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Effects of Positive Feedback on Oxygen Consumption and Heart Rate During a 3-Minute Step Test

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EFFECTS OF POSITIVE FEEDBACK ON OXYGEN CONSUMPTION AND HEART RATE DURING A 3-MINUTE MODIFIED STEP TEST

by

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ABSTRACT

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The positive effects of enhanced expectancies on motor performance and learning have been demonstrated by numerous studies. A more recent study by Stoate, Wulf, and Lewthwaite (2012) showed than enhancing one's expectancy by giving positive feedback increased movement efficiency and decreased oxygen consumption in experienced runners during a 20 minute running test at 75% of max oxygen consumption, compared to those who received no feedback. The purpose of the present study was to test if enhancing expectancies can improve movement efficiency (i.e., reduce oxygen consumption) during a sub-maximal exercise test. Participants were randomly assigned to one of two groups, enhanced expectancy or control. All participants completed four 3-minute modified step tests at a cadence of 24 steps per minute. During the step tests and rest periods, heart rate and oxygen consumption were recorded. The enhanced expectancy group receives positive feedback about their movement efficiency after each trial, while the control group received no feedback. Each participant was provided with a five minute rest period between trials. Rate of perceived exertion and were also recorded for each participant. Day two of testing consisted of two 3-minute modified step tests for each participant. During day two no feedback was given to either group to observe if the effects of the positive feedback from day one carry to the post-test. No significant group differences were found for any of the dependent variables. Possible reasons for the null effects are discussed.

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CHAPTER 1

INTRODUCTION

Positive feedback has been shown to increase motivation, increase muscle efficiency, and reduce perceived exertion when performing a motor task. Normative or social-comparative feedback that suggests good performance relative to others is particularly beneficial in enhancing performance and learning, as shown in the 2010 study by Lewthwaite and Wulf. Their study examined the motivational effects of social-comparative feedback on the learning of a balance task. Another study conducted by Stoate, Wulf, and Lewthwaite (2012) showed the benefits of positive feedback on oxygen consumption in runners. Positive feedback improves one's self-efficacy, which is responsible for motivation and the amount of effort one dedicates toward accomplishing a goal. Positive statements also improve performance and more important, have been shown to enhance learning of a task as well. People with decreased self-efficacy are more likely to "give up" or not put forth as much effort toward a task that they are unfamiliar with or have a fear of failing. Negative feedback and decreased self-efficacy is thought to invoke thoughts of one's self which hinders performance, also termed the "self-invoking trigger" as presented in a study conducted by Lewthwaite and Wulf (2010). Simply providing people with one positive statement can change their perceptions about themselves and the task and in turn improve performance and learning of the given task.

Purpose of the Study

The purpose of this study is to examine if positive social-comparative feedback can improve muscle efficiency (e.g., reduce volume of oxygen consumption) during a step test. This is important because social-cognitive factors are not typically considered in exercise physiology. I will compare the heart rates and volume of oxygen consumption between two groups. One will be given positive feedback about their movement efficiency and the control group will be given no feedback.

Hypotheses

<u>Hypothesis #1: Participants who receive positive feedback will have decreased volume of oxygen consumption during exercise step test trials than the controls.</u>

<u>Hypothesis #2: Participants who receive positive feedback will have lower heart rates while performing the step test compared to the control group.</u>

<u>Hypothesis #3: Participants who receive positive feedback will have lower perceived exertion levels compared to the controls.</u>

Significance of the Study

This study is significant in that not many studies have been conducted comparing the effects of positive feedback on oxygen consumption (VO_2) levels in submaximal exercise testing. The benefits of positive feedback are tremendous and could change the way athletes are coached and the ways athletes train and practice. I'm sure we have all experienced the effects that positive statements have on our psyche but it can also enhance learning and movement efficiency. Could just simple positive feedback be a replacement for the performance enhancing supplements on the market? A recent study conducted by Stoate, Wulf, and Lethwaite (2012) showed that positive feedback not only improves the performance and learning of beginners and novices but also experienced performers. The benefits of positive thinking and positive reinforcement are endless.

Positive feedback could also be useful in physical rehabilitation. Studies have shown that positive feedback enhances not only performance but the learning of a skill. A study conducted by Wulf, Lewthwaite, and Chiviacowsky (2011), showed older adults had improved self- efficacy and learning of a balance task when given social comparative feedback about their performance compared to those who received no feedback. This was a very remarkable study showing that older adults who typically have preexisting fears or lower self confidence about performing physical activities can enhance their performance, self-confidence and the learning of a task by a simple positive statement.

Definition of Terms

The following definitions are given for the purpose of clarification:

Normative Feedback (Social-Comparative Feedback)

Feedback that provides a person with information about their performance relative to the average of their peers (or norms).

