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The Effects of Resistance Training on Mood Following an Autonomous vs. Yoked Protocol

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The Effects of Resistance Training on Mood Following an Autonomous vs. Yoked Protocol

by

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Dedication

I would like to dedicate this thesis to my parents, Charles & Tammie Cheshire. Without their support, encouragement, and love, I would not have this opportunity to chase my goals.

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Abstract

The Effects of Resistance Training on Mood Following an Autonomous vs. Yoked Protocol

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Background. Previous research has shown that an individual's post-exercise mood plays an important role in their likelihood to participate in that exercise activity in the future (Emmons & Diener, 1986; Williams et al., 2008; Williams et al., 2012). Of the possible moderating variables in the exercise-affect relationship, exercise intensity shows the most support. However, an uncoupling effect manifested in Parffit, Rose, & Burgess (2006) showed that self-selecting the intensity acted as an affective buffer and essentially allowed participants to exercise at higher intensity without the expected drop in affect. It may be, therefore, that autonomy may further serve to moderate the impact of exercise on mood. Design. To explore this issue, we employed a "yoked" design (Dickerson & Creedon, 1981). Participants were randomly assignment to either a free-choice resistance exercise, or a yoked control. The yoked participant performs a bout of exercise that matches the selection of their autonomous counterpart. In this study, 14 college-aged students participated in a testing session to estimate 1-repetition maximums, and a resistance exercise session that was either autonomous (self-selected) or a relative replication (yoked). Participants completed mood questionnaires following the resistance exercise session. Results. A 2 (group) x 3 (time) with repeated measures on the second factor showed significant main effects of time for the Felt Arousal Scale $F(2, 13) = 4.15$, *p* = .05 and Negative Affect $F(2, 11) = 4.28$, $p = .05$ such that arousal and negative affect both declined during recovery. Additionally, five of the seven yoked participants were unable to progress through their relative resistance exercise bout without a decrease in weight in order to achieve the prescribed number of repetitions. Conclusion. Autonomy does not appear to be a critical component of affect following resistance training. Further research is needed to explore resistance training as a model of autonomy manipulation, and to test the possibility of a performance detriment accompanying a loss of autonomy.

Table of Contents

List of Tables

List of Figures

Introduction

There is a growing body of research testing the relationship between exercise and affect. This emphasis on exercise-affect interactions arises from the application of hedonic theory to the fundamental motivational challenges of exercise adherence. According to hedonic theory, individuals innately gravitate to behaviors that generate pleasure, and avoid those that cause displeasure (Cabanac, 2006). A unique feature of exercise identified as having potential motivational significance is the affective response (e.g. pleasure or displeasure, tension or relaxation, energy or tiredness) that exercisers experience (Ekkekakis, Parfitt, & Petruzello, 2011). Previous research has shown that an individual's post-exercise mood plays an important role in their likelihood to participate in that exercise activity in the future (Emmons & Diener, 1986; Williams et al., 2008; Williams et al., 2012). Therefore, understanding the relationships between exercise and affect may provide the theoretical foundation to better develop exercise programs and initiatives to which people may better adhere.

There are several literature reviews evaluating the general relationship between exercise and affect. In the early 1990's, meta-analyses cited evidence for the anxiolytic and anti-depressant effects of exercise on mood in clinical (i.e., populations diagnosed with anxiety or mood disorders) and non-clinical populations (Petruzello et al., 1991; Byrne & Byrne, 1993). A meta-analysis reviewing the exercise-affect relationship in elderly populations, published in 2000, further lent support for these effects (Arent et al., 2000). For a summary of these reviews, please see Table 1. All three reviews called for more detailed research into variables that could provide testable explanatory mechanisms within this relationship. An additional request by Arent was that future researchers measure both positive and negative affective responses to exercise as the review showed a disproportionate ratio of 41 studies evaluating negative affective measures (i.e., depression, tension, anxiety) and only 10 evaluating positive affective measures (i.e., vigor, feeling "good").

