differences were found in the PSS between conditions (each score was within one point of each other between conditions; only 6 instances out of 250 total had a two point difference, and no differences were greater than two points apart.) This indicates that stress level was well-matched between conditions and was unlikely to impact the HR measurements.

In both sessions, participants wore a Polar heart rate monitor transmitter across their chest and rested in a supine position for two minutes. During the KHR session,

participants held the heart rate monitor watch with the heart rate display at their waist and were asked to glance at it occasionally throughout the two minutes. Participants were instructed to hold the watch rather than wear it, so that it could be angled towards the head. This allowed them to stay in the reclined position without moving their forearm to glance at their heart rate, which may have caused unwanted increases in heart rate. In the UKHR session, the data collector held the display so that the participant could not see it. Heart rate was recorded once after two minutes.

Participants then were asked to participate in the YMCA Cycle Ergometer submaximal $V0_{2max}$ estimation test. This process is detailed in the section below. In the KHR session, participants could see their heart rate on the ergometer's display, which they were also utilizing to keep their pedaling revolutions per minute (RPM) constant. A piece of tape was placed over the heart rate portion of the display during the UKHR session. The data collector held the watch in both sessions and recorded heart rate every fifteen seconds.

2.4 YMCA Cycle Ergometer Test Protocol

Seat height on the Monark stationary bicycle was adjusted for the participant by ensuring that their knee was flexed at approximately 5-10 degrees when the pedal was pushed down (participant in seated position). The participant was asked to pedal a few strokes to ensure comfort with the seat, and any adjustments for comfort were made as needed.

The participant was reminded of the test procedures and asked to keep the pedaling rate of the bike at 50 RPM. As an additional auditory pace-keeper, a

metronome was set at 50 beats per minute (BPM) and played throughout the test. As soon as the participant reached 50 RPM, the stopwatch was started.

As stated earlier, heart rate was recorded from the Polar heart rate watch every 15 seconds throughout each protocol. During the first three minutes of the test, the resistance for all participants was set at .5 kilopascals (kP). Resistance was increased every three minutes if the participant's heart rate had stabilized. Heart rate was considered "stable" if the minute two and three measurements were within 5 BPM of one another. If the minute two and three heart rates were not within 5 BPM of one another, participants continued cycling for one additional minute until heart rate stabilization was achieved. NOTE: the test would have ended if heart rate stabilization failed to occur after the fourth minute at any given workload, but this situation was not applicable during any of the test sessions that occurred during the study.

Participants continued through four workload stages. The test would have been terminated early if heart rate stabilized within 10 BPM of 85% of their age-predicted heart rate maximum, but no participants reached this stage. Workload stages were determined by the participant's heart rate in the last minute of the first stage. These increases are documented in the table below:

Table 1: *Workload Determinations*

First Workload	.5 kP			
	Heart rate in the last minute of first workload			
	HR<80	HR 80-89	HR 90-00	HR>100
2nd stage	2.5 kP	2.0 kP	1.5 kP	1.0 kP
3rd stage	3.0 kP	2.5 kP	2.0 kP	1.5 kP
4th stage	3.5 kP	3.0 kP	2.5 kP	2.0 kP

A VO_{2max} estimation was calculated according to the equation given from the Canadian Physical Activity, Fitness and Lifestyle Approach (see attached data collection form and equation) (Canadian Society for Exercise Physiology, 2003/2010, s7-s8).

2.5 Study variables

2.5.1 Knowledge of heart rate

The independent variable in this study was known or unknown heart rate. Workload, fitness level (as estimated by the $V0_{2max}$ test), and order of the tests were considered as covariates during the data analysis. All other variables that may have affected heart rate, such as dietary intake and activity, were kept as constant as possible between conditions.

2.5.2 Variability in Heart Rate Measurements

Variability in heart rate measurements was the dependent variable. This was analyzed in the form of standard deviations during each test.

2.6 Data Analysis Procedures

Because variability in heart rate measurements was our interest and not individual heart rates, standard deviations were calculated for the heart rates of each exercise test. A paired-samples t-test was used to determine differences between conditions concerning heart rate variability during exercise and resting heart rate. As a secondary test, a stepwise linear regression was used to determine if fitness level (VO_{2max} estimation) or workload had an effect on heart rate variability.