Retention

The performance of a skill subsequent to a period of practice in the absence of instruction, augmented feedback, or any experimental manipulation that was present during practice. It is used as a measure of learning.

Self- Efficacy

Task or situation specific- confidence that one can do what is needed to achieve desired outcomes.

Motor Learning

Change in motor performance as a result of experience with a task over time.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Mind-set and Physiological Responses

The effects of an individuals' mindset on performance and health has been widely studied. A study conducted by Crum and Langer (2007) examined the effects of mindset on exercise. The study included 84 female hotel housekeepers. Seven different hotels were assigned to one of two conditions, the informed group and a control group. All participants were told the purpose of the study was to find ways to improve health and happiness of women in a hotel workplace. The informed group was given information about how their work is a good form of exercise and more specifically that exercise does not need to be hard or painful to benefit one's health. The information was conveyed in the form of handouts, posters and verbal presentation. The control group was not given this information. To prevent contamination room attendants within a hotel were assigned to the same condition. All participants worked 32-40 hours per week and cleaned approximately 15 rooms per day. All participants filled out self reported exercise questionnaires and anthropometric measures were taken. Blood pressure, presence of substance abuse and diet were also assessed. After four weeks subjects in the informed condition reported higher levels of perceived amount of exercise time, and had decreased body weight, lowered systolic blood pressure, and decreased body fat percentage compared to the control group. An important note is that although the housekeepers in the informed group reported higher rates of exercise, they did not report getting any additional exercise outside of work (Crum & Langer, 2007). Another study examining the effects of mind set on other aspects of the body and health was conducted by Crum, Corbin, Brownell, and Salovey (2011). The purpose of the study was to determine if physiological satiation as measured by ghrelin, a gut peptide varies depending on mindset. Participants were recruited through fliers presenting the opportunity to participate in a "Shake Tasting Study". There were a total of 46 participants with average body mass index (BMI) of 22.5. The participants were scheduled for two 2.5 hour sessions that were one week apart. The participants were to fast the night before the session. During the first session, participants were told that the clinic was designing two different milkshakes with different nutrient contents and they would taste one milkshake the first session and the other milkshake during the second session. The participants were told the goal of the study was to evaluate whether the milkshakes tasted similar and to examine the body's reaction to the different nutrients (high vs. low fat, high vs. low sugar). The participants were unaware that the nutrient content of the shakes were identical. At each session blood was drawn from each participant at 20, 60, and 90 minute intervals. During the first interval participants were asked to view and rate the label of the shake. The label depicted on the beverage differed from sessions one and two. The "indulgent" condition presented as high fat, high calorie. The "sensi-shake" was labeled as low fat, low calorie. During the second interval participants were asked to taste and rate the shake. They were instructed to consume the shake within the first 10 minutes of this interval. The third blood sample was taken after a 20 minute rest period. Ghrelin, taste ratings, hunger ratings, and dietary restraint were all assessed. When participants drank the indulgent shake they had a significantly steeper decline in ghrelin than when they drank the sensible shake. This indicates that after drinking the “indulgent” shake, participants had increased satiation. Participants rated the “sensi-shake” significantly healthier than the “indulgent” shake. There were no significant between- subjects’ effects in hunger and restrained eating questionnaires. These studies show that mind-set can cause changes in physiological processes in the body.

Enhanced Expectancies and Motor Learning

A number of recent studies have shown that enhancing learners’ performance expectancies can enhance their performance and learning of motor skills (Lewthwaite & Wulf, 2010; McKay, Lewthwaite & Wulf, 2012; Hutchinson, Sherman, Martinovic & Tenenbaum, 2008). Increased self-efficacy is one possible effect of enhancing a person’s expectancies, which can in turn lead to more effective learning.

The advantageous effects of positive feedback on performance have been demonstrated in many studies. For example, there have been a number of studies showing that positive feedback can enhance self-efficacy which in turn increases motivation, increase in sustained exertion, and improved performance. Positive feedback has been shown to decrease anxiety and other negative thoughts or fears that can hinder performance by decreasing the automaticity of body movement (Wulf, Chiviacowsky & Lewthwaite, 2010). Self-efficacy is the belief in one’s capability to successfully complete a given task. Persons with high self-efficacy have decreased perceived effort of a given task and an increase in sustained effort toward the task. This was evident in a study completed by Hutchinson, Sherman, Martinovic and Tenenbaum (2008). The study used an isometric hand grip task. There were three groups: control, high efficacy, and low efficacy. Participants in the high and low efficacy groups were given false feedback about their performance. Those in the high efficacy group had improved self-efficacy, decreased levels of perceived effort, and an increase in sustained effort compared to the low efficacy group. Persons with high self-efficacy had lower levels of perceived aches and pains and a more positive affect, which leads to increased motivation and interest towards completing the task. It also resulted in longer sustained effort toward the task at hand (Hutchinson et al., 2008).