Of the possible moderating variables depicted in early meta-analyses, exercise intensity shows the most promise by providing consistent results and lending itself to greater experimental control (Kilpatrick et al., 2007). In their review article, Ekkekakis, Parfitt, and Petruzello (2011) analyzed 33 studies, including 1,007 individuals, published between 1999 and 2009 that engaged the intensity-affect association within the bifurcated-affect paradigm (See Table 2 for a summary of the articles). The authors found all but one study to show a significant impact of exercise intensity on affect, and the authors posited the one null study may be due to an insufficient N (only 20 participants). The authors reached the overall conclusion that the affective response to exercise was a non-linear moderation by intensity. That is, studies demonstrated the greatest increases in positive affect and decreases in negative affect at moderate levels of intensity versus low or high intensities. Interestingly, an uncoupling effect manifested in one study that incorporated self-selected intensities rather than prescribed intensities (Parffit, Rose, & Burgess, 2006). This study showed that self-selecting the intensity acted as an affective buffer and essentially allowed participants to exercise at slightly higher intensity levels without the expected drop in positive affect and increase in negative affect. It may, therefore, that autonomy may further serve to moderate the impact of exercise on mood.

AUTONOMY

Autonomy is a construct defined by a perception of freedom and an internal locus of control (Ryan & Deci, 1985). The lack of research in this area is not unexpected as its emphasis is fairly recent, and there are not many active researchers in this area. Despite the dearth of studies, there are two studies on point. Parfitt, Rose, & Markland (2000) separated affect into positive and negative by incorporating the Subjective Exercise Experience Scale (SEES) which indicates positive well-being, psychological distress, and fatigue. The study participants underwent 20 minutes of exercise on a treadmill at a prescribed intensity of 65% of VO2-max or at a self-selected intensity. Both conditions showed improved post-exercise mood, and self-selecting the intensity lead to an even greater effect in more fit individuals. While this appears to be strong support for autonomy as a mediating agent in this relationship, it also shows that individuals tend to select low-moderate intensity activity. This range has been associated with the greatest affective benefits. Moreover, few individuals choose a high intensity workload. Thus these data appear to be a confirmation of hedonic theory such that at high levels of intensity, there is more displeasure, and thus the individual would prefer a lower intensity – rather than a test of autonomy. There is, however, also support from Ekkekakis & Ekkekakis (2009). This study demonstrated that merely the perceived loss of autonomy was sufficient to negatively impact mood. Despite working at the same intensity as they selected in a previous exercise bout, the participants reported a more positive mood state and higher energy after their self-selected bout vs. their "prescribed" bout. Thus, there appears to be sufficient evidence to continue this line of research.

While both aerobic exercise (walking, jogging, cycling, etc.) and resistance training (weightlifting) result in improved mood (Martinsen, 1987; Thayer, 1987; Bartholomew et al., 2001; Bartholomew & Miller, 2002). It is important to study how to maximize this benefit, and how self-selection (duration, mode, intensity) can improve mood relative to assigned exercise (Miller, Bartholomew, & Springer, 2005; Vazou-Ekkekakis & Ekkekakis, 2009). Thus far, the application to autonomy only exists for aerobic, but not resistance exercise (Ekkekakis & Lind, 2006).

Self-selection & resistance exercise

While aerobic exercise lends itself to simpler applications of self-selection, there are a limited number of controllable intensity-related parameters (speed and incline for treadmills, and speed and resistance for cycle ergometers). In addition, as was shown by Parfitt and colleagues (2009) most people self-select the same intensity. The result is that is very challenging to vary autonomy without confounding that with variation in intensity. Therefore, resistance training may provide a better model to test a range of choices within an exercise paradigm (exercise selection and order, weight, reps, sets, and rest).

The greatest challenge to applying self-selection to resistance training is the consideration of intensity (expressed as a percentage of an individual's 1-repetition maximum). Researchers must be wary of experimental designs that may undermine a participant's choice in favor of greater control. As Ekkekakis & Ekkekakis's 2009 study demonstrated, even a perceived loss of autonomy undermined participant mood and performance. To solve this conundrum of allowing for free choice while still controlling for intensity, we employed a "yoked" design which is the classic method to vary self-selection (Dickerson & Creedon, 1981). In this design, participants are matched according to relevant attributes. In this case, experience with resistance training, gender, and strength. Then, participants receive a random assignment to either a free-choice resistance exercise, or a yoked control. The yoked participant performs a bout of exercise that matches the selection of their autonomous counterpart. If the free-choice participant completes 3 sets of 15 repetitions on the bench press with 1 min of rest between sets, then the yoked control will perform the same pattern and intensity of exercise. This allows the researcher to isolate the impact of autonomy from the impact of exercise intensity or mode. It is the purpose of this study to test the impact of autonomy on positive affect, negative affect, and arousal following a bout of resistance training.