CHAPTER 3

RESULTS

As stated earlier, 25 participants completed the requirements of the study and were considered in data analysis. Standard deviations of heart rate (SD_HR) were analyzed for each workload of each exercise session, which included the 12 to 16 heart rates per workload (an additional minute was added to any workload stage in which heart rate did not stabilize within 5 bpm between minutes 2 and 3, leading to four additional measurements of heart rate). Paired samples t-tests allowed for comparison between conditions for both the SD_HR for each workload as well as resting heart rate. Because only one heart rate was taken in the resting portion of the test, the means of the resting heart rates, and not the standard deviations, were used in the analysis. Table 1 shows the results of these tests.

The results from the t-tests indicate no significant difference between conditions in either resting heart rate or SD_HR of the four workloads. The differences in resting heart rate approached significance at a level of $p=0.076$, with the UKHR condition being approximately 3 bpm less than the KHR condition. None of the standard deviations of heart rate for workload approached significance. The closest value was for the third workload, in which there was an approximate difference of -0.49 between the standard deviations of the heart rate between conditions, but the p value, at $p=0.125$, is too high to be considered statistically significant.

Table 2: *Descriptive Statistics for Dependent Variables and Fitness Level*

	KHR	**UKHR**	**Difference**	**p-value**
RHR	69.56	66.36	3.2	.076
WKLD 1	3.05	3.42	-.37	.358
WKLD 2	6.18	6.41	-.24	.656
WKLD 3	4.17	4.67	-.49	.125
WKLD 4	4.55	4.60	-.05	.855

RHR is the average resting heart rate for all 25 participants, shown by condition. Workloads 1-4 represent the averages of the SD of the 12-16 heart rates taken in that workload during the exercise test. The “Difference” column represents the values in the UKHR subtracted from the values in the KHR.

A stepwise linear regression determined the effects of fitness level, or estimated $V0_{2max}$, on heart rate variability. Condition (KHR or UKHR) was entered as the independent variable and SD_HR as the dependent variable, while both workload and fitness level were added in as covariates. The results are listed in Table 2.

This analysis shows no real effect of fitness level on heart rate, and it also confirms the previous analysis in that condition had no effect on variability in heart rate measurements. The correlation between variability in heart rate and condition was very low, at a level of $R=0.071$, and also insignificant, with $p=0.626$. Workload, however, greatly affects heart rate variability, where $p<0.001$. This was expected. For example, we would expect a participant who was working at a lower workload to have a lesser increase in heart rate throughout the test. However, a participant who was at a higher workload would likely have a greater increase in heart rate as well, producing greater heart rate variability.

Fitness level was the last covariate to be added into the stepwise linear regression. Statistically, it is significant at a level of $p=0.001$. However, because it is a stepwise linear regression, and because workload has such a tremendous effect on heart rate variability, it is likely that much of the difference accounting for the significance in the last step can still be attributed to workload. The R^2 change is only 0.08 after adding fitness level, whereas it was 0.623 after adding in workload as a covariate. In fact, the p-value actually increases from $p<0.001$ to $p=0.001$, indicating that fitness level is likely not a significant contributor to the variability in heart rate measurements without also considering workload.

Table 3: *Stepwise Regression for SD_HR Plus Variables*

	R	**R^2**	**R^2 Change**	**Significance**
1	.071	.005	.005	.626
2	.793	.628	.623	.000
3	.842	.709	.080	.001

1: SD_HR with KHR or UKHR (KorUK) as independent variable
2: SD_HR with KorUK as independent variable plus Workload as covariate
3: SD_HR with KorUK as independent variable plus Workload and $V0_{2max}$ as covariates

CHAPTER 4

DISCUSSION

The results of the investigation indicated that there was no relationship between variability in heart rate and biofeedback during the cycle ergometer test, as well as no relationship between resting heart rate and biofeedback. Because variability in heart rate measurements can be affected by the intensity of exercise performed, we tested the differences in variation of heart rate measurements at each workload and found no difference. To determine the effect of fitness level on the variation in heart rate measurements, we ran a stepwise linear regression, which showed a significant relationship between estimated $V0_{2max}$ and heart rate variability. However, this was considered only after factoring workload into the analysis; it is possible that the influence of $V0_{2max}$ may not be significant without considering workload first.

We hypothesized that variation in heart rate measurements would not be different between conditions with no instructions to attenuate heart rate. This hypothesis was supported by the results. Although many studies have shown that physiological markers can be altered with instructions to attempt to alter said markers (Goldstein et al., 1977; Hatfield et al., 1992; Inoue & Sadamoto, 2002; Lo & Johnson, 1984; Moleiro & Cid, 2001), this study's results show that, without instruction, variability in heart rate measurements is not significantly different with biofeedback. The largest difference within a workload between conditions for standard deviation of heart rate was 0.49, and it was non-significant at $p=0.125$. Although some researchers choose to take

precaution by hiding this physiologic data during exercise tests, this may not be necessary based on the results of this study.