Another study examining the effects of positive feedback by Lewthwaite and Wulf (2010) examined the effects normative feedback on a balance task. The study consisted of three groups: control, “better”, and “worse”. The participants were required to stand on and balance on a stabilometer. Participants were all given veridical feedback (error scores reflecting deviation from the target) about their performance after each trial. In addition to the veridical feedback, participants were given average performance scores indicating that they were either above average (better group) or below the average (worse group). Those who assumed they performed better had superior performance overall during the practice phase and during the retention test, where feedback was removed. The “better” group demonstrated more effective balance and more automaticity in their movement adjustments (Lewthwaite & Wulf, 2010).This study was not the first to show the benefits of normative positive feedback but it was the first to show that this type of feedback can also enhance the learning of a motor skill.

The effects of normative feedback were also demonstrated in another study by Wulf, Chiviacowsky, and Lewthwaite (2010). Participants were asked to perform a sequential timing task. Subjects were assigned to a better or worse group. The subjects were all given veridical feedback about their performance, which provided both groups with some evidence of success in their performance. False feedback about a peer group's average performance was also given. Scores indicated either greater (better group) or less (worse group) than average improvement. The subjects performed a transfer and retention test after the acquisition phase. Both groups reduced their timing errors across the practice phase and had similar absolute timing errors on the retention test. However, the "better" group had smaller errors than the "worse" group on the transfer test. Transfer tests are often a better indication of how well the task is learned as it is a related skill but one that was not practiced in the acquisition phase as with retention tests (Wulf, Chiviacowsky, & Lewthwaite, 2010).

The negative affect that is created by the negative (normative) feedback can interfere with memory processing and degrade learning by directing attention resources to suppressing the negative thoughts and emotions and not on the task at hand. The negative affect for oneself also causes decreased interest to the task which decreases motivation and effort towards learning the task (Wulf, Chiviacowsky, & Lewthwaite, 2010). On the other hand the positive affect created by the positive (normative) feedback is linked to dopamine release that supports sequence learning (Hutchinson et al., 2008). The positive affect also alleviates one's thoughts of concern towards performance, which allows decreased attention to oneself, allowing for more automaticity of movement (Lewthwaite & Wulf, 2010).

A more recent study conducted by McKay, Lewthwaite and Wulf (2012) examined the causal role of perceived ability for performance in challenging situations on high-pressure motor performance. The study consisted of thirty-one university students.

Participants were quasi-randomly assigned to the enhanced expectancy group or the control group. All participants were informed that they were to complete a block of 20 baseball throws, complete 2 questionnaires, and might be asked to complete 20 more throws. After the first set of 20 throws (given instruction to do their best) the participants completed two questionnaires. The questionnaires were designed to assess individual's perception of locus of causality and overall sense of volition and self-determination. Participants were told that the questionnaires were used to determine their scores on (bogus) performance index (PI), which was allegedly a well-studied measure used to predict performance under pressure. The enhanced expectancy group was then shown a normal curve of the (supposed) distribution of scores on the PI. The participants were told that people who scored 75 and below were likely to "choke" under pressure and people who scored 125 and above were likely to excel. Finally, the participants in the enhanced expectancy group were also told they scored 159 on the PI and were therefore very likely to do well under pressure.

The control group was told that the questionnaires were used to determine their score on the PI and that the purpose of the experiment was to evaluate how scores on the questionnaires related to performance under pressure.

After the participants were told they would be completing the second block of 20 throws they were asked to complete a final questionnaire assessing their perceived ability for performance under pressure. Participants were asked to rate how much they agreed with five statements (e.g. "I feel that I perform my best when the stakes are high"). Responses could range from 1 (strongly disagree) to 10 (strongly agree). To increase pressure the second block of throws were videotaped and they were told that their movement patterns would be analyzed and compared to other participants. The results showed that the enhanced expectancy group reported significantly higher perceived ability to perform under pressure than the control group. The control and enhanced expectancy groups had similar throwing accuracy on the first block of throws under low pressure conditions. During the second block of throws the control group maintained their throwing accuracy under the high-pressure conditions. However, the enhanced expectancy group participants increased their throwing accuracy during the second block of throws. This study showed that enhancing an individuals' expectancy regarding their capability under pressure can benefit their motor performance in challenging situations (McKay et al., 2012).

