EXPLORING THE RELATIONSHIP BETWEEN IN-TASK AFFECT AND ENJOYMENT FOLLOWING ACUTE BOUTS OF VARYING INTENSITY RESISTANCE EXERCISE

BY

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THESIS

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ABSTRACT

Exercise intensity has been shown to influence affect during and enjoyment following aerobic exercise, but little is known about this phenomenon in resistance exercise. **Purpose:** Examine the dose-response relationship between resistance exercise intensity and affective change with emphasis on affective response during exercise. **Methods:** Males (N=17; *M* age = 21.12 ±2.45 yrs) and Females (N=5; *M* age = 22.6 ±4.72 yrs) completed two resistance training protocols on different days. Individual 10 repetition (reps) maximum (10-RM) was assessed on Day 1 for 7 exercises (bench press, leg curls, bent over rows, leg extensions, shoulder press, biceps curls, triceps extensions); on Days 2 and 3 resistance training protocols at 70% or 100% 10-RM were completed (randomly assigned). Measures of affect (Energy, Tiredness, Tension, Calmness) were taken before, Post-0, and Post-20 min after each condition; enjoyment (PACES) was measured immediately after each condition. Feeling Scale (FS) was measured before, after each set (3 sets, 10 reps, 7 exercises), and at 5, 10, 15 and 20 min post exercise. Perceived exertion (RPE) and Felt Arousal Scale (FAS) were measured before, after each of the 7 exercises, and Post-20 min in each condition. **Results:** Enjoyment was significantly different between conditions (P= .046; 70%=106.55±10.21; 100%=99.23±17.62; effect size d= 0.53). Energy increased following exercise independent of intensity (p< 0.001), then decreased Post-0 to Post-20 (p< .001). Tiredness decreased Pre- to Post-0 (p=0.003), then increased Post-0 to Post-20 (P=0.038), independent of condition. Calmness decreased following both intensities (p=.007), but increased from Post-0 to Post-20 (p<0.001) independent of condition. Condition x Time interactions were significant for Tension with increased Tension in the 100% 10-RM condition relative to the 70% 10-RM condition (p<.001).

Tension was significantly increased Post-0 relative to Pre (p= .003) and Tension Post-0 was significantly greater than Post-20 (p<.001) independent of condition. FS values were significantly higher in the 70% 10-RM relative to the 100% 10-RM condition (p=.002). Finally, affect measured during exercise was significantly correlated with enjoyment (r_s=0.37, P_s=0.036), but only for the 100% condition. **Conclusions:** The findings are consistent with previous research and extend that research by examining the link between exercise intensity, affect and enjoyment to resistance exercise. Further, this shows that in-task affect is important to consider in this relationship.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

Exercise has many well documented and widely accepted benefits, yet a vast

majority of the population shies away from regular exercise and exercise programs. The

benefits of regular exercise include, but are not limited to: decreased morbidity and

mortality; reduced risk of developing diabetes, hypertension, colon cancer and heart

disease; reductions in blood pressure; and weight control. Exercise is also known to

improve mental health, help build healthy bones, muscles, and joints, improve body image

and self-esteem, and makes activities of daily life easier to perform (Lox, Martin Ginis, &

Petruzzello, 2006). With all of these well documented benefits, it is puzzling why so many

adults continue to live sedentary lifestyles. According to Tudor-Locke et al. (2010), 3.2% of

U.S. adults achieve physical activity recommendations. Adults and children spend an

average of 54.9% of their waking time motionless (i.e. experiencing no motion of any kind)

(Tremblay, Colley, Saunders, Healy, & Owen, 2010). One possible explanation for the

sedentary trends in the United States (and around the world) may stem from lack of

enjoyment from exercise. Not only are 38 percent of American's completely sedentary, but

of those that do adopt an exercise regimen, over 50 percent drop out within 3-6 months

(Lox et al., 2006). One of the main purposes of this study is to examine enjoyment of

exercise, specifically resistance exercise, in order to begin to determine an optimal exercise

intensity that maximizes the positive affect experienced during/following exercise. This

should result in exercise that is more enjoyable and thus more likely to be adhered to.

The effects of aerobic exercise on affect and anxiety are well documented in the

literature. Currently, acute bouts of aerobic exercise are associated with reductions in

negative affective states (e.g., anxiety, depression) and improvements of positive affective states (Dunn, Trivedi, Kampert, Clark, & Chambliss, 2005; Hale, Koch, & Raglin, 2002). A recent comprehensive review of 33 studies conducted since 1999 by Ekkekakis, Parfitt, and Petruzzello (2011) examined the relationship between exercise intensity and affective response. One of the main findings supports the idea of reductions in pleasure when exercise intensity exceeds the ventilatory (VT) or lactate threshold (LT). At intensities below this threshold, there is evidence of a dose response relationship. Specifically, individuals report feeling better as intensity increases until it reaches the point that exceeds their LT/VT. Beyond this point affect becomes progressively less positive/more negative. In spite of a rather large literature examining these issues with aerobic exercise, relatively little research has been done with resistance exercise. This is surprising considering the growing popularity of resistance training around the world. In a review article, Smith and Bruce-Low (2004) give evidence to the enormous growth in resistance training as evidence from increased article publications and books on resistance exercise. This growth can also be witnessed by the expansion of fitness as an industry in state of the art work out equipment and facilities. However, the affective consequences of resistance exercise are not well understood. It is important to understand whether resistance exercise results in patterns of intensity-driven affective responses that are similar to aerobic exercise, and, if not, to understand these differences. It is also important to examine the impact that resistance exercise has on enjoyment to further elucidate the exercise intensity-affect-enjoyment link with the ultimate goal of influencing exercise adherence.

CHAPTER 2

LITERATURE REVIEW

As noted in Chapter 1, there has not been very much research done to examine the affective consequences of resistance exercise, especially compared to the vast literature that has accumulated on aerobic exercise. This is somewhat surprising given that resistance exercise has been a fairly popular form of exercise for quite some time. Resistance training has gained popularity and support in recent years and has even climbed from the number 6 fitness trend in 2007 to the number 2 fitness trend for 2012, according to the *American College of Sports Medicine* (Thompson, 2011). What follows is a review of the work that has been done to date.

Doyne, Ossip-Klein, Bowman, Osborn, McDougall-Wilson, and Neimeyer (1987) conducted one of the earlier studies on the psychological effects of resistance exercise, comparing the effects of aerobic and resistance exercise on depression. Using an 8 week intervention, 40 women were randomly assigned to a running, weight lifting, or control group. Participants (*M* age = 28.5 ± 4.4 yrs) were all diagnosed with a major or minor depressive disorder according to Research Diagnostic Criteria. The running intervention consisted of having participants walk or run around an indoor track. Heart rate (HR) was assessed every 7 min and participants were instructed to speed up or slow down to maintain a HR of 80% HR_{max} (with HR_{max} determined as 220 b·min^{-1} – age). The weight lifting intervention consisted of a 10 station program (details not provided) with the goal of maintaining HR between 50-60% HR_{max}. Control (i.e., no intervention) participants were told their exercise program was postponed 8 weeks, but they completed the same assessments as exercise groups. Assessments were taken at baseline (during a screening

process), pre (before start of activity), mid (after week 4), and post (after week 8)

condition. Results indicated that the exercise interventions had almost identical effects,

with both resulting in significant reductions in depressive symptoms. These findings are

limited to women displaying depressive symptoms, but other labs have examined how

resistance exercise influences anxiety and affect.

Whereas Doyne et al. (1987) examined depressive symptoms, Bartholomew and

Linder (1998) examined the relationship between state anxiety and varying intensities of

resistance exercise in two distinct experiments. Experiment 1 included a high, moderate,

and low intensity condition consisting of six resistance exercises: chest extension, chest

flexion, leg extension, leg flexion, shoulder extension, and shoulder flexion. Each

participant, 10 males (M age = 21.5 ± 2.4 yrs) and 9 females (M age = 22.9 ± 2.8 yrs),

performed three sets of eight repetitions for each exercise with a 1 minute rest interval

between sets. Exercise was continued for 20 minutes. Intensity levels were identified using

Borg's (1983) RPE scale: low intensity was defined as lower than 9 (very light), moderate

intensity was defined as a score between 10 and 13 (up to somewhat hard), and high

intensity was defined by a score between 15 and 18 (hard to very hard). Spielberger's State

Anxiety Inventory (STAI) was used to assess anxiety immediately after and 5, 15, 30, 45,

and 60 min post exercise. Results indicated significant gender by time interactions across

all intensity conditions. Anxiety decreased significantly in males at 30, 45, and 60 min post

low intensity condition. During the moderate intensity condition, anxiety was significantly

increased at 5 min post exercise in males, but returned to baseline by 15 min post exercise.

There was also a significant increase in anxiety at 5 and 15 min post high intensity

condition, but for males only. Females showed no significant change in anxiety following

exercise at any condition. Bartholomew and Linder discussed the idea that females may differ from males in perceptions of exertion. This led to a follow up study using a more precise measure of exertion.

The second experiment (Bartholomew & Linder, 1998) examined state anxiety and two resistance exercise conditions: high and low intensity. Resistance intensity levels were determined using one repetition maximum estimations (1-RM$_{est}$) based on protocols from Lombardi (1989). Low intensity was defined as 40-50 percent 1-RM$_{est}$ and high intensity was defined as 75-85 percent of 1-RM$_{est}$. The second experiment consisted of six exercises: flat chest, incline chest press, vertical latissimus pulls, horizontal latissimus pulls, leg extensions, and hip extensions. Exercises followed the same protocol as Experiment 1: three sets of 8 repetitions with a 1 minute rest interval between sets for a total of 20 minutes. Participants were 10 males (*M* age = 22.8 ± 2.97 yrs) and 10 females (*M* age = 24.4 ± 3.9 yrs) who were enrolled in a beginning weight lifting class. Spielberger's State Anxiety Inventory (STAI) was used to assess anxiety immediately after and 5, 15, and 30 min following the end of exercise. Relative to pretest baseline measures, males and females showed a significant reduction in state anxiety at both 15 and 30 min following the low intensity condition and a significant increase in anxiety at 5 and 15 min post high intensity condition. There was no difference between genders in either condition. Bartholomew and Linder speculated that it is possible that the nature of resistance exercise causes females to report working harder than they actual are, thus failing to work at a high enough intensity to invoke changes in state anxiety in the first experiment.

Like Bartholomew and Linder (1998), Focht and Koltyn (1999) examined how different intensities of resistance exercise influenced state anxiety. Using a between-

subjects design, 84 participants were recruited from physical activity classes, and randomly assigned to a control, high or low intensity condition. Participants were further classified as experienced (30 males, 12 females) or inexperienced (21 males, 21 females). Experienced participants had a mean of 3.2 years (SD = 1.45) exercise experience while inexperienced participants had a mean of 0.12 years (SD = 0.09) exercise experience. High intensity was defined as 80 percent 1-RM and low intensity was defined as 50 percent 1-RM for four different exercises: bench press, leg press, torso-arm pulldown, and overhead press. The low intensity condition consisted of 3 sets of 12 to 20 repetitions of each exercise with a rest period of 45-75 seconds. The high intensity condition consisted of 3 sets of 4-8 repetitions with rest periods of 120-150 seconds. Participants in the control condition watched a resistance exercise technique video for 30 minutes, which was of comparable length to the exercise conditions. Focht and Koltyn evaluated state anxiety, various mood states, and HR prior to, immediately after, and 20, 60, 120, and 180 minutes post-conditions. State anxiety was assessed with the STAI, and mood states were assessed with the Profile of Mood States Inventory (POMS), a 65-item questionnaire designed to measure tension, depression, anger, vigor, fatigue, and confusion. Baseline measures were obtained prior to informing participants of which condition they had been randomly assigned to for all assessments taken.