Methods

Participants

Participants were recruited from a large university in the southwestern United States. In order to ensure that the participants held prior experience with resistance training, they were recruited from the university's weightlifting classes. Participants received "extra credit" points for missed classes that counted towards their weightlifting class grade in compensation for their time. In total, 14 individuals (8 male, 6 female) with a mean age of 20.67 years completed the study. This resulted in 7 matched pairs. We excluded participants with incomplete data or who failed to attend the second visit.

Procedures

This study consisted of 2 separate visits completed at approximately the same time of day and within 1 week. To minimize confounds, we utilized a sequestered training facility within the university. All exercise was completed individually, and only 1 researcher present at a time. Additionally, whomever supervised a participant's 1st visit also monitored the 2nd visit. During the first visit, participants received and signed the informed consent, and underwent a 5-repetition maximum test for 4 resistance exercises (Leg Press, Pull down, Bench Press, & Prone Leg Curls). The Baechle equation was used to estimate the participants' 1-repetition maximum for each exercise (Baechle, Earle, & Wathen, 2000). Following testing, we assigned participants into pairs based on strength and gender. Within the pairs, participants were randomly assigned into either: Autonomous or Yoked.

Visit 2: Autonomous

The autonomous participants proceeded through a self-selected resistance exercise protocol. We allowed the participants free reign within the gym to complete their exercise bout.

The only instruction was that the workout needed to be restricted to resistance exercises. The observer ensured proper use of the equipment and documented the exercise order, number of sets, number of repetitions, weight lifted, rest between sets and exercises, and rating of perceived exertion (RPE) following each set. Once the participant indicated that they completed their desired workout, the mood questionnaires were completed immediately, 5 minutes post-exercise, and 20 minutes post-exercise.

VISIT 2: YOKED

The yoked participants proceeded through a replication of their matched autonomous participant's exercise protocol. However, we adjusted the yoked participant's exercise resistance to match the autonomous participant's relative intensity expressed as a percentage of their 1-repetition maximum (i.e., both participants lifted the same percentage of their own 1-RM). The observer ensured proper use of the equipment and maintained the exercise order, number of sets, number of repetitions, weight lifted, and rest between sets and exercises. Following each set, the observer recorded the participant's RPE. Upon completing the yoked exercise bout, mood questionnaires were completed immediately, 5 minutes post-exercise, and 20 minutes post-exercise.

MEASURES

In order to provide a measure of affect and its valence consistent with previous research, we utilized the Feeling Scale (FS) and the Felt Arousal Scale (FAS) (Sheppard & Parfitt, 2008; Ekkekakis & Ekkekakis, 2009; Lind, Ekkekakis, & Vazou, 2008). The FS (Hardy & Rejeski, 1989) is a 1-item, 11-point Likert scale questionnaire that asks participants to circle the number that best relates to how they feel in the moment. The FS anchors are "very bad" (-5) to "very good" (+5). The FAS (Svebak & Murgatroyd, 1987) is a 1-item, 6-point Likert scale that asks participants to circle the number that best corresponds to how aroused they feel in the moment. The FAS anchors are "Low Arousal" (1) to "High Arousal" (6). Additionally, the Positive and Negative Affect Schedule (PANAS), developed by Watson and Clark (1988) was used in order to incorporate the bifurcated affect perspective called for by Arent et al. (2002). The PANAS consists of two mood scales, one that measures positive affect and the other which measures negative affect. Each scale within the PANAS contains ten descriptors rated on a 5-point scale anchored by "very slightly or not at all" (1) and "extremely" (5). Watson and Clark (1988) reported that for the Positive Affect Scale, the Cronbach alpha coefficient was 0.86 to 0.90; for the Negative Affect Scale, 0.84 to 0.87. Over an 8-week time period, the test-retest correlations were 0.47-0.68 for the PA and 0.39-0.71 for the NA. The Borg 6-20 Rating of Perceived Exertion (RPE) scale was used to observe participant's effort (Borg, 1970; Borg 1998).

Results.