Enhanced Expectancies and Movement Efficiency

Enhanced expectancies have also been shown to increase movement efficiency or economy. Movement efficiency refers to the metabolic energy required for goal achievement. A movement outcome that is achieved with less energy is considered to be more efficient or economical (Wulf & Lewthwaite, 2009). A person with better economy has lower VO_2 values at a given speed compared to those with higher VO_2 values at the same speed. A study conducted by Stoate, Wulf, and Lewthwaite (2012) demonstrated how positive feedback can improve movement efficiency in experienced runners. The study consisted of two groups of experienced runners, one experimental group (enhanced expectancy), which received feedback and a control group that received no feedback. Each subject was required to run on a treadmill at 75% of their VO_2 max for 10 minutes (following a 10 minute warm-up). The subjects in the experimental group received fabricated feedback about the efficiency of their running style every two minutes. The subjects were also given a questionnaire before and after running, in which they rated the ease of running and degree of tiredness. This questionnaire was used in order to determine the subject's self-efficacy and affect. VO_2 and heart rate were measured for each subject during the run. Oxygen consumption decreased in the enhanced expectancy group and remained the same in the control group. Heart rate did not differ between groups. Performance perception and positive affect had a greater increase in the enhanced expectancy group compared to the control. The decrease in oxygen consumption in the enhanced expectancy group showed an increase in movement efficiency or economy in those who receive positive feedback. Those subjects who were led to believe they were efficient runners had better running economy compared to those in the control group whom received no feedback (Stoate et al., 2012).

The effects of positive feedback in cardiorespiratory fitness have not been widely studied. With the step test, I will be able to examine how positive feedback decreases volume of oxygen consumed and improves individual's movement efficiency or economy during a submaximal exercise test. Submaximal exercise testing has greater applicability to everyday experiences and in clinical arenas such as physical rehabilitation (Noonan & Dean, 2000). The YMCA step test has been used to predict maximal aerobic capacity and is a reliable measure of aerobic fitness.

The correlation between heart beat count (HBC) from VO_2 max test and a 3-minute YMCA step test was tested in a study conducted by Santo and Golding (2003). Sixty healthy participants between ages 18-55 participated in the study. The second purpose of the study was to determine if there was a better correlation between VO_2 max and HBC with a shorter (15s) HBC than the present 1min HBC. The participants first completed a height adjusted (modified) YMCA 3-minute step test. The heights of the bench were adjusted using the following equation: $H_f = (.189)(I_h)$ for women and $H_f = (.192)(I_h)$ for men, where I_h = participant's height (in cm) and H_f = bench height (in cm).The participants were attached to an EKG machine during the test and their HBC was recorded at 15s and 1min. The VO_2 max test was then completed after the participants heart rate returned to resting levels, which averaged 15 minutes of rest between tests. The results showed that the 15s and 1min HBC's were significant in predicting VO_2 max but there was no significant difference when using the 15s and 1min HBC.

The current study will also examine if positive feedback reduces levels of perceived exertion in individuals. The benefits of positive feedback and creating a positive affect in individuals have been shown to be very valuable in the performance and learning of a motor skill and there is much more to be learned on the subject. The results of this study may offer insight into new methods of coaching, training, and physical rehabilitation for individuals of all ages and skill levels.

CHAPTER 3

METHODS

Subject characteristics

Fourteen undergraduate students ranging from ages 18-35 participated in this study. See demographic data below (Table 1). All participants gave informed consent before beginning of testing, and all were unaware of the specific purpose of the experiment.

Table 1 Characteristics of the participants

	Total (N = 14)	*Female (n = 7)*	*Male (n = 7)*
Height (inches)	66 ± 5.6	63.5 ± 7.8	69 ± 2.2
Weight (pounds)	154.8 ± 55	132 ± 52.3	177.5 ± 45.6
Body Mass Index (BMI)	24.1 ± 7.8	22.2 ± 4.0	25.5 ± 8.2

Values are means ± are Standard Deviations

Instrumentation

The submaximal exercise test was the YMCA height adjusted step test (Santo & Golding, 2003). The participants were asked to complete a 3-minute step test by stepping up and down on a 12-inch high wooden bench to a cadence of 24 steps per minute (in synchrony with metronome). The participants were free to choose which foot to lead with upon each step onto the bench.

Collection of the Data

The subjects were first given a consent form and data collection sheet upon arrival. The data sheet consisted of age, sex, height, weight, and frequency of exercise. The subject's height and weight were obtained using a standard height and weight scale. The subjects were then given direction as to how to perform the step test (e.g. "Step up and down on the bench to the beat of the metronome") and what to expect while performing the test. They were then connected to the metabolic cart, which measured the subject's volume of oxygen consumed during the 3 minute exercise phase and for one minute during the resting phase. The subject's heart rate was also measured using a Polar heart rate monitor. Heart rates were recorded every 30 seconds during the 3 minute exercise phase and every 15 seconds for one minute during the resting phase. The subjects were instructed to step to a pre-set cadence (in synchrony to metronome). The cadence is approximately 24 steps per min. The subjects assigned to the enhanced expectancy group were given positive (normative) feedback (see Appendix 1) about their performance (e.g. "Your heart rate is recovering very well compared to those of your age and gender"). The subjects in the control group received no feedback. The rating of perceived exertion for each subject was determined by having subjects point to a standard RPE scale at 2:45 into the step test. RPE was measured each trial. On the second day of testing, which occurred two days after initial testing, subjects completed 2 step tests. The procedure was the same as in Day 1 except no feedback was given to either group.