Results indicated that state anxiety significantly decreased from pre-exercise levels at 180 minutes following the low intensity condition, but no changes in state anxiety were detected for the high intensity or control conditions. A significant reduction in vigor was detected following the low intensity condition that persisted for 20 minutes, while the high intensity and control conditions showed no change in vigor. Depression was significantly

decreased at 60, 120, and 180 min post low intensity condition only. Anger was significantly reduced at 20, 60, and 180 min post low intensity and at 180 min post high intensity conditions, with no changes observed in control. No significant differences were observed between experienced and inexperienced participants for any measures. HR was significantly increased immediately after both the low and high intensity conditions as compared to the control condition. One of the issues with this study was that, in addition to the different intensities, work load was further manipulated by altering the number of repetitions in each condition. By altering both the number of repetitions and intensity, it is difficult to determine if these results are a function of workload (i.e., number of repetitions), intensity, or a combination of both. Additionally, rest periods in the high intensity condition were up to three times longer than those in the low intensity condition. Longer rest period lengths, as compared to short rest periods, have been linked to increases in positive affect, decreases in negative affect and decreases in anxiety during resistance exercise (Bibeau, Moore, Mitchell, Vargas-Tonsing, & Bartholomew, 2010).

O'Connor, Bryant, Veltri, and Gebhart (1993) assessed state anxiety following varying intensity resistance exercise in females. Using a within-subjects design, 14 female participants (*M* age = 22.6 ± 3.9 yrs) completed three sets of 10 repetitions for six exercises: knee extension, knee flexion, arm pull down, chest press, shoulder press, and abdominal curl. Participants' 10-repetition maximum (10-RM) was determined for every exercise and each participant completed three bouts of resistance exercise at low (40% 10-RM), moderate (60% 10-RM) and high (80% 10-RM) intensity. Each participant also completed a control condition that consisted of the assessment procedures for equal duration of exercise conditions. Each session lasted 30 minutes and state anxiety (STAI)

was assessed prior to, immediately after, 15, 30, 45, 60, 75, 90, 105, and 120 min post exercise. State anxiety levels were significantly reduced across all exercise conditions from 90 to 120 min post condition. This study indicates that state anxiety may not be reduced until 90 min post exercise, and many studies (Arent, Landers, Matt, & Etnier, 2005; Bartholomew & Linder, 1998; Bartholomew, 1999; Bibeau et al., 2010) do not provide post-exercise analysis beyond 60 minutes.

Koltyn, Raglin, O'Connor, and Morgan (1995) assessed state anxiety following an acute bout of resistance exercise. The experimental group was 13 males and 12 females (*M* age = 19 ± 3 yrs) enrolled in a beginners' weight training class; the control group consisted of 10 males and 15 females (*M* age = 18 ± 1.5 yrs) enrolled in a lecture course. The experimental group completed about 50 min of weight training on major muscle groups, with each individual completing different exercises as no specific protocol was given to participants. Each participant completed two to three sets (2.5 ± 2) of 6-8 reps (8 ± 2) for 7-10 exercises (8 ± 2) using weights ranging from 30-80% of their body weight (50 ± 15%). The subjects in the control group sat quietly for a 50 min lecture. The STAI was completed by each subject before and 3-5 min after each condition. This study found that state anxiety did not differ by condition, and concluded that state anxiety doesn't significantly differ following weight training or quiet rest. The high rate of variability between subjects in terms of number of sets, repetitions, and exercises, as well as the large range of intensity levels, makes it difficult to accurately depict the relationship between resistance exercise and anxiety. A more precise exercise protocol, especially regarding intensity levels, as well as assessing state anxiety multiple times post condition would have strengthened this work.

Moving beyond examining anxiety or depression, Bartholomew, Moore, Todd, Todd, and Elrod (2001) examined how varying resistance exercise intensities influenced other psychological states using a between-subjects design. The study involved 54 participants (35 males, 19 females), all undergraduate students who had 6 weeks of weight training prior to the study. Participants were randomly assigned to one of three different conditions: control (*M* age = 20.8 ± 2.0 yrs), low intensity (*M* age = 20.2 ± 1.6 yrs), and high intensity (*M* age = 21.3 ± 1.6 yrs). Exercise conditions consisted of 3 sets of 5 repetitions for three upper body exercises: bench press, overhead press, and dumbbell row. The low intensity condition was performed at 50% 1-RM and the high intensity condition at 80% 1R-M. Psychological state was evaluated using the Exercise-Induced Feeling Inventory (EFI; Gauvin & Rejeski, 1993) prior to and 10, 25, and 40 min post-exercise.

Bartholomew et al. (2001) found that all participants experienced a reduction in physical exhaustion (including the control group), with a significant reduction being noted at 40 min post-condition. There was also a significant increase in revitalization, but only following the exercise conditions. The increase in revitalization persisted during the entire recovery period following the low intensity condition (at 10, 25, and 40-min post-exercise). The increase in revitalization was significant only 10 min post exercise in the high intensity condition. No changes were observed for positive engagement or tranquility for any condition. Bartholomew et al. (2001) used exercise conditions consisting of only 3 exercises for 3 sets of 5 repetitions. Other studies, including O'Connor et al. (1993), had participants perform 3 sets of 10 repetitions for six different exercises (4 times as much work). The limited number of repetitions per set, as well as the limited number of overall exercises, may have been insufficient to elicit significant changes in psychological states.

Also, according to Baechle, Earl, and Wathen (2000), working at 80% of 1-RM, an individual should be able to complete 8 repetitions, not just five. It is possible that the participants were either not exercising at a high enough intensity level or for an adequate duration to have experienced exercise-induced changes in positive engagement or tranquility. It is also possible that resistance exercise doesn't have an influence on these affective states.

Arent et al. (2005) examined the association between varying intensity resistance exercise and affect. Participants were 15 male (*M* age = 22 ± 0.7 yrs) and 16 female (*M* age = 20.8 ± 0.5 yrs) undergraduates who were active aerobic exercisers and were not currently weight training. Using a within-subjects design, all participants completed four different conditions: control, low, moderate, and high intensity resistance exercise. Intensity was based on percentage of 10-RM with low, moderate, and high intensity representing 40, 70, and 100% of 10-RM, respectively. Each exercise condition consisted of three sets of 10 repetitions for six different upper body exercises: bench press, latissimus pulldown, shoulder press, seated rows, triceps extensions, and biceps curls. During the control condition, participants watched a 45 minute video on the history of weight training. The STAI was used to assess state anxiety, the Activation-Deactivation Adjective Check List (AD-ACL) was used to assess arousal/activation, and the Positive Affect-Negative Affect Schedule (PANAS) was used to assess positive and negative affect. Measures were taken immediately before and 0-5, 15, 30, 45, and 60 min post-condition.

Results were reported using an adjusted area under the response curve approach adjusted for baseline values, rather than just as time after end of exercise (reports one overall value for assessment measures instead of one for each time measured post exercise). Reported over the duration of recovery period, significant decreases in anxiety,

negative affect, and tiredness, along with increases in positive affect, energy, and calmness were observed following the moderate intensity (i.e., 70%) condition. The low intensity (i.e., 40%) condition failed to produce any beneficial changes and was not significantly different from the control group on any measured construct. Significant increases in anxiety, negative affect, tiredness, and tension, as well as significant reductions in energy and calmness, was observed following the high intensity (i.e., 100%) condition. These findings support idea of a curvilinear dose-response relationship mentioned in the review by Ekkekakis et al. (2011). Specifically, the results of Arent et al. (2005) mirror the threshold effect noted in Ekkekakis et al. (2011) review.

Bibeau et al. (2010) examined resistance exercise of varying intensities and rest periods on anxiety and affect. Participants were 58 male and 46 female (*M* age = 20.5 ± 2.7 yrs) all enrolled in a weight training class at a large university. Using a between-subjects design (participants completed only 1 condition) composed of 5 different conditions (control, low intensity-long rest, low intensity-short rest, high intensity-long rest, and high intensity-short rest), anxiety, positive affect, and negative affect were measured immediately after the cessation of each condition. Long conditions had a rest time of 90 sec, while short conditions had a rest time of 30 sec, between sets. High intensity conditions were performed at 80-85% of 1-RM for 6-7 repetitions, while low intensity was set at 50-55% of 1-RM for 10-11 repetitions. According to Baechle et al. (2000), the maximum number of repetitions a person should be able to complete at 85% of their 1-RM is 6 repetitions. This means that during the high intensity condition participants were working at, or near, their maximal anaerobic capacity for the duration of the exercise condition. Bibeau et al. (2010) found a significant increase in positive affect only for the low-long

group at 5 min following exercise and no difference in negative affect between groups. All groups reported an increase in anxiety, with the largest increases associated with short rest periods. Overall, the results of this study were mixed. Bibeau et al. (2010) did not keep intensity or total work load consistent across conditions, which could have confounded their findings. There was also no moderate intensity condition.

It is widely accepted that aerobic exercise has positive effects on mood (Reed & Ones, 2006; Reed & Buck, 2009). Bartholomew (1999) specifically examined this well accepted idea using resistance exercise. 40 male participants completed three sessions of either resistance exercise (*M* age = 23.2 ± 1.9 yrs) or no exercise (*M* age = 23.6 ±2.8 yrs). Because five participants failed to complete all exercise sessions, the final analysis consisted of 35 participants (resistance exercise N = 17, no exercise control N = 18). High intensity resistance exercise was performed, as defined by an RPE rating of 15 (hard) or more, for 20 min in which participants completed sets of 4 repetitions for six exercises (exercises not provided). Participants in the control condition were shown college yearbook photographs and asked to provide details on as many people as possible in 20 min. The sessions differed in that pre-exercise, participants were exposed to 20 minutes of positive, negative, or neutral guided imagery. Mood was assessed using measures of anger (Spielberger's State Anger Inventory), state anxiety (STAI), negative affect, and positive affect (PANAS).

Results indicated that immediately following positive imagery, positive affect was high. However, after the 20 min intervention (control or resistance) positive affective state was significantly reduced. Following negative mood induction, both groups displayed high levels of state anxiety and anger that decreased post intervention. No exercise effect was

observed for anger, but the resistance group showed prolonged reductions in state anxiety compared to the control group. Following the control condition, the resistance group showed a significant increase in state anxiety and anger at 5 min post intervention compared to the control group. During the recovery period, in the resistance group, anger returned to baseline at 15 min post intervention where it remained. However, state anxiety in the resistance group returned to baseline at 15 min post intervention and was significantly less than the control group at both 30 and 45 min post intervention. This indicated an exercise-specific beneficial effect on state anxiety (i.e., reduction). The resistance exercise condition also resulted in significant increases in positive affect at the end of the 45 minute recovery period as compared to the control condition.

Studies examining other psychological outcomes of resistance exercise have also examined affective changes. Chang and Etnier (2009) examined changes in cognition as a function of varying intensity resistance exercises. Using a between-subjects design, 68 participants (*M* age = 26.0 ± 3.2 yrs) completed either a control condition or resistance exercise at 40, 70, or 100 percent of their baseline tested 10-RM. Because three participants failed to complete all cognitive tests, the final analysis consisted of 65 participants (32 females, 33 males). Exercise conditions involved two sets of 10 repetitions for six upper body exercises (bench presses, right and left rowing, lateral arm raise, and right and left arm curl). Feeling Scale (as a measure of affective valence), Felt Arousal Scale (as a measure of affective arousal), and RPE measures were assessed immediately after completion of each exercise (Chang & Etnier, 2009). While the main focus of the study was to assess cognitive function, this was the first study to assess affect *during* resistance exercise. However, Feeling Scale data was excluded from the results section of this paper,

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with the only mention occurring in the discussion section. Here it was stated that affective valence (from the Feeling Scale)was not significantly different between conditions. As expected, HR, RPE, and arousal increased with increasing intensity (Chang & Etnier, 2009).

The effect of pre-exercise anxiety on state anxiety following an acute bout of resistance exercise was examined by Focht (2002). Using a within-subjects design, 19 females (*M* age = 20.6 ± 3.1 yrs) completed three different conditions: self-selected intensity, prescribed intensity, and a control condition. Each exercise condition involved three sets of 10 repetitions for four different exercises (leg extension, chest press, torso-arm pulldown, and overhead press extension). The prescribed intensity condition was performed at 75 percent of the participants' pre-determined 1-RM; participants were instructed to choose a comfortable weight during the self-selected intensity condition. The control condition consisted of quiet rest for a duration equal to both exercise conditions. Assessments of state anxiety (STAI) were taken before, immediately after, and 20, 60, and 120 minutes following each condition. To examine the effect of baseline anxiety on anxiety following acute bouts of resistance training, Focht (2002) placed participants into a high or low baseline anxiety group using a median split on baseline anxiety scores. Baseline anxiety was measured with the 20-item Form Y-1 (SAI) of the STAI. RPE values were obtained and showed that the prescribed intensity condition resulted in significantly higher RPE scores than the self-selected intensity condition.