A 2 (group) x3 (time) analysis of variance (ANOVA) with repeated measures on the second factor was used to analyze the FS, FAS, PA, and NA. A significant main effect for group was predicted, whereby the autonomous group would report significantly greater mood than the yoked group. A summary of these data are presented in Table 1. For the FS and FAS scales, all 7 pairs were analyzed. However, due to incomplete survey data, one pair was excluded from the analysis of the PANAS.

<u>FS and FAS</u>. The FS showed no interaction between time and group $F(2, 13) = 0.20$, $p = .82$, no significant main effect of time $F(2, 13) = 2.25$, $p = .14$, and no significant main effect of group $F(1, 13) = .74$, $p = .50$. The FAS showed no interaction between time and group $F(2, 13) = 0.20$, $p = .82$, and no significant main effect of group $F(1, 13) = .38$, $p = .55$. There was, however, a significant main effect of time $F(2, 13) = 4.15$, $p = .05$ such that arousal was lower at 20 minutes following exercise than immediately post-exercise ($p = .03$).

PANAS. The NA showed no interaction between time and group $F(2, 11) = 0.10$, $p = .83$, and no significant main effect of group $F(1, 11) = .99$, $p = .35$. There was, however, a significant main effect of time $F(2, 11) = 4.28$, $p = .05$ such that negative affect was significantly lower at 20 minutes than immediately post-exercise. The PA showed no interaction between time and group $F(2, 11) = .001$, $p = .99$, no significant main effect of time $F(2, 11) = 3.72$, $p = .07$, and no significant main effect of group $F(1, 11) = .21$, $p = .66$.

RPE. A paired-samples t-test was conducted to compare RPE assessed during both bouts of exercise. This test showed no significant difference between mean RPE for autonomous (M = 13.42, SD = 1.50) and yoked (M = 13.87, SD = 3.05) conditions (t = -0.34, p = .37).

Discussion

This thesis was designed to test the potential post-exercise mood effects and interactions comparing a self-selected exercise session with a prescribed exercise bout. The design utilized resistance training to extend the current research observing the exercise-affect relationship. Additionally, the incorporation of a "yoked" control allowed for the manipulation of autonomy while controlling for intensity. It was hypothesized that participants in the yoked control condition would experience a significantly negative affective response to resistance training compared to the autonomous condition.

The data did not support the hypotheses. There were significant main effects for arousal and negative affect. For both arousal and negative affect, mean scores significantly decreased over the 20-minute recovery period. Additionally, these data demonstrate that participants experienced a moderately high positive affect, with FS scores being positive at all time-points and PA mean scores in the "moderately" to "quite a bit" range. Coupled with these positive affective indicators, the NA mean scores were fairly low. These effects were consistent with prior research by Kilpatrick et al. (2007). The study participants progressed through aerobic exercise bouts at 85% and 105% ventilatory threshold. Both conditions increased in arousal with a return to near baseline levels during the 15-minute recovery period.

There was no effect of autonomy vs being yoked on these outcomes. This coincides with the results of Parfitt, Rose, & Markland (2000) that showed no significant difference between self-selected and imposed intensities applied to aerobic exercise. However, there were additional findings that are notable. For instance, five of the seven yoked participants were unable to progress through their relative resistance exercise bout without a decrease in weight in order to achieve the prescribed number of repetitions for most, if not all, of the exercises. The weight was adjusted to minimize contamination of multiple failures on the participants' mood. It appears that there may be a performance detriment accompanying a loss of autonomy. Further research is needed to explore these potential effects.

LIMITATIONS

There is a challenge within a yoked protocol pertaining to the inclusion of participant data. If one of the matched individuals does not complete the study, then both are lost. This can lead to difficulty in attaining a sufficiently-powered design. In this study, seven individuals completed their condition but remained unmatched, and 12 participants attended the first visit but did not complete the study. Additionally, in the present study, it is not clear whether the autonomous participants fully understood or utilized their potential freedom. For example, one individual expressed confusion when instructed to engage in a resistance training bout of their choosing. The participant required additional guidance, and seemed uncomfortable throughout the workout. Moreover, several autonomous participants indicated that they were merely progressing through their "normal" exercise protocol that they use in the introductory weightlifting course. This may indicate that the yoked participants, being recruited from the same course, received little actual loss in free-choice due to their familiarity and comfort with the prescribed protocol drawn from their course.