Data Analysis Methods

VO_2 and heart rate during exercise were averaged across the 6 measurement times for each trial and analyzed in a 2 (groups) x 4 (trials) analysis of variance (ANOVA) with repeated measures on the second factor for day1, and in a 2 (groups) x 2 (trials) ANOVA for day 2 (post-test). Rating of perceived exertion (RPE) on day 1 of testing were averaged across 4 measurement times and analyzed in a 2 (groups) x 4 (trials) ANOVA with repeated measures on the second factor for day 1, and in a 2 (groups) x 2 (trials) ANOVA for day 2 (post-test). Resting data were averaged across the 3 measurement times for each rest period and analyzed in a 2 (groups) x 4 (trials) repeated measures ANOVA for day 1 and in a 2 (groups) x 2 (trials) ANOVA for day 2. Bonferroni adjustments were made for all post-hoc tests.

CHAPTER 4

RESULTS

Oxygen Consumption

Day1. Volume of oxygen consumed in control (trial mean: 17.7 *SD*: 5.5; rest mean: 9.2 *SD*: 2.24) and enhanced expectancy groups (trial mean: 18.27 *SD*: 3.6; rest mean: 11.7 *SD*: 2.1) did not differ significantly for exercise or rest periods on Day 1 (see Figure 1). The main effect of group was not significant for exercise, $F(1, 15) < 1$, or rest, $F(3, 45) < 1$. Oxygen consumption did not change across exercise trials or rest periods for either group. The main effect of trial was also not significant for exercise, $F(3, 45) =$

1.04, $p > .05$, or rest, $F(3, 45) < 1$. There was no interaction of group and trial during exercise, $F(3, 45) = 1.04$, $p > .05$, or rest $F(3, 45) < 1$.

Day 2 (post-test). Volume of oxygen consumed in control and enhanced expectancy groups did not differ significantly for exercise or rest periods for Day 2 (see Figure 1). The main effect of group was not significant for exercise, $F(1, 8) < 1$, or rest, $F(1, 15) < 1$. Oxygen consumption did not change across exercise trials or rest for either group on day 2. The main effect of trial was also not significant for exercise, $F(1, 8) = 2.85$, $p > .05$, or rest, $F(1, 8) = < 1$. There was no interaction of group and trial during exercise, $F(1, 8) < 1$, or rest, $F(1, 8) < 1$.

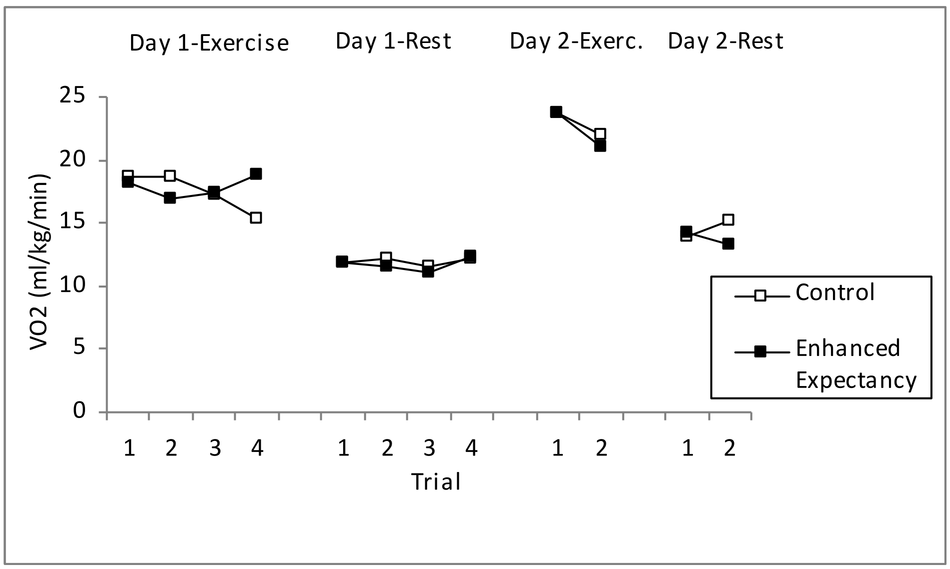

Figure 1. Volume of Oxygen Consumption during trial and rest period for Days 1 and 2.