Results showed a significant reduction in state anxiety during all post assessments, as compared to baseline, in both the self-selected and prescribed intensity conditions, but only in the high baseline anxiety group. The low baseline anxiety group showed a significant reduction in state anxiety only 60 and 120 minutes following the self-selected

intensity condition. These results indicated that with higher levels of baseline anxiety, an acute bout of resistance exercise can reduce state anxiety independent of intensity.

One difference in the study by Focht (2002) was that participants were allowed to leave the lab after their 60 minute assessment and then return for the assessment at 120 minutes. By leaving the testing environment, outside factors may have influenced the anxiolytic (i.e., anxiety-reducing) responses. Thus, the reduction in state anxiety observed at the 120 min assessment cannot be directly attributed to the exercise stimulus.

Many variables have the potential to confound research results, with one such variable being the testing environment. Arent, Alderman, Short, and Landers (2007) conducted a study examining the impact of the testing environment on affect following resistance exercise. They randomly assigned 23 males (18-30 yrs old) to a "Stay" or "Go" group. Each participant completed a control and exercise condition, after which they all remained in the laboratory for 60 minutes. Those in the "Go" group left and came back at 90 and 120 minutes post exercise, while those in the "Stay" group remained in the laboratory during that time. The control condition consisted of a 30 minute video on resistance training techniques, and the exercise condition consisted of three sets of 12-20 repetitions at 50 percent of their 1-RM for five exercises (bench press, shoulder press, latissimus pull-down, leg press, and dead lift). State anxiety (SAI) and arousal/activation (AD ACL) were assessed before and 5, 15, 30, 60, 90, and 120 minutes post condition.

Results indicated a significant increase in state anxiety and tension, along with a decrease in calmness, at 5 and 15 minutes post-exercise as compared to the control condition for both "Stay" and "Go" groups. At 60 and 90 minutes post exercise, both groups showed a slight decrease in state anxiety as compared to the control condition, but this was

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not significant. The results for "Stay" and "Go" groups were similar, but showed some notable differences. For energetic arousal, the "Stay" group showed an increase at 5 min post while the "Go" group showed an initial decrease. Although no set patterns were identifiable, it was clear that staying in the laboratory or allowing participants to leave resulted in different affective responses post exercise versus post control conditions. The results of this study are important in that future research should be consistent in allowing participants to stay in or leave the laboratory.

Concerns

Of the previous studies on resistance exercise and affect or anxiety, none has focused specifically on affective responses during resistance exercise. Chang and Etnier (2009) included measures of affective valence during resistance exercise, but didn't report any results relative to these data. For the purpose of the present study, affective state will be defined as a temporary positive or negative feeling that influences, and is influenced by, exercise behavior (Ekkekakis et al. 2011). The current study is the first to assess affect during varying intensity resistance exercise using a within-subjects design. One of the main goals of the current study is to assess, via the Feeling Scale (FS), affective valence after each set for every exercise. There is also an inconsistency with the types of exercises performed in previous research. Some studies focus only on upper body exercises (Arent et al. 2005), while others included both upper and lower body exercises (Bartholomew et al., 1998; Bibeau et al., 2010). The current study will include upper and lower body exercises.

One study has been conducted on exercise order and affective responses. Bellezza, Hall, Miller, and Bixby (2009) assessed affect using FS and FAS measures in response to exercise order. Participants (18 women, 11 men; *M age* = 20.9 ± 1.9 yrs) completed two

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exercise conditions consisting of 2 sets (one at 80%, one at 100% predetermined 10-RM) for nine exercises. Exercise conditions differed only by exercise order: 1) chest press, 2) leg press, 3) rows, 4) leg extension, 5) overhead press, 6) hamstring curl, 7) biceps curl, 8) calve raise, and 9) triceps extension or the same exercises in the reverse order. Affect was assessed pre, after overhead press for both conditions, immediately post, and 5 min post condition. Results indicated participants felt more positive during and 10 min post exercise in the small to large condition, with no differences in FS pre or immediately post-condition. FAS did not differ between conditions at any assessment time. These results support the notion that small to large exercise order may be associated with improved affect during exercise. Larger muscle groups require more energy and cause fatigue at an accelerated rate. With fatigue comes lactic acid build up, which a participant may associate with feeling less positive on the FS. With FS assessed only once midway through condition, less positive FS cannot be directly associated with exercise order. Also, larger muscles are more prone to fatigue and should be performed before small muscles to limit injury potential (Baechle et al., 2000).

In the current study, core exercises will be performed before assistant or minor body part exercises. Core exercises involve large muscles of the chest (e.g., chest press), shoulders (e.g., shoulder overhead press), back (e.g., bent-over rows), and legs (e.g., leg press). Assistant exercises involve smaller muscle groups (e.g., arms), but are not limited only to biceps and triceps exercises (Baechle et al., 2000). Larger muscles or multiple-joint exercises are more influenced by fatigue and an individual is more prone to injury due to poor form brought on by fatigue. Thus, these exercises should be performed first in a resistance training program. Also, these larger muscles or multiple-joint exercises require a

larger amount of energy to perform and should be performed at the beginning of an exercise program to ensure that the individual has sufficient energy to complete them.

Additionally, according to Baechle et al. (2000), alternating upper body and lower body exercises can be beneficial to an individual, especially if that individual is a novice weight trainer, because the upper body has a chance to rest while the lower body works and vice versa. Another factor that must be considered when deciding upon an exercise order is overlap. While completing bench press that specifies the pectoral muscles, the deltoid muscles are also working. For these reasons, it is important to alternate between push and pull methods of training. Push exercises consist of bench press, shoulder press, and triceps extension while pull exercises include latissimus pulldowns and bicep curls (Baechle et al., 2000). The order in which resistance exercises will be completed in the current study takes all these factors into account.

Previous research on the effects of resistance exercise on affect is inconsistent. One of the most important factors is establishing a common means to assess maximum strength as well as intensity. The review by Ekkekakis et al. (2011) details the inconsistencies in the aerobic exercise literature on defining exercise intensities. Like the literature on aerobic exercise, resistance exercise studies use many variations of intensity measures. Many studies use a 1-RM to assess maximum strength and design a workout plan based on percentages of an individual's 1-RM (Bartholomew & Linder, 1998; Bartholomew et al., 2001; Bibeau et al., 2010; Day, McGuigan, Brice, & Foster, 2004). Other studies evaluate maximum strength using a 10-RM protocol (Arent et al., 2005; Chang & Etnier, 2009; O'Connor et al., 1993). Even still, studies use HR percentages (Doyne et al., 1987), RPE (Day et al., 2004) and variations of maximum repetitions. Not only do these studies vary on

maximum strength tests, but they vary on intensity measures as well. O'Connor et al. (1993) used 40, 60, and 80% of a 10-RM as low, moderate, and high intensity, respectively. Arent et al. (2005) and Chang and Etnier (2009) used 40, 70, and 100% of a 10-RM as low, moderate, and high intensity, respectively. Similar, if not even broader, ranges of percentages have been associated with the 1-RM.

Most exercise studies require the subject to perform about 10 repetitions per set (Arent et al., 2005; Bartholomew & Linder, 1998; Bibeau et al., 2010). In the current study, a 10-RM test will be used rather than a 1-RM to assess baseline strength. Using a 10-RM is preferable to a 1-RM test for the following reasons: 1) 1-RM tests are significantly more dangerous than a 10-RM test, especially for untrained or novice resistance trained individuals; 2) as the intervention consists of 10 repetitions, using a 1-RM requires the use of approximations for all levels of intensity and diminishes the accuracy of the test; 3) load becomes increasing more variable as the % of 1-RM decreases (e.g., taking two participants with the same 1-RM, one might be able to do 10 repetitions at 75% of their 1-RM while the other may only be able to perform 5 repetitions at the same percentage); and 4) the tables used to estimate how many repetitions can be performed based on percentage of 1-RM assume a linear relationship (Baechle et al., 2000). However, many studies have found a curvilinear relationship between percent of 1-RM and number of repetitions (LeSuer, McCormick, Mayhew, Wasserstein, & Arnold, 1997; Mayhew, Ball, Arnold, & Bowen, 1992; Mayhew, Ware, & Prinster, 1993).

Rest period is another crucial aspect to any resistance exercise program. Rest period length should depend on the training goal. Rest periods need to be longer when training for strength or power (2-5 min), while a bit shorter if training for hypertrophy or size (30-90

sec) and even shorter if training for muscular endurance (<30 secs; Baechle et al., 2000). Also, according to the results of Miranda et al. (2007), participants experienced a decrease in number of repetitions after a 1 min rest period compared to a 3 min rest period. For the purpose of the current study, it is important that participants be able to complete the required number of repetitions without having to extend the length of each session to an unreasonable length. Because the current study does not focus on power or endurance, after considering the information above, rest periods will be 90 sec between sets and 2 min between exercises.

The current study will consist of two experimental conditions: a moderate and a high intensity resistance exercise bout. According to Wathen (1994), 70% and 100% of a 10-RM would represent moderate and high intensity, respectively. These specific intensity levels will be used in the current study as they have been established as accurate and have been used in other work regarding varying intensities of resistance exercise (Arent et al., 2005; Chang & Etnier, 2009). Experimental conditions will vary by intensity level only. By keeping the volume of exercise the same across conditions, total work will differ. However, according to Kilpatrick, Kraemer, Bartholomew, Acevedo, and Jarreau (2007), affective responses to exercise are dependent on intensity and not total work, at least for aerobic forms of exercise.

In keeping with the available literature, it is hypothesized that participants will report feeling better following moderate intensity resistance exercise and will report feeling worse after high intensity resistance exercise compared to baseline measures. More specifically, it is hypothesized that participants will report significant increases in positive affect (as reflected by increases in pleasant-activated affective states like energy and/or

pleasant-deactivated affective states like calmness) and decreases in negative affect (as reflected by decreases in unpleasant-activated affective states like tension and/or unpleasant-deactivated affective states like tiredness) after completion of the moderate condition as compared to the high intensity condition. It is also hypothesized that participants will report larger increase in negative affect (as reflected by increases in unpleasant-activated affective states like tension and/or unpleasant-deactivated affective states like tiredness) during the high intensity condition, relative to the moderate intensity condition. Participants will report significant decreases in positive affect (as reflected by decreases in pleasant-activated affective states like energy and/or pleasant-deactivated affective states like calmness) during the high intensity condition, while little to no change in positive affect will be reported during moderate intensity condition. Finally, it is hypothesized that participants will report significantly less enjoyment immediately after the high intensity condition relative to the moderate intensity condition. The findings from this study could have important implications for exercise adherence and will fill a void in the literature by examining affective responses before, during, and following varying intensity resistance exercise.

CHAPTER 3

RESEARCH METHODS

Participants

Participants were college age residents of the Champaign-Urbana area (*N*= 22: 17 males, 5 females) recruited from flyers placed on campus bulletin boards. The average age of the overall sample was 21.45 ± 3.04 yrs (females: 22.6 ± 4.72 yrs; males: 21.12 ± 2.45 yrs), average height was 177.2 ± 8.0 cm (females: 171.7 ± 12.0 cm; males: 178.8 ± 6.0 cm), average weight was 78.9 ± 14.1 kg (females: 70.5 ± 16.2 kg; males: 81.4 ± 12.8 kg). Average Bench Press 10-RM was 65.4 ± 26.6 kg (females: 28.1 ± 3.8 kg; males: 76.3 ± 19.0 kg), average Leg Curl 10-RM was 33.2 ± 7.4 kg (females: 23.6 ± 6.5 kg; males: 36.0 ± 7.6 kg), average Bent-Over-Rows 10-RM was 56.5 ± 19.2 kg (females: 31.8 ± 4.5 kg; males: 63.8 ± 15.2 kg), average Leg Extension 10-RM was 67.7 ± 16.0 kg (females: 54.0 ± 20.3 kg; males: 71.8 ± 12.6 kg), average Shoulder Press 10-RM was 38.6 ± 13.6 kg (females: 21.3 ± 2.0 kg; males: 43.6 ± 11.1 kg), average Biceps Curls 10-RM was 31.8 ± 10.1 kg (females: 17.2 ± 2.0 kg; males: 36.0 ± 6.9 kg), average Triceps Extension 10-RM was 30.1 ± 9.0 kg (females: 19.1 ± 2.0 kg; males: 33.4 ± 7.5 kg). All participants were instructed to refrain from drinking alcohol at least 1 day prior to testing and to refrain from performing resistance exercise 48 hours prior to testing.