IMPLICATIONS FOR FUTURE RESEARCH

Resistance exercise's numerous opportunities for experimental manipulation may provide a better modality for testing autonomy within the exercise-affect relationship. Aerobic exercise possesses limited self-selection variables for manipulation (speed and incline for treadmill, and RPM and resistance for cycle ergometers). In contrast, resistance exercise allows for variation of exercise, exercise order, weight, repetitions, sets, and rest periods. As demonstrated by Parfitt It may also benefit further studies to test alternate aspects of intensity in resistance exercise beyond %1-RM (e.g., rest periods). However, researchers should be mindful to how controlling for intensity impacts autonomy. Therefore, the yoked design methodology should be further explored and refined within resistance exercise protocols. However, studies should assess individuals' normal training programs to test if there are differences for yoked persons. The loss of choice may not lead to mood effects if the exercise bout is within the individual's prefe rred, standard training program. Future research may also benefit from utilizing experienced lifters that possess practice designing and implementing their own workout protocols. As Parfitt, Rose, & Markland (2000) demonstrated, post-exercise mood improvements were greater for more fit individuals. Novice lifters may have insufficient practice with choosing their workouts, and therefore do not suffer the affective detriments observed in previous studies when free-choice is removed.

Table 1. Summary of meta-analyses

Author	Overall ES (N)	Experimental ES (N)	p	Variable	Notes
Petruzello, et al., 1991	0.24* (207)	0.22* (67)	<.001	State Anxiety	Effects seen in both clinical and non-clinical populations
Byrne & Byrne, 1993**	- (30)	- (17)	-	Depression & Anxiety	26 of the studies showed improvement
Arent, et al., 2000	0.48* (51)	0.34* (23)	<.001	Global Mood	Only observed studies with elderly

Note: * Indicates Statistical Significance. ** Byrne & Byrne, 1993 did not calculate ES for reviewed studies.

Table 2. Summary of the Ekkekakis, Parfitt, & Petruzello (2011) meta-analytic review of the exercise intensity-affect relationship

Measurement of Intensity	Number of Studies	LI *Effect on PA / NA (n)	MI *Effect on PA / NA (n)	HI *Effect on PA / NA (n)
% of maximal capacity (VO2 or HR-reserve)	12	9 / 10	12 / 12	3 / 1
% of VT, LT, or the onset of blood lactate accumulation (OBLA)	10	8 / 11	11 / 12	2 / 1
Graded Exercise Tests**	8	-	-	-

Note: All of the studies used varying forms of aerobic exercise (e.g., treadmill or cycle ergometer). **LI** = Low Intensity; **MI** = Moderate Intensity; **HI** = High intensity; **PA** = Positive Affect; **NA** = Negative Affect. * Indicates the effect was positive (i.e., improved the affective valence). ** The graded exercise tests all showed a decline in positive affect and an increase in negative affect from moderate to high intensity.

Table 3. Summary of articles exploring the exercise-autonomy-intensity-affect relationship

Author	Population; Activity	IV	DV	Metric; p-value; finding	Notes
Sheppard & Parfitt,(2008)	22 adolescent boys & girls; Cycle at low, high, and SS intensities	SS Intensity vs. High intensity	FS Score	F = 13.6; p<.01[a] & F = 109.5; p<.01[b]; SS intensity had higher FS score	Pre/Post-ex and during ex assessments showed SS intensity was NS from low intensity
Ekkekakis & Ekkekakis (2009)	19 female university students; Cycle ergometer	Perceived loss of autonomy	FS Score; AD ACL	F = 5.95; p<.05 Mood was greater in SS group; Pre-post energy was higher in SS group	Participants exercised at SS and prescribed intensities that were identical
Lind, Ekkekakis, & Vazou (2008)	25 middle-aged females; 20-min treadmill bout (SS and 10% greater)	SS Intensity vs. 10% Increase	FS; FAS	F = 3.70; p<.05 (FS) F = 24.54; p<.001 (FAS); FS only decreased over time in imposed group & FAS was higher in imposed group	Ratings of pleasure remained stable during SS, but decreased when intensity increased by only 10%
Parfitt, Rose, & Markland (2000)	26 male and female undergraduates; 20 mins of treadmill exercise at prescribed intensity (65% VO2max) and SS intensity	SS Intensity vs. Imposed	SEES Score	PWB: F=7.14; p<.02 PD: F=21.22; p<.01 Fatigue: NS SS intensity had better mood scores; seen mores so in more fit individuals	Assessed affect pre-, during, and post-exercise