Heart Rate

Day1. Heart rates in the control (trial mean: 132 *SD*: 8.4; rest mean: 117.3 *SD*: 9.4) and enhanced expectancy (trial mean: 140 *SD*: 8.5; rest mean: 121.5 *SD*: 8.3) groups did not significantly differ for exercise or rest periods on Day 1 (see Figure 2). The main effect of group was not significant for exercise, F (1, 14) < 1, or rest, F (1, 8) < 1. Heart rate increased across trials for both groups. The main effect of trial was significant for exercise, F (3, 45) = 12.15, p < .001. Heart rate was lower during rest periods, but also increased across trials. The main effect of trials was significant or rest F (3, 42) = 11.95, p < .001. There were no interactions of group and trial during exercise, F (3, 45) < 1, or rest, F (3, 42) < 1.

Day2 (post-test). Heart rates in the control and enhanced expectancy groups did not significantly differ for exercise or rest periods on Day 2. The main effect of group was not significant for exercise, F (1, 9) < 1, or rest F (1, 20) < 1. Heart rates did not change very much across trials or rest periods for either group. The main effect of trial was also not significant for exercise, F (1, 8) = < 1, or rest, F (1, 9) = < 1. There was no interaction of group and trial during exercise, F (1, 8) < 1, or rest, F (1, 9) < 1.

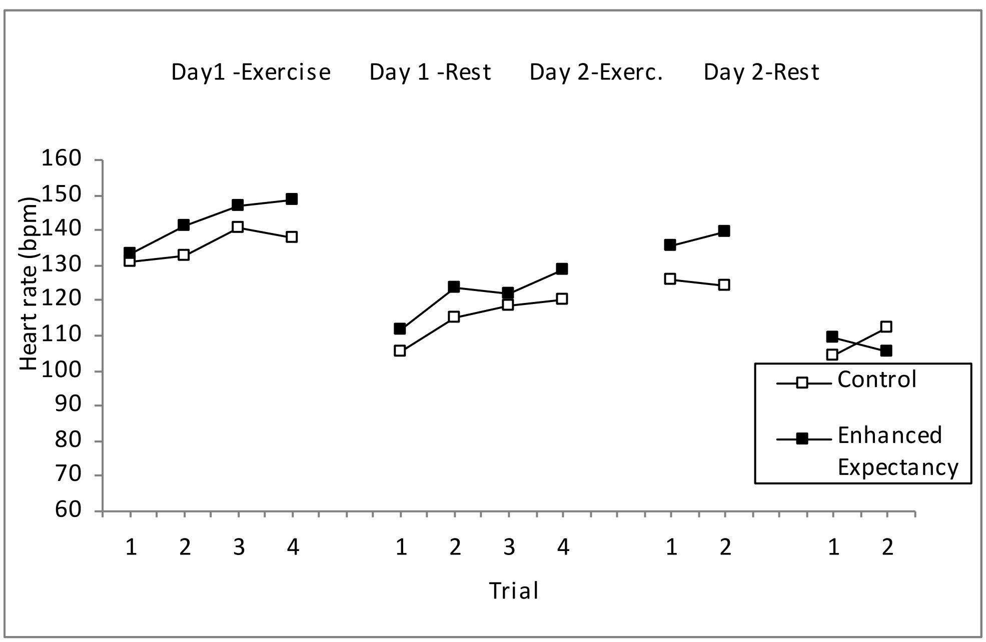

Figure 2: Heart rate during trials and rest period for days 1 and 2.

Rate of Perceived Exertion

Day1 Rating of perceived exertion (RPE) in control and enhanced expectancy groups did not differ significantly across trials on Day1 (see Figure 3). The main effect of group was not significant, $F(1, 12) < 1$. The main effect of trial was also not significant, $F(3, 60) < 1$. There was no interaction of group and trial, $F(3, 60) < 1$.

Day2. RPE in control and enhanced expectancy groups did not differ across trials on Day2. The main effect of group was not significant, $F(1, 15) < 1$. The main effect of trial was not significant, $F(1, 12) < 1$. There was no interaction of group and trial, $F(1, 12) < 1$.