Measures

Affect. The Feeling Scale (FS; Hardy & Rejeski, 1989), the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985), and the Activation Deactivation Adjective Check List (AD ACL; Thayer, 1986) were used for assessment of affect. Taking a dimensional approach to assessing affect (Ekkekakis & Petruzzello, 2002), the FS was used to measure affective

valence. The FS is an 11-point, single-item, bipolar measure of pleasure-displeasure, which is commonly used for the assessment of affective responses during exercise (Ekkekakis & Petruzzello, 1999). The scale ranges from +5 to -5, with anchors provided at zero (Neutral) and at all odd integers, ranging from 'Very Good' (+5) to 'Very Bad' (-5). The FAS was used to measure perceived activation during the exercise bouts. The FAS is a 6-point, single-item measure, ranging from 1 (Low Arousal) to 6 (High Arousal). The FAS is strongly correlated with valid single-item measures used to assess activation. The AD ACL is a 20-item measure, with five items comprising each of four subscales: Energy, Tiredness, Calmness, and Tension. Each item is rated on a 4-point rating scale (definitely feel=4, feel slightly=3, cannot decide=2, definitely do not feel=1; Thayer, 1986).

Perceived Exertion. Perceptions of effort were assessed with the 15-point Rating of Perceived Exertion (RPE; Borg, 1998) scale. The RPE scale is commonly used for assessing perceived effort during exercise along a psychophysical continuum that ranges from 6 (no exertion at all) to 20 (maximal exertion).

Enjoyment. The Physical Activity Enjoyment Scale (PACES; Kendzierski & DiCarlo, 1991) was used in order to assess enjoyment following each condition. The PACES contains 18 bipolar statements that anchor the ends of a 7-point response scale where participants choose the number that most closely corresponds to the way they feel at the moment about the physical activity they have just been doing [e.g., "I enjoy it (1) .... I hate it (7)"; "I dislike it (1) .... I like it (7)"]. Scores on the PACES range from 18 to 126. Kendzierski and DeCarlo (1991) demonstrated that the PACES was valid and had acceptable internal consistencies in two separate studies (Cronbach's alphas = 0.93 in both). PACES scores in the present

study ranged from 89 to 123 (*M* =106.55) in the moderate intensity condition and 55 to 125 (*M* = 99.23) in the high intensity condition.

Procedure

Participants came to the Exercise Psychophysiology Laboratory (ExPPL) on three separate occasions. Each participant completed all three sessions at the same time of day exactly one week apart (3 weeks total); one female had to reschedule her third day but was rescheduled at the same time of day as her previous sessions. At the first meeting, participants read and signed an informed consent document approved by the University's Institutional Review Board. The participants then completed the Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992) and a health and physical activity history inventory in order to determine if they met the inclusion criteria (participants would have been excluded if they answered yes to any item on the PAR-Q; none did). Upon meeting inclusion criteria, the participants then continued with the first session of the study.

After completion of all initial questionnaires, participants were informed of all testing procedures and taken from the ExPPL to a room containing the weights and machines used in the study. Each participant's 10 repetitions maximum (10-RM) was determined for 7 exercises. The 7 exercises and the order in which they were performed were: 1) bench press, 2) leg curls, 3) bent over rows, 4) leg extensions, 5) shoulders press, 6) biceps curl, and 7) triceps extensions in the supine position. 10-RM was defined as the maximum amount of weight an individual could successfully lift 10 times (Baechle et al., 2000). Between exercises and 10-RM attempts, participants were given a 3 minute rest to ensure recovery of the phosphocreatine system (main energy system for short duration,

high intensity activity; Baechle et al., 2000). The complete protocol used to assess 10-RM,

taken from Earl et al. (1999), is shown in Figure 1. Participants were scheduled for their

next session and then allowed to leave the testing environment after completion of their

triceps extension 10-RM.

Figure 1. 10-RM testing protocol altered from Earle (1999).
1. Instruct the athlete to warm up with a light resistance that easily allows 6-10 repetitions
2. Provide a 1 min rest period
3. Estimate a warm-up load that will allow the athlete to complete 15 repetitions by adding
   a. 5-10 lbs for upper body exercises
   b. 15-20 lbs for lower-body exercises
4. Provide a 2 min rest period
5. Estimate a conservative, near-10-RM load that will allow the athlete to complete 4-6 repetitions by adding
   a. 5-10 lbs for upper body exercises
   b. 15-20 lbs for lower-body exercises
6. Provide a -4 min rest period
7. Make a load increase
   a. 5-10 lbs for upper body
   b. 15-20 lbs for lower body
8. Instruct the athlete to attempt 10-RM
9. In successful, provide a 2-4 min rest period and go back to step 7
10. If athlete failed, provide 2-4 min rest period, decrease load by subtracting
    a. 2.5-5 lbs for upper body
    b. 7.5-10 lbs for lower body
    c. THAN RETURN TO STEP 8

Continue to increase or decrease load until the athlete can complete 10-RM with

proper form.

After completion of 10-RM tests for all 7 exercises, a high and moderate intensity

condition was determined for each participant. The high intensity condition was defined as

completion of 3 sets of 10 repetitions at the predetermined 10-RM (100%). The moderate

intensity condition was calculated as 70% of the predetermined 10-RM. These calculations

were rounded to the nearest 5 pound increment and performed for 3 sets of 10 repetitions.

The moderate intensity condition ranged from 66.67% to 75% of each participant's 10-RM. Participants were then randomly assigned an order in which to complete the two intensity conditions. After completion of each experimental session, participants were required to remain in the lab for an additional 20 min. The total duration of each exercise session was approximately 65 min for each participant: 5 min warm up, 40 min exercise session, 20 min recovery period.

Within each exercise session, participants completed the AD ACL before, immediately after, and 20 min post each condition. The PACES was completed immediately after each condition. Each participant was asked to rate their FAS and RPE before, after completing each of the 7 exercises, and 20 min post each condition (9 time points per condition). FS measures were collected before, after every set (3) for every exercise (7), and at 5, 10, 15, and 20 min post-condition (26 time points per condition).

During all exercise sessions and including the 10-RM assessment, participants were allowed to drink water ad libitum, but were not allowed to listen to music. For safety, there was a minimum of two spotters present and ready to assist the participant during every session.

Data Analysis

Data analysis was conducted using SPSS 12.0.1 for Windows. Data were initially inspected for any unusual data points, with corrections made as needed. Analysis of differences in enjoyment between the two intensity conditions was done with a *t*-test. All other analyses of pre- to post-exercise changes in affect and pre-, during, and post-exercise changes were conducted with multivariate analyses of variance (MANOVA), with repeated measures analyses of variance (RM-ANOVA) used for follow-up analyses. RM-ANOVAs used

the Huynh-Feldt epsilon correction to protect against violations of the sphericity

assumption. Effect sizes were calculated as Cohen's *d* (Cohen, 1988).

CHAPTER 4

RESULTS

It was hypothesized that exercise at an intensity of 100% 10-RM would result in less enjoyment of the exercise compared to exercise at an intensity of 70% 10-RM. To test this first hypothesis, a *t*-test was used to compare self-reported enjoyment (assessed via PACES) of the two exercise intensities. The 70% 10-RM condition resulted in reported enjoyment of 106.55±10.21 (*M±SD*) while the 100% 10-RM condition resulted in reported enjoyment of 99.23±17.62 (*M±SD*) [*t*(21)=2.12, *p*= .046; Cohen's *d*=0.53]. Thus, in this study, intensity did influence self-reported enjoyment.

It was hypothesized that there would be less pleasant affect *during* the 100% 10-RM intensity condition compared to the 70% 10-RM intensity condition, and no real difference in affect between intensity conditions from pre- to post-exercise. Examination of the pre- to post-affective responses (Energy, Tiredness, Calmness, Tension) were initially done with an Intensity Condition (2: 70%-10 RM, 100% 10-RM) x Time (3: pre, post-0, post-20) multivariate analysis of variance (MANOVA). There were significant Condition [Wilks λ= .388, F(4, 18)= 7.09, *p*= .001, partial η^2= .612], and Time [Wilks λ= .297, F(8, 14)= 4.14, *p*= .01, partial η^2= .703] main effects. However, the Condition x Time interaction was also significant [Wilks λ= .318, F(8, 14)= 3.75, *p*= .015, partial η^2= .682]. This was followed up with a series of repeated measures [Condition (2: 70%-10 RM, 100% 10-RM) x Time (3: pre, post-0, post-20)] ANOVAs for each of the individual affective subscales of the AD ACL (i.e., Energy, Tiredness, Calmness, and Tension). Significant Time effects (all p_s≤ .002) were seen for all four measures. The nature of these time effects can be seen in Figures 2 and 3, with means (±*SD*) collapsed across Intensity Condition shown in Tables 1 and 2.

For Energy (see Figure 2, top panel), a significant Time main effect [$F(2, 42)=13.51$, $p<.001$, partial $\eta^2=.391$; H-F $\varepsilon=1.0$] was seen, but the Condition ($p=.57$) and Condition x Time interaction ($p=.98$) were not significant. Regarding the Time main effect (see Table 1), Energy was significantly increased immediately post-exercise (M difference= 3.46, $p<.001$, $d=1.03$) compared to pre-exercise and Energy immediately post-exercise was significantly greater than post-20 (M difference= 2.93, $p<.001$, $d=-0.86$). Energy at post-20 was not different from pre-exercise ($p=.48$).

Table 1. Mean ($\pm SD$) affective responses before and after exercise, collapsed across intensity conditions, for Energy and Tiredness.

Measure	Time	*M*	*SD*
Energy	Pre	11.03	3.27
	Post-0	14.48	3.45
	Post-20	11.55	3.35
Tiredness	Pre	11.30	4.06
	Post-0	9.03	2.54
	Post-20	10.07	3.17

For Tiredness, neither the Condition main effect ($p=.123$) nor Condition x Time interaction ($p=.142$) was significant (see Figure 2, bottom panel). However, the Time main effect was significant [$F(1.90, 39.92)=7.33$, $p=.002$, partial $\eta^2=.259$; H-F $\varepsilon=.951$]. Tiredness was significantly decreased immediately post-exercise (M difference= 2.27, $p=.003$, $d=0.69$) compared to pre-exercise and Tiredness immediately post-exercise was significantly

less than post-20 (*M* difference= 1.05, *p*= .038, *d*= -0.36). Also, Tiredness post-20 was

marginally lower than pre-exercise Tiredness (*M* difference= 1.23, *p*= .064, *d*= 0.34; see

Table 1).

For Calmness, neither the Condition main effect (*p*= .171) nor Condition x Time

interaction (*p*= .861) was significant. However, the Time main effect was significant [F(2,

42)=8.30, *p*= .001, partial η^2= .283; H-F ε=1.0 see Table 2]). Calmness was significantly

decreased immediately post-exercise (*M* difference= 1.73, *p*= .007, *d*= -0.59) compared to

pre-exercise and the immediate post-exercise Calmness was significantly less than post-20

(*M* difference= 2.41, *p*= .001, *d*=.80). Calmness at post-20 was not different from pre-

exercise (*p*> .28).