Note. **FS** = Feeling Scale, indicates individual's affect with anchors of "very bad" to "very good." Superscript a reflects affect during exercise; superscript b reflects pre/post-exercise affect. **AD ACL** = Activation deactivation adjective check list, indicates the valence level of the positive/negative affective state. **SS** = Self-selected. **FAS** = Felt Arousal Scale, indicates valence of affective state. **SEES** = Subjective exercise experience scale, indicates positive well-being (PWB), psychological distress (PD), and fatigue.

Table 4. Means and standard deviations for post-exercise mood surveys

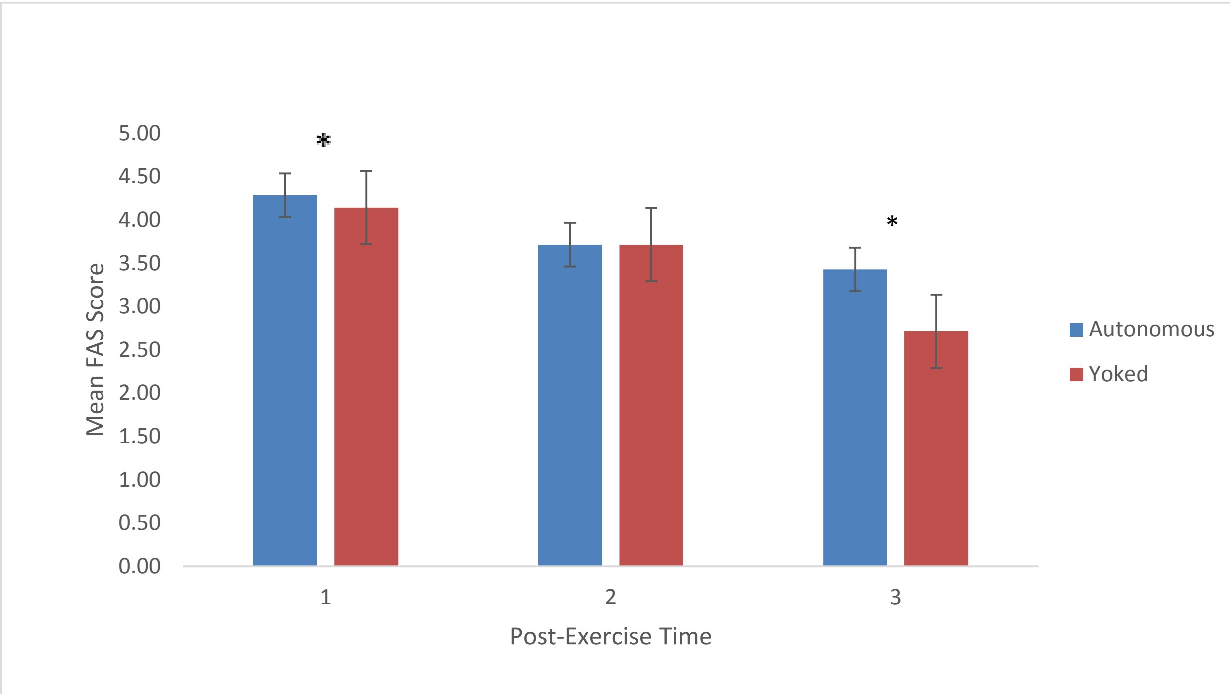
FAS	Immediately	5 minutes	20 minutes
Autonomous			
Mean	4.29	3.71	3.43
SD	1.38	0.95	0.53
Yoked			
Mean	4.14	3.71	2.71
SD	1.21	1.5	0.76

FS			
Autonomous			
Mean	2.43	2.29	1.57
SD	2.44	1.25	1.13
Yoked			
Mean	2.86	2.43	2
SD	1.68	0.98	1.73

PA			
Autonomous			
Mean	3.58	3.23	2.97
SD	0.95	0.93	1.05
Yoked			
Mean	3.35	3	2.75
SD	0.89	0.84	1.13

NA			
Autonomous			
Mean	1.42	1.30	1.22
SD	0.25	0.15	0.20
Yoked			
Mean	1.32	1.13	1.08
SD	0.45	0.21	0.11