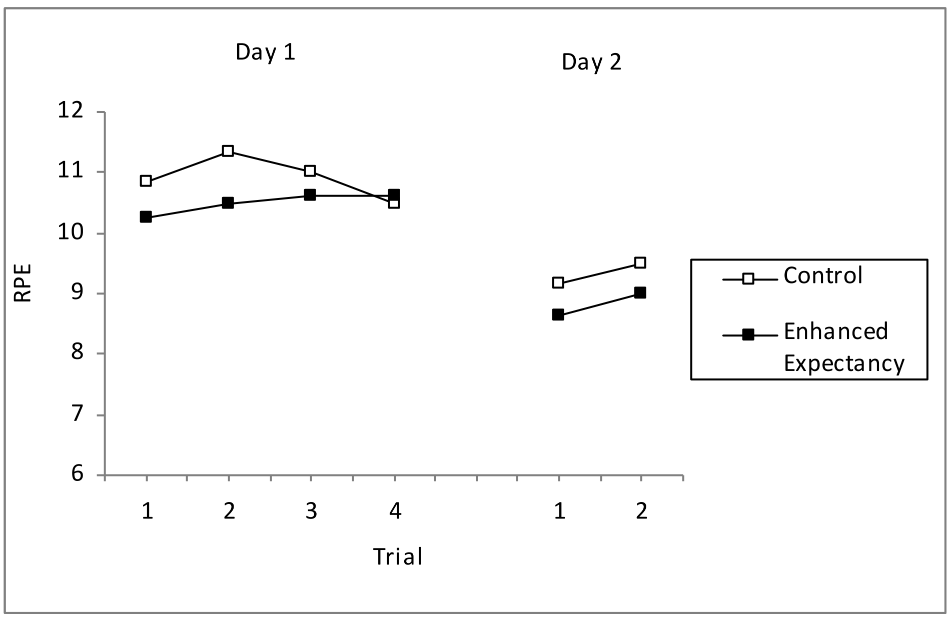

Figure 3: Ratings of perceived exertion over trials for Days one and two.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Discussion of Results

The purpose of the present study was to determine if positive feedback had any effect on volume of oxygen consumption, heart rate and perceived exertion during a three-minute step test. There was no significant difference between the enhanced expectancy and the control groups. The prediction that participants in the enhanced expectancy group would have lower VO_2 consumption, lower heart rate, and lower ratings of perceived exertion was not supported. The failure to support these hypotheses may be due to insufficient sample size, the amount and type of feedback given, the use of different types of equipment within subjects to measure VO_2 consumption. Heart rates and RPE did increase across exercise trials on Day 1 as one would expect. Heart rates did not however have much of an increase across trials on Day 2.

The feedback given to participants was minor. However even the most brief feedback statements have been shown to increase motivation and exercise efficiency in participants as demonstrated in the study conducted by Stoate et al. (2011). The difference between this study and previous study is that the feedback was given during the task, which could be one explanation for the lack of supporting data for the proposed hypotheses. Another possibility of the lack of supporting data could be the amount of feedback given. One possibility for a future related study could be to increase the number of trials which would increase the amount of times feedback is given. The feedback may not have been adequate to cause an effect in mindset which may have promoted improved performance.

Previous studies have also shown the positive effects that an individual's mindset has on performance and physiological responses in the body. The belief or mindset of a person sometimes called the placebo effect, has been found to influence physiological responses in the body. For example the physiological responses (e.g. increased wt loss) to being told ones job is a good form of exercise versus someone who was not given this information (Crum et al., 2007). Motivational factors have also been shown to improve physiological factors related to movement efficiency and perceived effort (Hutchinson et al., 2008). Another example is the physiological responses to food (e.g. ghrelin) (Crum et al., 2011).

Positive feedback promotes positive thinking which alleviates an individual's concerns or anxiety about their performance. Reducing concerns about performance promotes an external rather than internal focus of attention which facilitates more automaticity of movement (Wulf et al. 2011). Reducing one's concerns about performance also provides a relaxing effect (anxiety reduction) on the body which promotes deeper breathing, increased cardiac output and increased blood flow to skeletal muscles. Positive feedback has also been shown to increase sustained effort towards a task or reduce the feeling of fatigue or pain. Fatigue is sensed exclusively by the brain as proposed in the "Central Governor Model" by Noakes (2001). The central governor model proposes that max exercise capacity is a process coordinated by the subconscious brain. Once fatigue is sensed by the brain, the work output of the heart and muscles fall, decreasing oxygen demands of the heart, eventually decreasing or ceasing exercise

(Noakes, 2001). Alterations in central nervous system (CNS) arousal which can be promoted with positive thinking, facilitates motor unit recruitment to increase strength and alter the state of fatigue (Powers & Howley, 2007). Self efficacy has also been shown to lower perceptions of aches and pain, which can act as barriers to sustaining a given task. Reducing the perception of pain, leads to increased sustained effort and motivation towards the task (Hutchinson et al., 2008).

Although the current study did not support the proposed hypotheses, the previous examples and many other studies have been conducted supporting the benefits of enhanced expectancies. All of the data supporting the beneficial effects of enhancing one's expectancies promotes the need for further research on the topic.

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APPENDIX I

Feedback Statements

Trial 1: “You are in good shape”. “You are recovering quickly”.

Trial 2: “You are doing well”. “Your heart rate is low for your age and gender”.

Trail 3: “Your heart rate is going down fast”.

Trial 4: “You are still doing very well for your age and gender”. “You are recovering very quickly”.