Table 2. Mean (±*SD*) affective responses before and after exercise, collapsed across
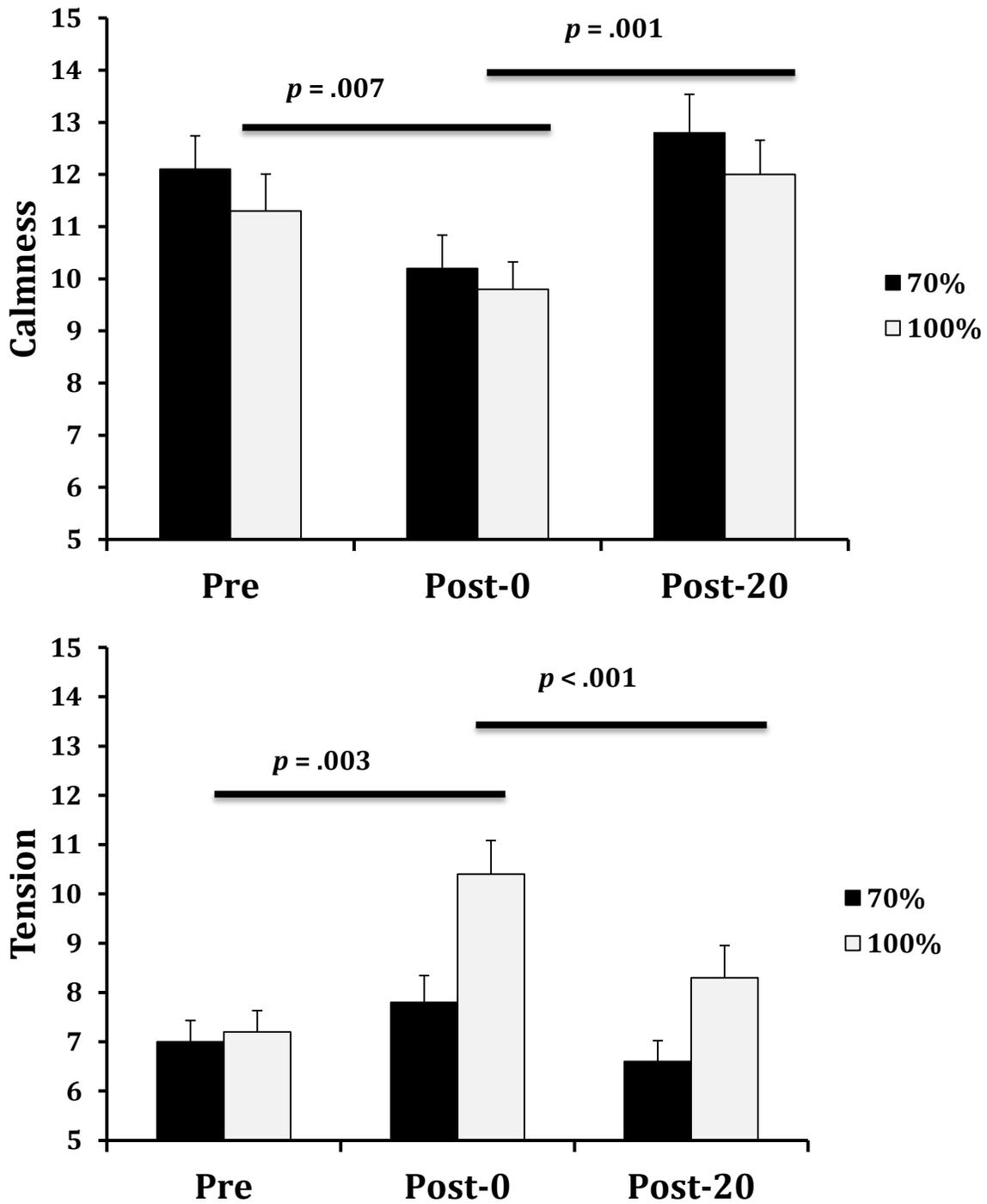
intensity conditions, for Calmness and Tension.

Measure	Time	*M*	*SD*
Calmness	Pre	11.71	3.16
	Post-0	9.98	2.73
	Post-20	12.39	3.27
Tension	Pre	7.09	2.03
	Post-0	9.09	2.87
	Post-20	7.46	2.52

For Tension, both the Condition [F(1, 21)=21.75, *p*< .001, partial η^2= .509; H-F ε=1.0;

see Table 2] and Time [F(1.76, 36.93)=8.68, *p*= .001, partial η^2= .292; H-F ε=.879; see Table

2] main effects were significant. However, the Condition x Time interaction was significant [F(1.65, 34.598)=10.76, p< .001, partial η^2= .339; H-F ε=.824; see Table 2]. Tension was significantly increased immediately post-exercise (*M* difference= 2.00, *p*= .003, *d*= -0.82) compared to pre-exercise and Tension immediately post-exercise was significantly greater than post-20 (*M* difference= 1.64, *p*< .001, *d*= 0.61). Tension at post-20 was not different from pre-exercise (*p*> .50). Tension was significantly increased in the 100% 10-RM condition (M difference= 1.49, *p*< .001, d= 0.75) relative to the 70% 10-RM condition. Tension increased significantly from pre-exercise to immediately post-exercise (*M* difference= 3.14, *p*< .001, *d*= -1.20 and then decreased significantly from post-0 to post-20 (*M* difference= 2.09, *p*< .001, *d*= 0.67) in the 100% 10-RM condition. However, in the 70% 10-RM condition, there was no change in Tension from pre- to immediately-post exercise (*p*= .16) or pre- to post-20 (*p*= .55); Tension did change significantly from post-0 to post-20 (*M* difference= 1.18, *p*= .002, *d*= 0.52).
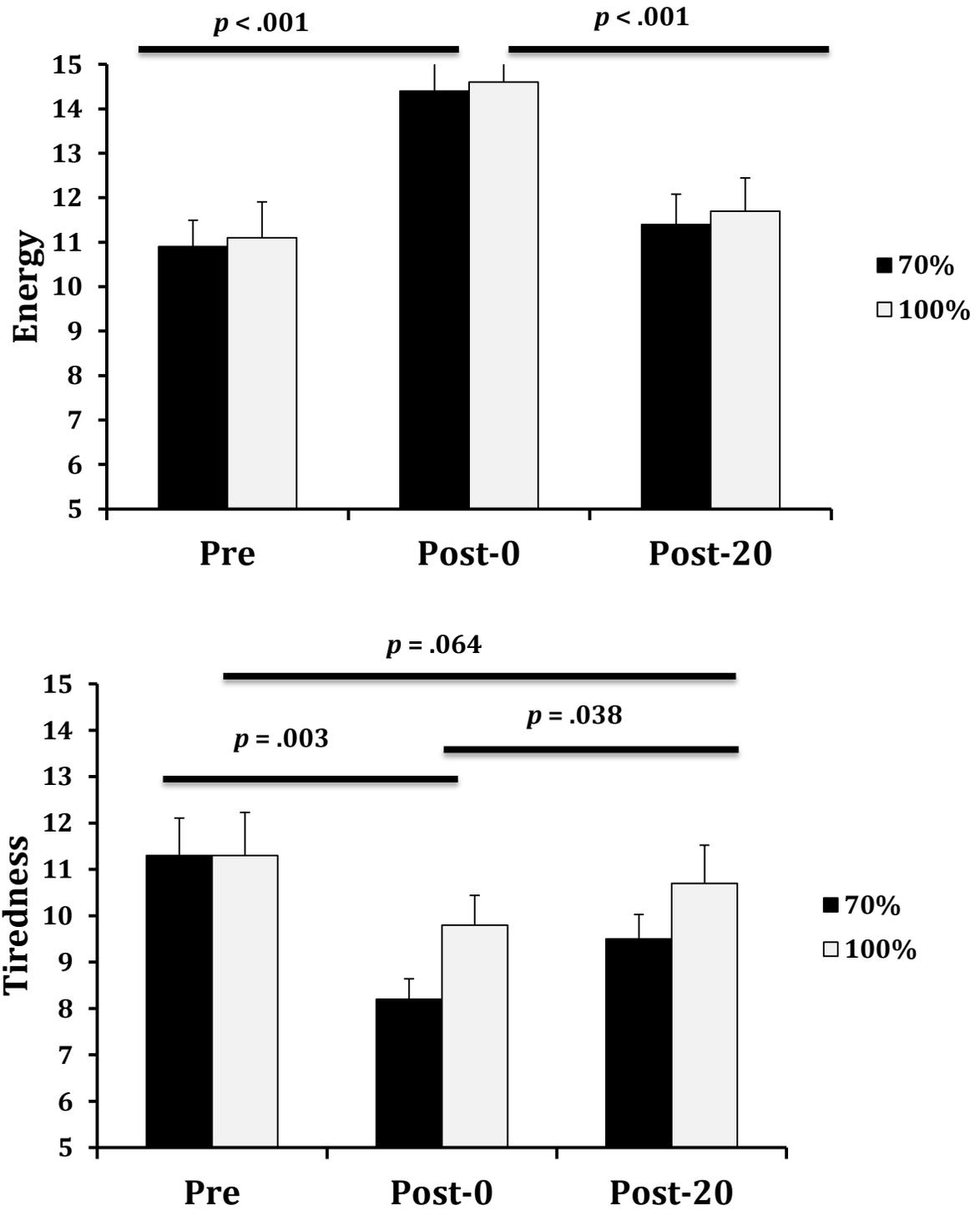
Figure 2. AD ACL scores for Energy (*top*) and Tiredness (*bottom*) subscales pre- and post-exercise in the two intensity conditions.

Figure 3. AD ACL scores for Calmness (*top*) and Tension (*bottom*) subscales pre- and post-

exercise in the two intensity conditions.

For State Anxiety, the Condition main effect was not significant ($p= .17$). However, the Time main effect [$F(1.596, 22.34)=9.85$, $p= .002$, partial $\eta^2= .413$; H-F $\varepsilon=.798$; see Table 3] and the Condition x Time interaction was significant [$F(2, 28)=2.71$, $p= .084$, partial $\eta^2= .162$; H-F $\varepsilon=1.0$; see Table 3].

Table 3. Mean (±*SD*) state anxiety before and after exercise.

| Measure	Condition	Time	*M*	*SD*
State Anxiety	70%	Pre	18.07	5.92
		Post-0	18.47	3.83
		Post-20	15.60	3.04
	100%	Pre	18.53	5.73
		Post-0	21.27	3.47
		Post-20	16.73	4.13
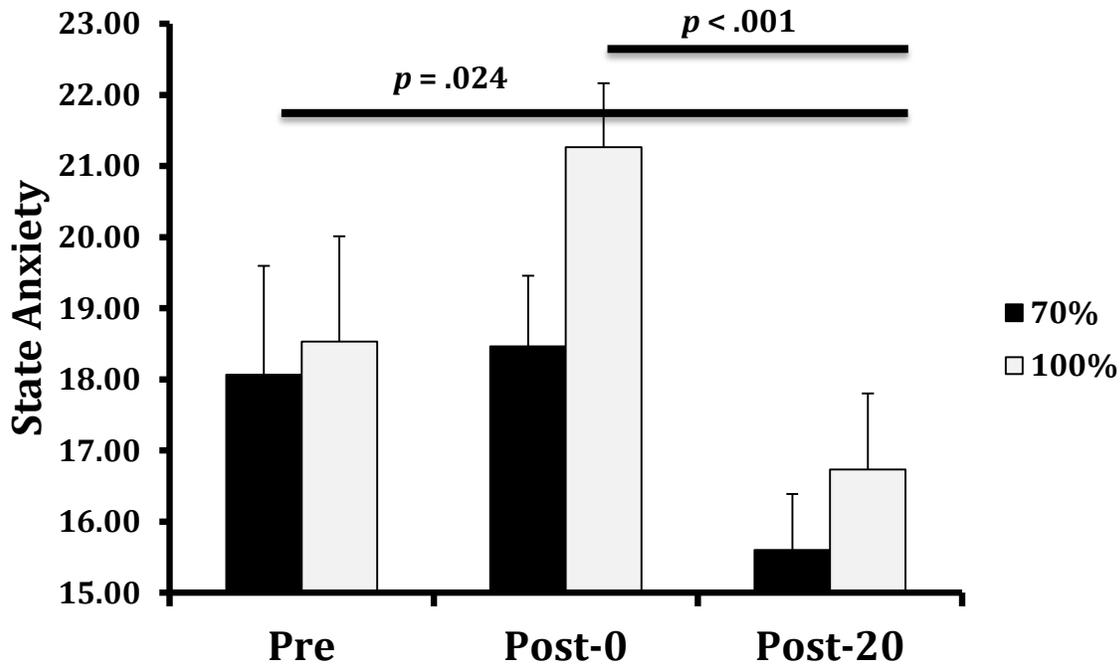
Figure 4. State Anxiety scores pre- and post-exercise in the two intensity conditions.