We also tested differences in resting heart rate both with biofeedback and without, and we found no significant differences between conditions. Because we only had one resting heart rate measurement for each testing session, we used the resting heart rate means and compared them by condition rather than the standard deviations of heart rate, as we did for the exercise protocol. The average resting heart rate for the KHR condition was 69.56 bpm, while the average resting heart rate for the UKHR condition was 66.36 bpm. Though this translates to an approximate 3 bpm difference, with the KHR condition eliciting the higher heart rate, this was not considered statistically significant, at $p=0.076$.

Despite the fact that variation in heart rate measurements during exercise and resting heart rate differences did not register as statistically significant, they did provide an interesting and notable trend. Within all four workloads of the cycle ergometer test, the UKHR repeatedly produced slightly higher heart rate variability than the KHR condition. The difference was as little as .05 standard deviations, as in fourth workload, but the UKHR produced variability as high as .49 standard deviations above the KHR in the third workload. Unfortunately, because only one measurement was taken for the resting heart rate and we therefore do not have a measurement of variability, it is unknown whether that same pattern exists at rest. However, the results suggest that, even though not statistically significant, KHR may elicit a higher heart rate than UKHR, with a 3 bpm difference between conditions.

In order to determine how fitness level affected variability in heart rate measurements, we ran a stepwise linear regression, with SD_HR as the dependent variable, condition as the independent variable, and workload and fitness level added in as covariates. We did find that workload had a significant effect on the variability in heart rate measurements during exercise, and this result was expected. Like any incremental exercise test, heart rate increases in a linear fashion until maximal levels have been achieved. This can be seen in all types of aerobic activities, including step aerobics (Zaletel, Furjan-Mandic, & Zagorc, 2009), cycle ergometry (Vehrs & Fellingham, 2006), and treadmill walking and jogging (Moleiro & Cid, 2001). Fitness level, as determined by the $V0_{2max}$ estimates calculated from the cycle ergometer test, was also significantly related to variation in heart rate, but only after workload was considered. Therefore, had we chosen a steady state exercise protocol, variability in heart rate would likely not be different amongst participants of different aerobic fitness levels. This supposition needs to be tested for further confirmation.

Potential Limitations

One potentially confounding issue was different workloads between conditions. Because the workload was determined by the participants' heart rate in the first three minutes of the test, many of the workloads were different between the conditions for the same participant. Only 9 participants out of 25 used the same workload in both the KHR and UKHR conditions. However, no pattern in the data could be found for one condition eliciting a higher variability in heart rate despite having different workloads. Of the 16 participants who had different workloads during their two testing sessions, 10had

a higher workload in the UKHR condition, while 6 had a higher workload in the KHR condition. This seems to indicate a proclivity, albeit a weak one, toward higher heart rates in stage 1 of the YMCA test in the KHR condition (higher heart rate in stage 1, means a lower workload throughout the test). This pattern would need to be tested more thoroughly using a larger sample size before any concrete statements could be made.

It is possible that some errors occurred along with calculation and methodology. For the resting heart rate measures, participants were instructed to not speak throughout the two minutes to ensure a better heart rate. However, during the cycle ergometer test, participants were allowed to engage in conversation with the researcher throughout the protocol if they wished. Though the conversation was kept to “small talk,” and any conversation that could be perceived as emotional was deflected by the researcher, it is possible that this conversation could have affected the heart rate. However, research shows that the “talk test,” or having participants talk at different stages of exercise, is a reliable method to determine exercise intensity (Persinger, Foster, Gibson, Fater, & Porcari, 2004). When speech is still comfortable for participants, the exercise intensity is within the recommended guidelines for exercise prescription, and only when speech becomes uncomfortable does the intensity exceed these guidelines. Because participants were not required to talk, it is unlikely that participants continued conversation when it was uncomfortable, thus keeping them within the “recommended guidelines.” It is possible, though unlikely, that conversation elevated heart rates unnaturally.