Figure 1. Mean felt arousal scores post-exercise



*Note: * indicates a statistically significant difference*

Figure 2. Mean feeling scale scores post-exercise

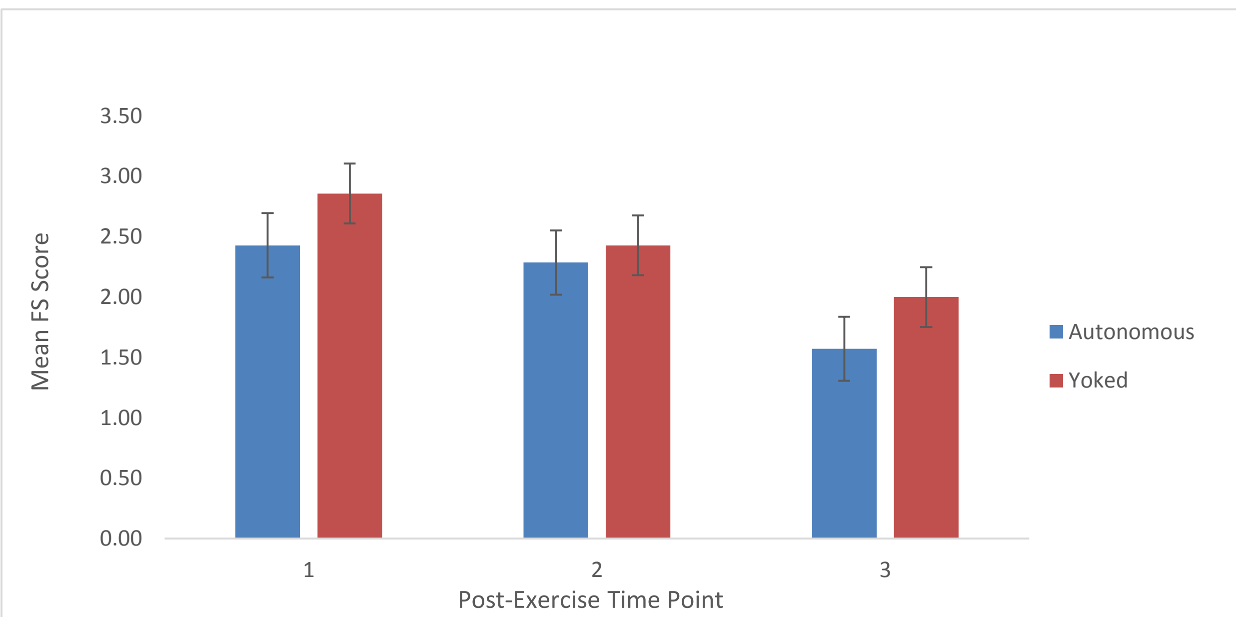


Figure 3. Mean positive affect scores post-exercise