Not surprisingly, perceptions of effort (RPE) were significantly higher in the 100% 10-RM condition than in the 70% 10-RM condition. There was a significant Condition, Time, and Condition by Time effect for RPE: Condition main effect [$F(1, 21)=60.88$, $p< .001$, partial $\eta^2= .744$, H-F $\varepsilon =1$], Time main effect [$F(5.52, 115.94)=215.29$, $p< .001$, partial $\eta^2= .911$, H-F $\varepsilon =.69$], Condition x Time interaction [$F(4.61, 96.83)=28.89$, $p< .001$, partial $\eta^2= .579$, H-F $\varepsilon =.576$; see Figure 5]. Participants reported significantly more effort in the 100% 10-RM condition than in the 70% 10-RM condition.

Again, not surprisingly, felt arousal was significantly higher in the 100% 10-RM condition than in the 70% 10-RM condition. There was a significant Condition, Time, and Condition by Time effect for FAS: Condition main effect [$F(1, 21)=29.87$, $p< .001$, partial $\eta^2= .587$, H-F $\varepsilon =1$], Time main effect [$F(4.06, 85.2)=38.78$, $p< .001$, partial $\eta^2= .649$, H-F ε

=.507], Condition x Time interaction [$F_{(7.94, 166.71)}=7.02$, $p < .001$, partial $\eta^2 = .579$, H-F ε =.992; see Figure 6].

Finally, for the Feeling Scale, the Condition [$F_{(1, 21)}=13.18$, $p=.002$, partial $\eta^2 = .386$, H-F ε =1.0] and Time main effects [$F_{(3.3, 69.30)}=2.28$, $p=.081$, partial $\eta^2 = .098$, H-F ε =.300] were significant, but these were superseded by the significant Condition x Time interaction [$F_{(4.72, 99.02)}=3.06$, $p=.015$, partial $\eta^2 = .127$, H-F ε =.429; see Figure 7].
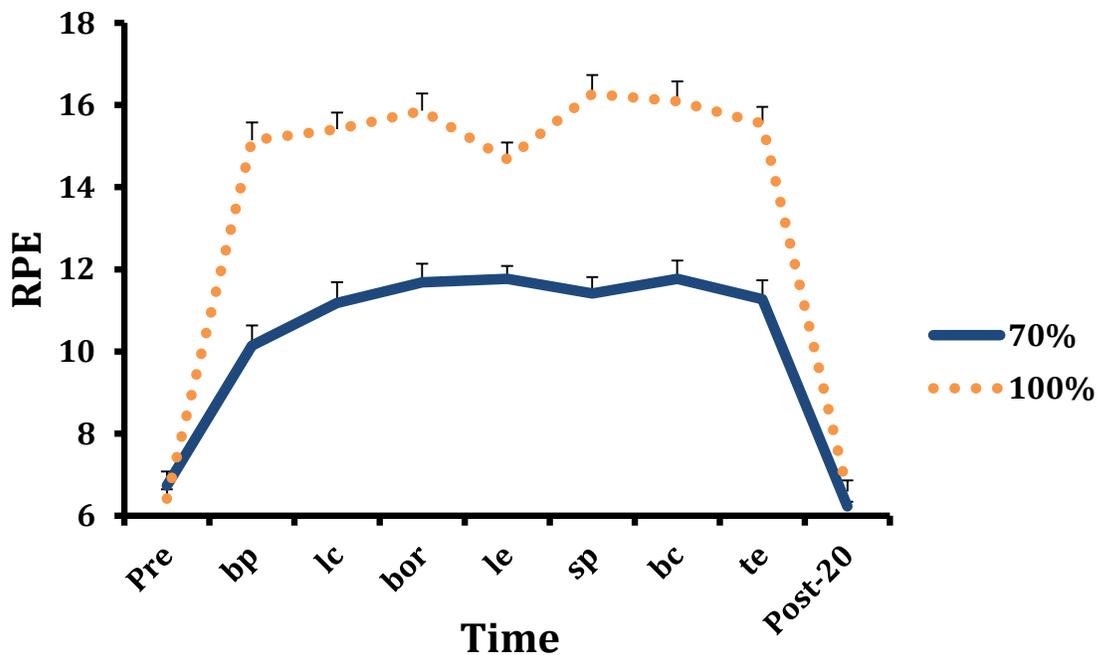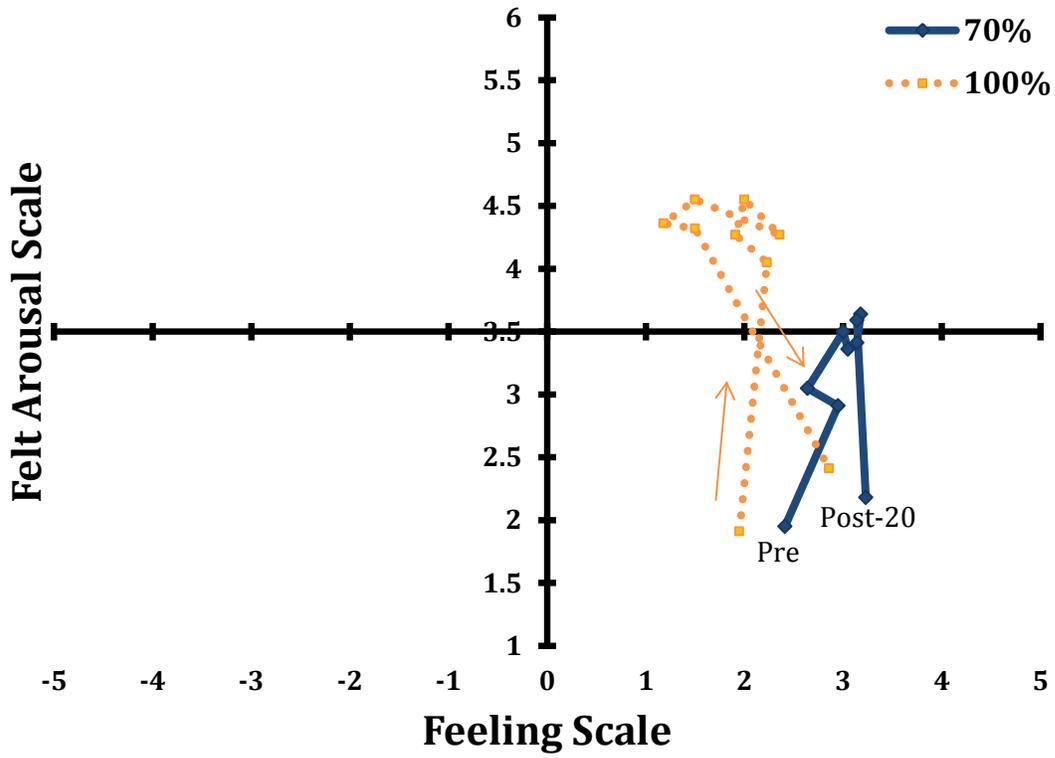

Figure 5. Rating of Perceived Exertion during exercise in the two intensity conditions.
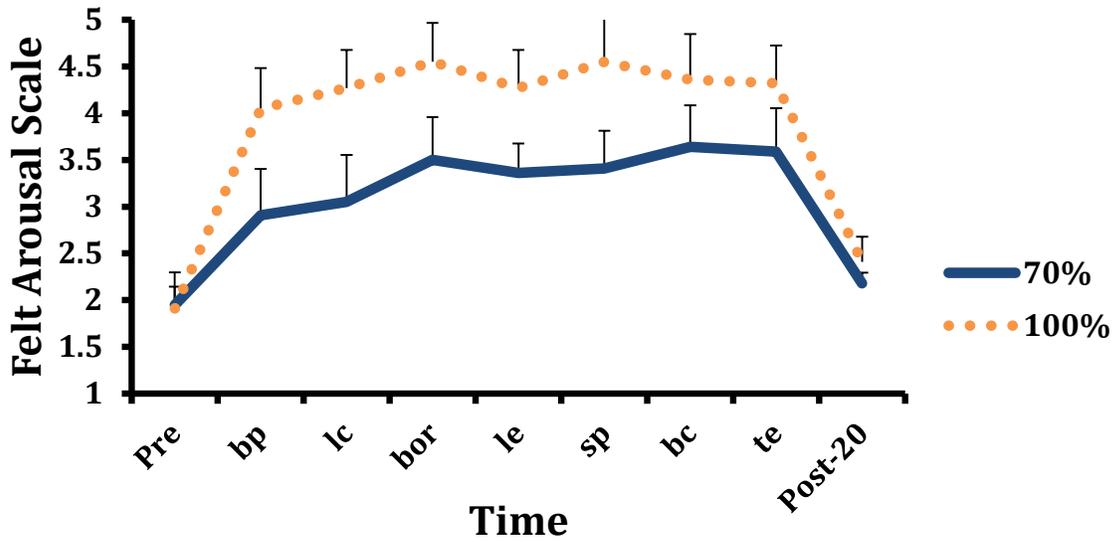
Figure 6. Felt Arousal Scale during exercise in the two intensity conditions
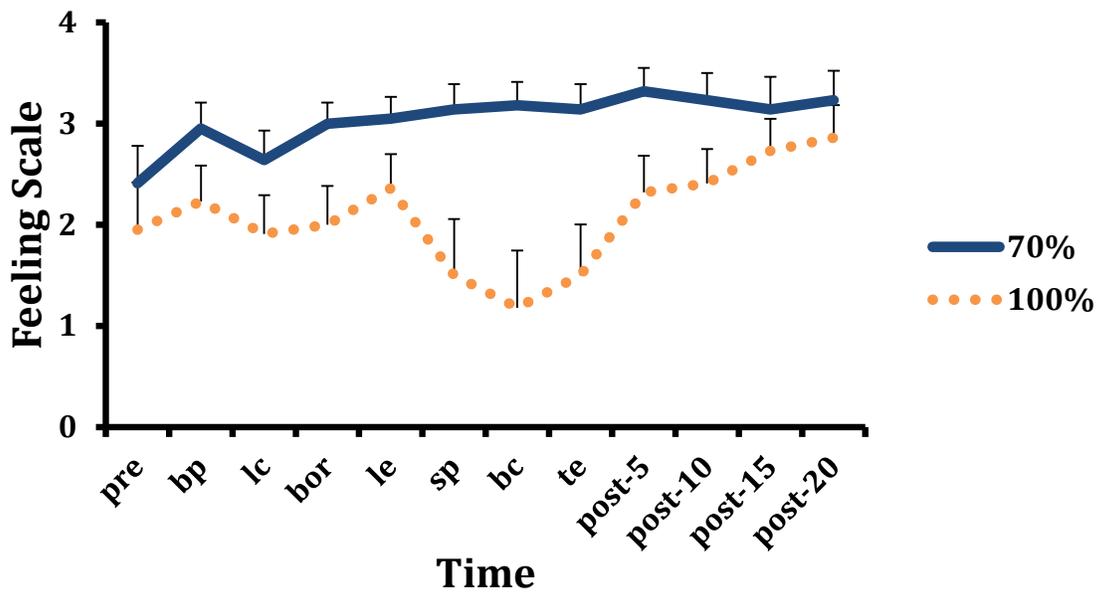
Figure 7. Feeling Scale (pre, during and post exercise) in the two intensity conditions. FS

during is a measure of FS2 or the second FS measure taken for each exercise.