Two errors with the heart rate monitors occurred during cycle ergometry testing as well. In one instance, the watch lost the connection to the transmitter, and one heart rate was not recorded. In the other instance, the watch stopped reading heart rates completely, so while the participant continued cycling, the researcher retrieved a replacement watch and continued monitoring heart rate. Three heart rates were not recorded in this instance. The missing heart rates were averaged from the surrounding heart rates in both cases. It is possible, though unlikely, that heart rate was significantly different during these times of error. However, because the standard deviation of heart rates during the cycle ergometry test was being utilized and not specific heart rates, and because we also know that heart rate typically increases in a linear fashion until maximal levels have been achieved, it is highly unlikely that these errors caused discrepancy in the data.

CHAPTER 5

CONCLUSIONS AND SUMMARY

To our knowledge, this is the only study testing the effects of heart rate biofeedback during both exercise and rest without specific instructions to attenuate heart rate. Although it has been made clear that physiologic functioning can be affected with biofeedback along with instructions to lower heart rate, respiration, or other factors (Goldstein et al., 1977; Hatfield et al., 1992; Inoue & Sadamoto, 2002; Lo & Johnson, 1984; Moleiro & Cid, 2001), the results of this study show that this is not the case when participants are not given any instructions.

Some researchers have taken the precaution of hiding physiologic data from participants during exercise in the event that the biofeedback may affect the actual data being collected (Eston et al., 2006; Faulkner et al., 2007). The results of this study suggest that this may not be necessary. However, because this is the only study that we are aware of that has tested this hypothesis, we would encourage all researchers to continue collecting data as they have been, until further studies can either confirm or deny this study's results.

Despite finding no significant differences between conditions, a few trends did appear. The UKHR condition consistently produced greater variation in heart rate measurements than the KHR condition within a given workload. Again, none of these differences were significant, but the noticeable trend deserves a closer look on a larger scale. It would also be interesting to examine variation in heart rate at rest across time.

As stated earlier, only one heart rate was taken per testing session for the resting condition and future research should test the trends on biofeedback and variability of heart rate at rest, without instructions to attenuate heart rate.

Because all participants were between the ages of 18 and 28, it may be beneficial to extend the research into other generations as well. Additionally, the protocol used for this study was an incremental cycle ergometer test. It would be interesting to see if steady state exercise produced the same outcome and if similar outcomes are noted in an alternate form of exercise, such as treadmill walking, for example. Overall, researchers should maintain their usual practice, including hiding biofeedback measures from participants, until further research can confirm or deny these results.

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APPENDIX

Appendix A

Par-Q Form

Physical Activity Readiness Questionnaire (PAR-Q) and You

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly:

YES	NO		
☐	☐	1.	Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
☐	☐	2.	Do you feel pain in your chest when you do physical activity?
☐	☐	3.	In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4.	Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5.	Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6.	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7.	Do you know of <u>any other reason</u> why you should not do physical activity?

If you answered:

YES to one or more questions

Talk to your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want – as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to <u>all</u> PAR-Q questions, you can be reasonably sure that you can:

- Start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- Take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively.

Delay becoming much more active:

- If you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- If you are or may be pregnant – talk to your doctor before you start becoming more active.

Please note: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed use of the PAR-Q: Reprinted from ACSM's Health/Fitness Facility Standards and Guidelines, 1997 by American College of Sports Medicine

Appendix B

Percieved Stress Scale

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts **during the last month.** In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

Name ______________________________ Date __________

Age ________ Gender (*Circle*): **M F** Other ______________________

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly?	**0**	**1**	**2**	**3**	**4**
2. In the last month, how often have you felt that you were unable to control the important things in your life?	**0**	**1**	**2**	**3**	**4**
3. In the last month, how often have you felt nervous and "stressed"?	**0**	**1**	**2**	**3**	**4**
4. In the last month, how often have you felt confident about your ability to handle your personal problems?	**0**	**1**	**2**	**3**	**4**
5. In the last month, how often have you felt that things were going your way?	**0**	**1**	**2**	**3**	**4**
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	**0**	**1**	**2**	**3**	**4**
7. In the last month, how often have you been able to control irritations in your life?	**0**	**1**	**2**	**3**	**4**
8. In the last month, how often have you felt that you were on top of things?	**0**	**1**	**2**	**3**	**4**
9. In the last month, how often have you been angered because of things that were outside of your control?	**0**	**1**	**2**	**3**	**4**
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	**0**	**1**	**2**	**3**	**4**

Please feel free to use the *Perceived Stress Scale* for your research. The PSS Manual is in the process of development, please let us know if you are interested in contributing.

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The PSS Scale is reprinted with permission of the American Sociological Association, from Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*, 386-396.

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Research Paper Title:
Variability in Heart Rate and Biofeedback with No Instructions to Attenuate Heart Rate

Major Professor: Phillip Anton