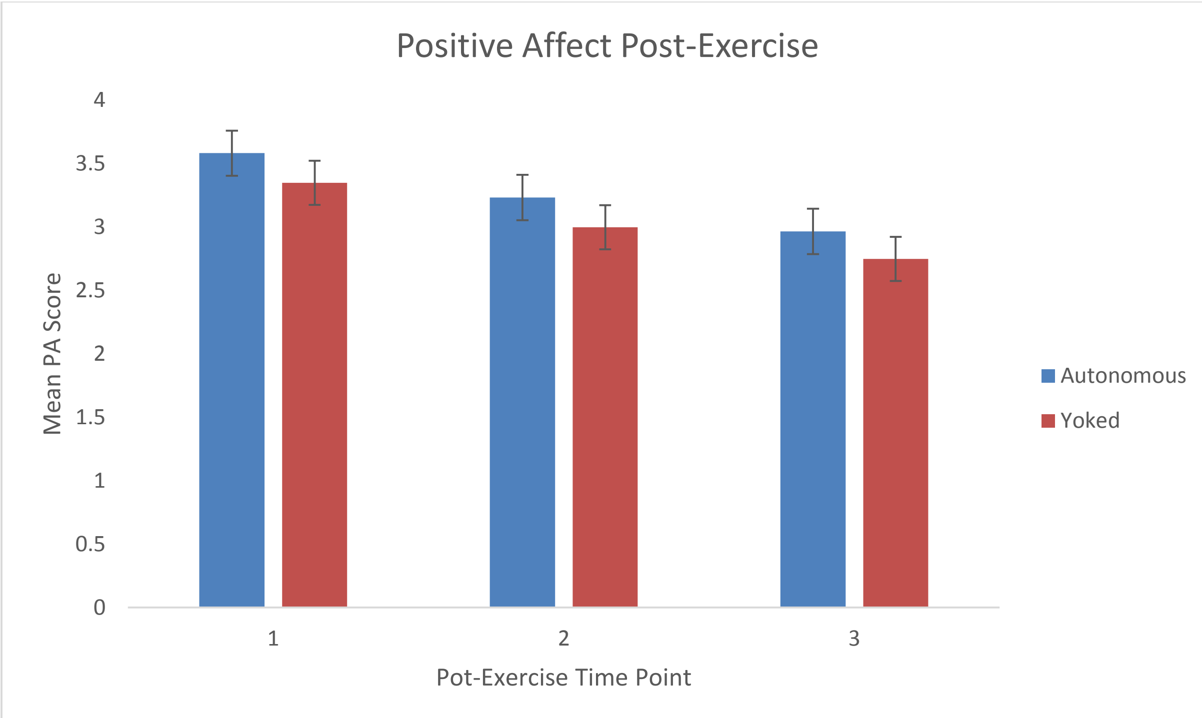
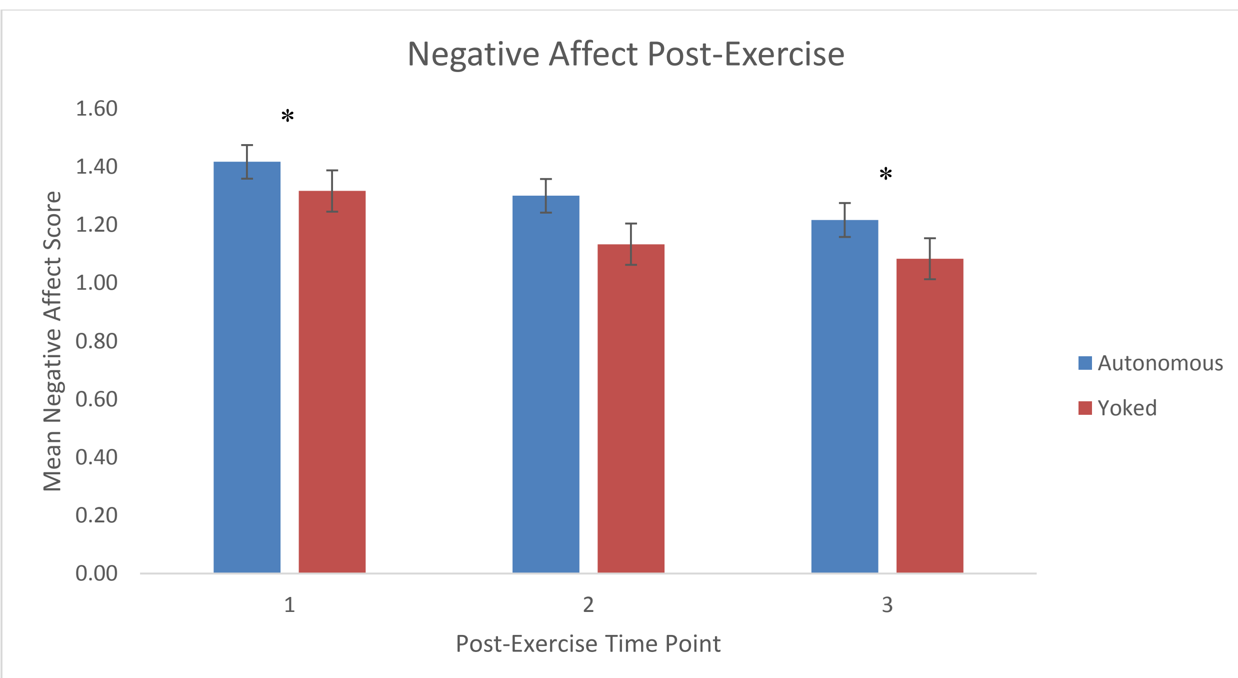


Figure 4. Mean negative affect scores post-exercise



*Note: * indicates a statistically significant difference*

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