Figure 8. Dimensional approach depiction of the dimensions of valence (FS) and activation (FAS) during the two intensity conditions.
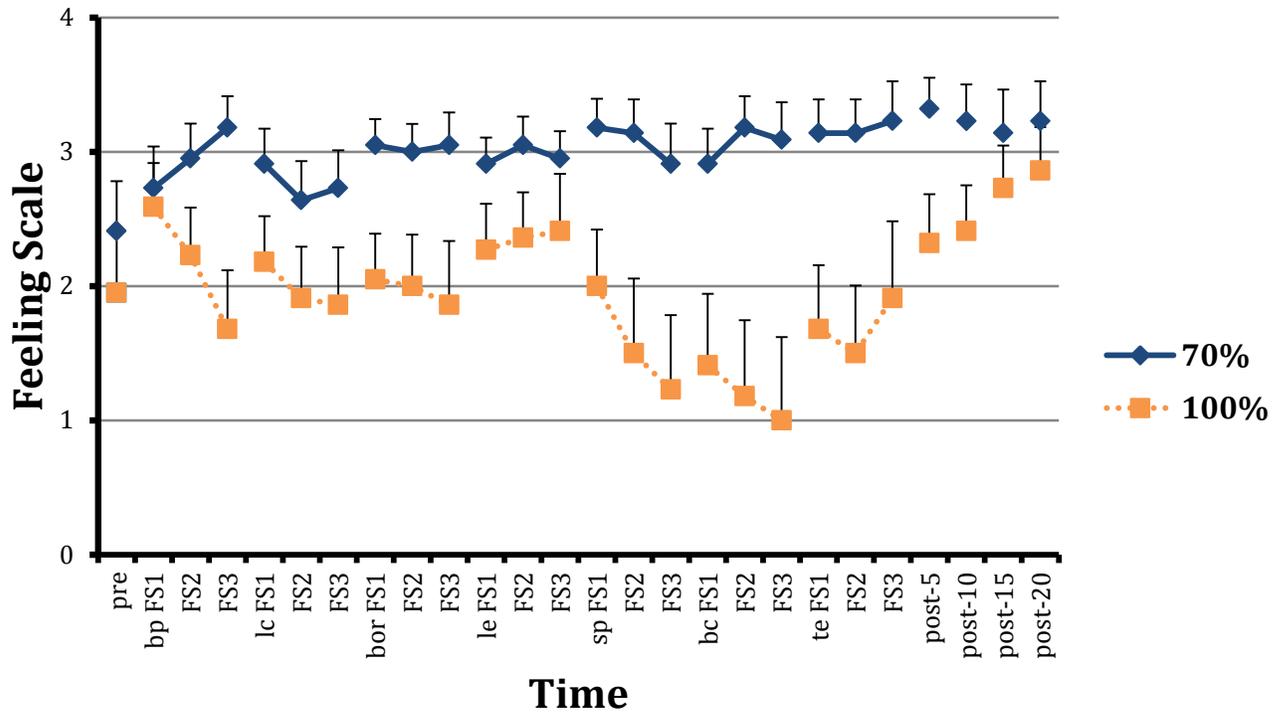
Figure 9. . Feeling Scale (pre, during, post exercise) in the two intensity conditions. All three FS measures taken during each exercise are displayed.

Using the dimensional approach to examining affective responses during the two intensity conditions (see Ekkekakis & Petruzzello, 2002), Figure 8 depicts the combination of affective valence and activation responses. As can be clearly seen, affect during the 70% 10-RM condition changes from pleasant, unactivated affect before exercise to a more activated, more pleasant affect (i.e., shifted up and to the right) during with a return to unactivated but continued pleasant affect at the end of exercise. In the 100% 10-RM condition, affect again began in an unactivated, pleasant state prior to exercise, but increased in activation for the duration of exercise while valence decreased (i.e., shifted to the left) during the last 3 exercises only. In the 100% 10-RM condition, subjects were in a

pleasant activated affective state at the end of the exercise bout, but this was distinctly different from the affect experienced during the 70% 10-RM condition. Figure 9 depicts all FS assessments across condition and shows clear trend for decreased FS as exercise progressed in the 100% 10-RM intensity condition and a stable trend for FS reported during the 70% 10-RM intensity condition.

Finally, there was a significant correlation between affect experienced during exercise and post exercise enjoyment in the 100% 10-RM condition only. As expected, participants who reported more positive affective valence during exercise enjoyed the exercise more (p= .036; 1-tailed; r= .36; see Figure 10); there was no relationship seen in the 70% 10-RM condition (p> .49; 1-tailed)., A significant correlation was seen in the 70% 10-RM condition between RPE during exercise and post exercise enjoyment (p= .032; r = 0.46; see Figure 11), but this relationship did not exist in the 100% 10-RM condition (p> .98). There was also a significant correlation in the 70% 10-RM condition between during exercise FAS and post exercise enjoyment (p= .087; r = 0.37; see Figure 12) and again, this relationship did not exist in the 100% 10-RM condition (p> .67).
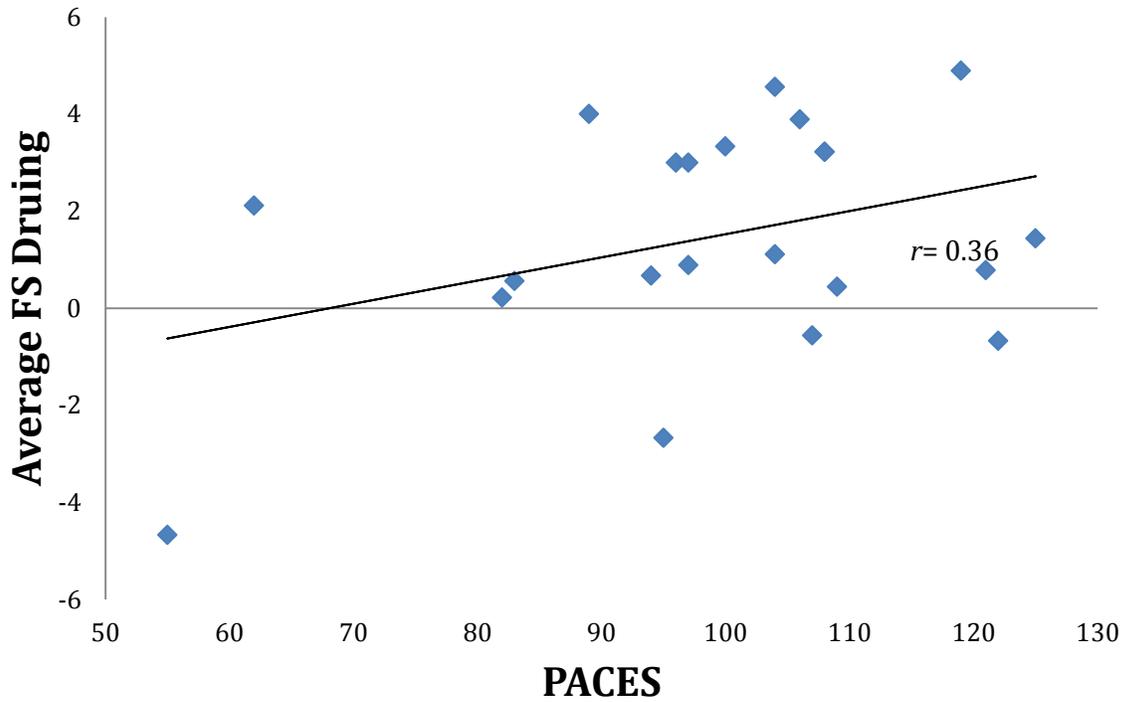
Figure 10: During exercise affect and post exercise enjoyment for the 100% 10-RM condition.
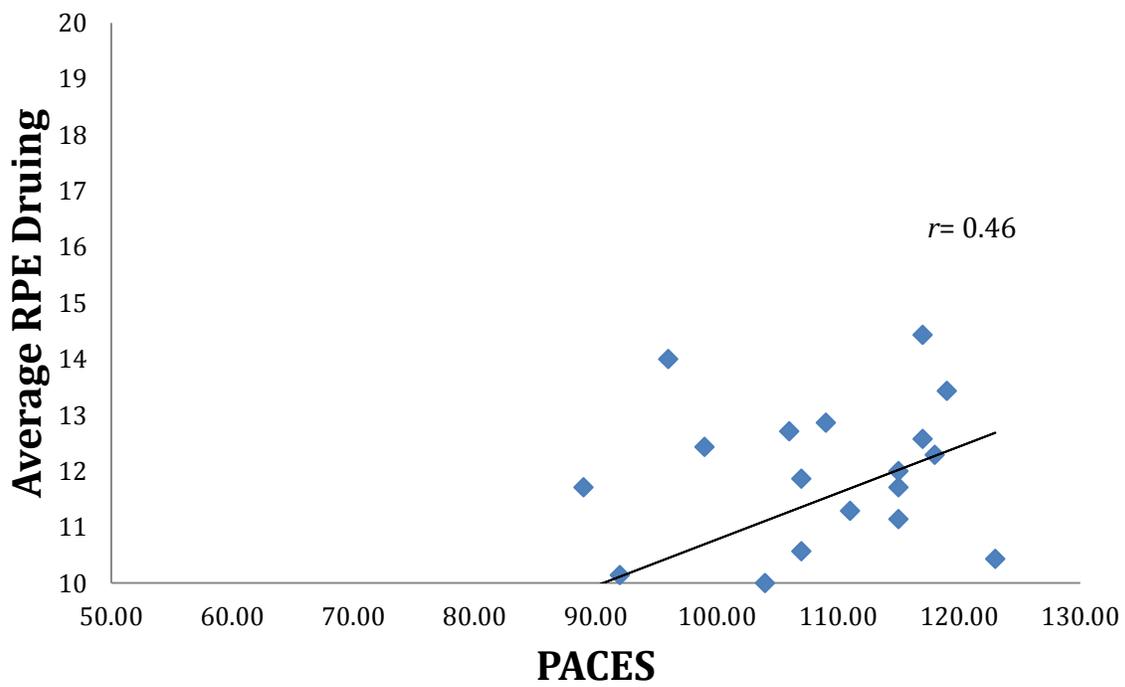
Figure 11. During exercise RPE and post exercise enjoyment for the 70% 10-RM condition.
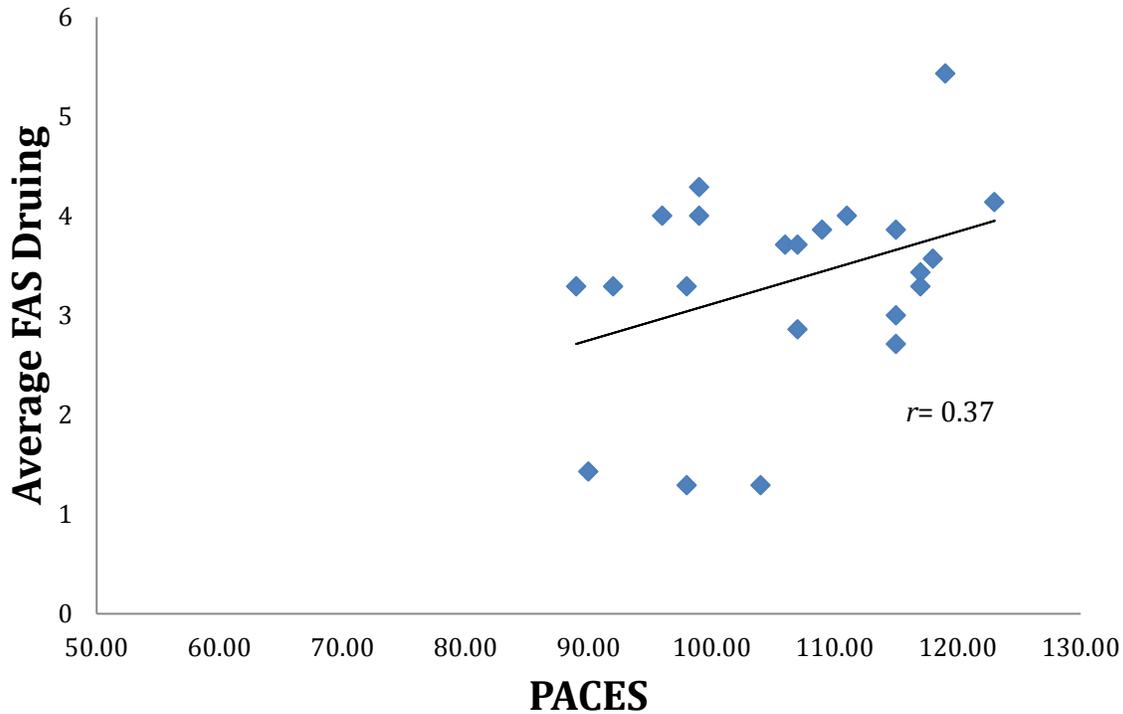
Figure 12. During exercise FAS and post exercise enjoyment for the 70% 10-RM condition.