APPENDIX II

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

INFORMED CONSENT

Department of Kinesiology and Nutrition Sciences

TITLE OF STUDY: Oxygen uptake and heart rate during a step test

INVESTIGATOR(S): Gabriele Wulf, PhD, Antonio Santo, PhD, and Leighann DeWitt

CONTACT PHONE NUMBER: 702-895-0938 (Wulf), 702-895-5329 (Santo), or 702-580-9202 (DeWitt)

Purpose of the Study
You are invited to participate in a research study. The purpose of this study is to evaluate the realationship between heart rate after exercise and sub-maximum aerobic capacity.

Participants
You are being asked to participate in the study because you are between the ages of 18 and 45, you are healthy, and you are able to complete the tasks assigned.

Procedures
If you volunteer to participate in this study, you will be asked to come into the Exercise Physiology Laboratory on 2 occasions. You will spend approximately 45 minutes in the lab the first time, and 30 minutes the second time (2 days later). You will be attached to a metabolic cart via a mask placed over the nose and mouth. You will be asked to complete a YMCA 3-minute step test. The step test involves stepping up and down on a bench, 12 inches in height, at a cadence of 24 steps/minute (in synchrony with the beats of a metronome). During the test your oxygen consumption and heart rate will be measured. After the 3-minute test you will be asked to sit and rest for 3 minutes. The entire procedure will be repeated 3 times on the first day, and once on the second day.

Benefits of Participation
There may not be direct benefits to you as a participant in this study. However, we hope to learn more about the relationship between oxygen consumption and heart rate.

Risks of Participation
There are risks involved in all research studies. You may experience some minor discomfort after the YMCA 3-minute step test or muscle soreness one or two days later.

Cost /Compensation
There will not be financial cost to you to participate in this study. The study will take a total of 75 minutes of your time. You will not be compensated for your time. However, you will receive extra class credit.

Participant Initials _____

1 of 2

Approved by the UNLV IRB. Protocol 1109-3922M
Received: 02-22-12 Approved: 02-29-12 Expiration: 09-28-12

Contact Information
If you have any questions or concerns about the study, you may contact **Dr. Gabriele Wulf at 702-895-0938 (or gabriele.wulf@unlv.edu), Dr. Antonio Santo at 702-895-5329 (or atonio.santo@unlv.edu), or Leighann DeWitt at 702-580-9202 (leighanndewitt@yahoo.com).** For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office of Research Integrity – Human Subjects at 702-895-2794.**

Voluntary Participation
Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality
All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed.

Participant Consent:
I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

______________________________ ________________
Signature of Participant Date

____
Participant Name (Please Print)

Participant Initials ____

Approved by the UNLV IRB. Protocol 1109-3922M
Received: 02-22-12 Approved: 02-29-12 Expiration: 09-28-12

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Biomedical IRB – Expedited Review
Modification Approved

Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation, suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: February 29, 2012

TO: **Dr. Gabriele Wulf**, Kinesiology and Nutrition Sciences

FROM: Office of Research Integrity – Human Subjects

RE: Notification of IRB Action
Protocol Title: **Oxygen Uptake and Heart Rate During a Step Test**
Protocol #: 1109-3922M
Expiration Date: September 28, 2012

The modification of the protocol named above has been reviewed and approved.

Modifications reviewed for this action include:

- Addition of a post-test to be conducted 2 days after initial testing using the same step-test as originally approved.

This IRB action will not reset your expiration date for this protocol. The current expiration date for this protocol is September 28, 2012.

PLEASE NOTE:
Upon approval, the research team is responsible for conducting the research as stated in the protocol most recently reviewed and approved by the IRB, which shall include using the most recently submitted Informed Consent/Assent forms and recruitment materials. The official versions of these forms are indicated by footer which contains approval and expiration dates.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through ORI - Human Subjects. No changes may be made to the existing protocol until modifications have been approved by the IRB. Modified versions of protocol materials must be used upon review and approval. Unanticipated problems, deviations to protocols, and adverse events must be reported to the ORI – HS within 10 days of occurrence.

Should the use of human subjects described in this protocol continue beyond September 28, 2012, it would be necessary to submit a **Continuing Review Request Form** 3*0 days* before the expiration date.

VITA

Graduate College
University of Nevada, Las Vegas

Leighann DeWitt

Home Address: 9599 W. Charleston # 2028

Degrees: Bachelor of Science in Dietetics

Thesis Title: Effects of Positive Feedback on Oxygen Consumption and Heart Rate During a 3- Minute Modified Step Test

Thesis Examination Committee:
Chair, Dr. Gabriele Wulf , Ph. D.
Committee Member, Dr. Antonio Santo , Ph. D.
Committee Member, Dr. Jack Young , Ph. D.
Graduate College Representative, Dr. Daniel Young , Ph. D.