In keeping with previous research utilizing the dimensional approach to studying affective responses to exercise, inter-individual variability was examined by assessing the change in FS responses from pre-exercise to the various time points during exercise. Table 4 shows the number (and percentage) of participants who increased, decreased or remained unchanged in FS across time along with the average FS unit change (and standard deviation). It also shows this information for both the 70% 10-RM (top half of table) and 100% 10-RM (bottom half of table) intensity conditions. For the 70% 10-RM condition, the vast majority of participants either had increased affect (36-50%) or had no change in affect (14-55%) during exercise compared to pre-exercise affect. Only 5-36% of the participants experienced a decline in affect, and this was more pronounced (in terms of number of participants) in the middle of the exercise bout. For the 100% 10-RM condition,

a different pattern emerged. The percentage of participants experiencing increased affect was similar to that in the 70% 10-RM condition (36% to 55%). However, there was a dramatic drop in participants showing no change in affect (9% to 23%) coupled with a large increase in participants reporting a decrease in affect (32% to 50%). Also, participants in the 70% 10-RM condition who reported a decrease in affect had a much milder decrease (-1.0 to -1.6) compared to those who reported a decrease in affect during the 100% 10-RM condition (-1.7 to -3.2).

Table 4. Individual differences in affective responses, based on Feeling Scale scores, from Pre-exercise to various times during exercise in the two intensity conditions (FS2 for each time point was used).

70% 10-RM Condition								
Time During Exercise		BP	LC	BOR	LE	SP	BC	TE
Increased Affect	*n*	9	8	10	11	11	10	9
	(%)	(41%)	(36%)	(45%)	(50%)	(50%)	(45%)	(41%)
	MΔ	1.44	1.38	2.10	2.09	2.27	2.50	2.67
	SD	0.53	0.74	1.29	1.22	1.27	1.27	1.12
Unchanged Affect	*n*	12	9	6	3	5	6	8
	(%)	(55%)	(41%)	(27%)	(14%)	(23%)	(27%)	(36%)
Decreased Affect	*n*	1	5	6	8	6	6	5
	(%)	(5%)	(23%)	(27%)	(36%)	(27%)	(27%)	(23%)
	MΔ	-1.00	-1.20	-1.33	-1.13	-1.50	-1.33	-1.60
	SD		0.45	0.52	0.35	0.84	0.82	0.89
100% 10-RM Condition								
Time During Exercise		BP	LC	BOR	LE	SP	BC	TE
Increased Affect	*n*	10	10	9	12	9	8	9
	(%)	(45%)	(45%)	(41%)	(55%)	(41%)	(36%)	(41%)
	MΔ	1.80	1.70	2.33	2.33	2.44	2.13	2.44
	SD	1.03	1.06	1.41	1.23	1.13	0.83	1.01
Unchanged Affect	*n*	5	3	3	3	3	3	2
	(%)	(23%)	(14%)	(14%)	(14%)	(14%)	(14%)	(9%)
Decreased Affect	*n*	7	9	10	7	10	11	11
	(%)	(32%)	(41%)	(45%)	(32%)	(45%)	(50%)	(50%)
	MΔ	-1.71	-2.00	-2.00	-2.71	-3.20	-3.09	-2.91
	SD	1.50	1.50	1.41	1.80	2.70	2.30	2.17

Note: increased affect reflects an increase in valence (i.e., more positive) from pre- to during exercise; decreased affect reflects a decrease in valence (i.e., more negative) from pre- to during exercise.

CHAPTER 5

DISCUSSION

Previous research has shown that intensity of exercise is related to non-adherence and dropout (Ekkekakis, Hall, & Petruzzello, 2008). One reason for this relationship may be the effect that exercise intensity has on affect and enjoyment. There exists an intuitive relationship between exercise enjoyment and exercise adherence. Individuals are more likely to continue to participate in exercise programs that they enjoy. This idea highlights the importance of determining the exercise intensity that can maximize exercise adherence rates. This intuitive relationship has always been discussed with respect to aerobic types of exercise. With so little known relative to resistance exercise, this study sought to examine the same intensity-affect-enjoyment relationship with this popular form of exercise.

It was hypothesized that participants would report less enjoyment following the 100% 10-RM intensity condition as opposed to the 70% 10-RM condition. The results from this study support this hypothesis as participants showed significantly higher levels of enjoyment following the 70% 10-RM condition when compared to the 100% 10-RM condition. At higher intensities, individuals are more prone to fatigue, lactic acid build up, and respiratory changes that, in the aerobic exercise literature, has been associated with decreased enjoyment. This study gives evidence to this same relationship extended to include resistance exercise. The same types of changes in physiological states could explain, at least in part, the significant decrease in enjoyment as a result of resistance exercise at 100% 10-RM. Enjoyment appears to be a key factor in exercise adherence rates, even more so than knowledge of physical activity health benefits (Dishman, Sallis, & Orenstein, 1985). With this in mind, maximizing enjoyment may in fact maximize exercise adherence.

It was also hypothesized that participants would report less pleasant affect *during* the 100% 10-RM intensity condition compared to the 70% 10-RM intensity condition. As proposed above, changes in physiological states occur during high (e.g., 100% 10-RM) intensity resistance exercise (i.e., altered internal homeostasis). Cabanac (2006) proposed that affect and disturbances in homeostasis are closely related. As shown above, affect during the 100% 10-RM condition showed an overall decline, with the worst affect being reported toward the end of the acute bout of resistance exercise. Affect showed a rebound effect at 5 min post exercise and continued to increase beyond pre-exercise levels for the duration of the 20 min recovery period for the 100% condition. This pattern of affective response during and post-exercise at a high intensity is consistent with previous research on affective responses to aerobic exercise (Ekkekakis, Hall, & Petruzzello, 2008).

Affect during the 70% 10-RM intensity condition showed a slight increase that persisted throughout and during the 20 min recovery period. Participants reported feeling better (as indicated by an increased FS response) during the 70% 10-RM condition, whereas affect worsened (as indicated by a decreased FS response) during the 100% 10-RM intensity exercise condition. As with enjoyment, this decreased affective response during exercise may be a result of changes in physiological states and give supporting evidence that resistance exercise at 70% 10-RM intensity would result in higher adherence rates. Affective responses to initial bouts of exercise may be a critical determinant in continued participation in such exercise (Rejeski, 1994).

Research on affective responses to resistance exercise has generally failed to assess affective responses during exercise. Assessing affect throughout the exercise bouts was important in revealing differences between the two conditions since both resulted in

similar positive affect post-exercise. Recall that, with the exception of tension, AD ACL responses were essentially not different between the two conditions when examined before and following exercise, thus not revealing any intensity influences. As mentioned previously, how one feels during exercise can be a strong predictor of exercise behavior (continued or discontinued exercise participation; see Williams, Dunsiger, Ciccolo, Lewis, Albrecht & Marcus, 2008). The significant decline in affect *during* the 100% 10-RM intensity condition again gives evidence regarding how important in-task affect can be, especially as pre and post affect between conditions was not different.

It is important to note that during the 100% 10-RM intensity condition participants reported an FS3 value (i.e., FS score following third set) much higher than FS1 or FS2 (i.e., immediately following the first and second sets, respectively) for the last exercise (triceps extension) which may be a strong indicator of a relief effect. That is, participants were aware that the exercise session was over and reported feeling more positive affect. This phenomenon was not observed during the 70% 10-RM intensity condition which may again be a reflection of the fact that participants enjoyed this exercise intensity more and were not necessarily relieved that it was over.

Consistent with previous research (Arent et al., 2005; Chang & Etnier, 2009), and consistent with the conditions being of different intensities, participants reported significantly higher perceptions of effort during the 100% 10-RM condition. This difference began after the first exercise that persisted until the last exercise, with perception of effort returning to baseline after the 20 min recovery period. Not surprisingly, participants also displayed higher arousal (i.e., FAS) during the 100% 10-RM intensity condition compared to the 70% 10-RM condition.

Interestingly, during exercise affect (measured by FS) predicted enjoyment in the 100% 10-RM intensity condition, but not in the 70% 10-RM condition. That is, those who reported more positive affective valence during exercise also reported greater enjoyment of the exercise experience (and vice versa). This could be due to the observation that participants felt more negative/less positive affect during exercise at 100% 10-RM, and those that reported a more moderate decrease in affect during exercise enjoyed the exercise more. This relationship was not observed with the moderate intensity condition.

In contrast with the 100% 10-RM condition, perceived exertion during the 70% 10-RM condition predicted post-exercise enjoyment. This was not observed in the 100% 10-RM condition. This could be due to the fact that participants who reported higher levels of perceived exertion felt a greater sense of satisfaction at their effort and thus enjoyed the exercise more. This is consistent with a suggestion by Raedeke (2007). The fact that this relationship was not observed with resistance exercise at 100% 10-RM may suggest that when perceived exertion exceeds a certain value (observed around 15; "Hard" on Borg Scale), enjoyment becomes unpredictable. There was a trend observed for decreased enjoyment as RPE increased beyond 15. FAS during exercise at 70% 10-RM intensity was also predictive of post-exercise enjoyment. As with RPE, it appears that as FAS increases, post-exercise enjoyment increases. The lack of this relationship observed during the 100% 10-RM condition, and the significantly higher FAS values reported during the 100% 10-RM intensity condition again give evidence to a ceiling effect. Once FAS values exceed a certain value (approximately 4 units), post-exercise enjoyment becomes less predictable. Other studies on resistance exercise and affect have not been able to predict enjoyment from changes in physiological constructs. Arent et al. (2005) suggested that, due to the lack of

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predictability of exercise enjoyment and affect, other important mechanisms may be impacting the exercise/affect relationship. Arent et al. (2005) proposed that changes in physiological states during exercise, not unexplored mechanisms, may be predicting enjoyment and affective changes.

Consistent with the previous literature, the 100% 10-RM intensity condition resulted in a significant increase in state anxiety from pre to immediately post exercise (Arent et al., 2005). State anxiety also showed a significant decrease in the 100% 10-RM condition from post-0 to post-20, with a marginal decrease observed from pre to post-20. In the 70% 10-RM condition, state anxiety showed no change from pre to post-0, and a significant reduction from pre/post-0 to post-20. It is important to note that the increase in state anxiety observed immediately after the 100% 10-RM condition could be due to the significant increase in tension. There is also the very distinct possibility that the "increase" in anxiety is nothing more than increases in perceived activation (see Ekkekakis, Hall & Petruzzello, 1999). This is further supported by the increased FAS values in the 100% 10-RM condition compared to the 70% 10-RM condition. The reduction in state anxiety at 20 minute post the 70% 10-RM intensity condition is consistent with previous literature (Bartholomew et al., 1998) and demonstrates another beneficial psychological change from exercise.

The results of the current experiment fit with models for exercise proposed by Csikszentmihalyi (1982), namely that optimal challenge or optimal stimulation are key components to exercise enjoyment. This model suggests that exercise intensity must be high enough to stimulate feelings of accomplishment, while not being too high as to promote negative physiological effects of exercise. When trying to determine an intensity

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to maximize adherence rates, it may be important to consider the idea of optimal challenge and stimulation.

The purpose of this study was to begin to examine the dose-response relationship in resistance exercise, focusing on intensity. A limitation of the present study was the lack of both a control and a lower intensity condition. However, previous research has shown low intensity resistance exercise does not produce favorable affective changes (Arent et al., 2005) and as such, intensities lower than 70% 10-RM were not considered in the current study. Not including a control condition was less of a concern because it was a between-condition effect that was most important and not changes in physiological states from a sedentary control condition.,

The psychological effects of resistance exercise have not received the same level of attention in the research literature as has aerobic exercise. There is much work that needs to be done to more fully understand the relationship between resistance exercise adherence, affect during such exercise, and post-exercise enjoyment. The present study expands the literature on resistance exercise by including affective measures during exercise as well as demonstrating the predictive nature of during exercise affect on post-exercise enjoyment. Future research should focus on this relationship and narrow the exercise intensity gap to more carefully elucidate whether there is a dose-response effect on affective responses. Such knowledge would ultimately help to maximize benefits and adherence to resistance exercise. We have shown a positive affective change with 70% 10-RM resistance exercise and a negative affective change with 100% 10-RM resistance exercise. It would be interesting for future research to explore this relationship with intensity levels of 80% and 90% 10-RM.

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