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POSITIVE AND NEGATIVE AFFECT ASSOCIATED WITH AN ACUTE BOUT OF AEROBIC EXERCISE

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ABSTRACT

RICHARD H. COX, TOM R. THOMAS, AND JOSEPH E. DAVIS. **Positive And Negative Affect Associated With An Acute Bout Of Aerobic Exercise**. **JEPonline**. 2001;4(4):13-20. The purpose of this investigation was to test the hypotheses that (a) positive and negative affect would fluctuate as a function of exercise intensity and mode of exercise, and that (b) the effects of exercise on positive and negative affect would be retained for up to 60 min following an acute bout of exercise. Male participants (N=24) were randomly assigned and habituated to exercise on either a treadmill, or a stationary stepper. Participants completed 30 min of exercise on their assigned apparatus at an intensity of either 50% or 75% predicted VO_2max. Psychological affect was assessed using the Subjective Exercise Experiences Scale (SEES) prior to exercise, and at 5, 30, and 60 min after. An intensity by mode by time (2x2x4) MANOVA resulted in a significant main effect for time (p=0.005), and borderline significant main effect for mode (p=0.056). From a univariate perspective a significant difference was noted between the stepper and the treadmill for perceived fatigue (p<0.025). A significant linear trend was observed across time for well-being (p=0.003), distress (p=0.001), and fatigue (p=0.037). The immediate effect of a 30 min bout of exercise was to increase well-being and fatigue but decrease distress relative to baseline measures. Thirty and 60 min after exercise, the effect was to increase well-being and decrease fatigue and psychological distress.

Key Words: Exercise Intensity, Fatigue, Exercise Mode, Perceived Exertion, Positive well-being, Psychological distress

INTRODUCTION

Research relating the effects of exercise upon psychological affect has focused upon acute bouts of resistance exercise as well as acute bouts of aerobic exercise. While results of these two separate lines of research tend to be similar (1), the specific focus of this investigation is upon acute bouts of aerobic exercise. Furthermore, the vast majority of research relating the effects of exercise upon psychological affect has focused upon the effects of exercise upon state anxiety, with lesser amounts devoted to the study of positive and negative affect generally. In this investigation, the focus is upon the effects of an acute bout of aerobic exercise upon positive and negative affect as measured by McAuley and Courneya's (2) exercise specific Subjective Exercise

Experiences Scale (SEES). Other inventories that have been used to study the effects of exercise upon positive and negative affect include, but are not limited to, Gauvin and Rejeski's (3) exercise specific Exercise-Induced Feeling Inventory (EFI), the Profile of Mood States (POMS) (4), and Watson, Clark and Tellegen's (5) Positive and Negative Affect Schedule (PANAS).

Berger and Motl (6) reviewed 25 investigations in which the Profile of Mood States (POMS) was used to measure changes in mood associated with acute bouts of aerobic exercise and physical activity. The vast majority of results show decreases in tension, depression, anger, and confusion associated with acute bouts of moderate intensity exercise. Moderate intensity exercise may not optimize fitness and sport training benefits, but it has consistently been associated with desirable mood changes (7,8,9). Conversely, high intensity exercise has been linked with either no mood changes or undesirable mood changes (8). Results obtained when using the POMS are generally consistent with those obtained with other instruments such as the EFI and SEES (10,11). Furthermore, research utilizing the POMS or other instruments designed to measure positive and negative affect is not biased by pre-exercise expectancy or repeated measurement of psychological affect (12,13,14). While moderate exercise has the effect of reducing negative affect and enhancing positive affect following exercise, this is not necessarily what occurs during exercise (15,16,17). Depending on the intensity of exercise, positive and negative affect may be high or low during exercise and then "rebound" or change following the cessation of exercise. For example, high intensity exercise is associated with a decline in positive affect during exercise but an increase following exercise (16,17).

In our own research we hypothesized that different modes of exercise may elicit differential responses relative to mood states. In a study reported by Thomas, Londeree, Lawson, Ziogas, and Cox (18) it was observed that an acute 60% VO_2max bout of aerobic exercise on the stationary cycle resulted in increased fatigue and decreased vigor compared to jogging. In related research, Berger and Owen (7) compared baseline differences and changes in mood for students enrolled in a semester of body conditioning, swimming, fencing, or yoga. A decrease in negative mood was reported for yoga and fencing students. Based upon their results, these authors proposed an exercise taxonomy for stress reduction. Modes that are more aerobic, noncompetitive, more predictable, and repetitive are believed to promote a greater degree of stress reduction.

While previous research generally shows that a moderate level of exercise is best for producing a reduction in negative affect and an increase in positive affect, this is not a universal finding and many questions remain unanswered. For example, it is unclear how mode of exercise interacts with intensity of exercise, and how long the beneficial effects of psychological mood persist following exercise.

In the current research we extend the body of knowledge by conducting an investigation in which modes and intensity of exercise are manipulated to determine their combined effect upon positive and negative affect. It was specifically hypothesized that the high and low levels of exercise intensity used in this investigation would have similar beneficial effects on post-exercise positive and negative affect, and the effects would persist for up to 60 min post exercise. It was also hypothesized that participants would differ in post-exercise positive and negative affect as a function of exercise mode.

METHODS

Participants

Participants were 24 male university students with an average age of 28.3 years (SD=8.3) who had an established history of engaging in some form of vigorous physical activity on the average of three times per week for 30-60 min each time they exercised. They were, however, recreational exercisers and not highly trained athletes. Participants provided informed consent and IRB approval was obtained for research using human participants.

Measurements

Heart Rate

The Polar Vantage Heart Rate Monitor (Model #1901001), with chest strap, signal transmitter, and wrist watch monitor, was used to measure participant's heart rate (HR) before and during an experimentally manipulated acute bout of exercise. The watch was fitted onto the handle of the exercise apparatus directly in front of the participant where it could be easily observed, read, and monitored by the experimenter.

Exercise Related Affect

Psychological affect, associated with exercise, was assessed using McAuley and Courneya's (2) exercise specific Subjective Exercise Experiences Scale (SEES). The SEES is a 12-item inventory, set to a 7-point Likert scale, which measures positive well-being (PWB), psychological distress (PD), and perceived fatigue (PF). The reported internal reliability of the three subscales of the SEES were 0.86, 0.85, and 0.88 respectively. Participants were asked to respond to the items according to how they felt "now, at this point in time." At the same time that the participants completed the SEES, they also completed Spielberger's State Anxiety Inventory (19). Results of research associated with state anxiety are reported elsewhere (20).

Perceived Exertion

Perceived exertion was measured using Borg's Rating of Perceived Exertion (RPE) scale (21), which requires participants to rate, on a 20-point scale, their perceptions of exertion. For the present study, participants were asked to provide ratings of perceived exertion at the 9, 19, and 29-min points of a 30-min bout of acute exercise. An overall RPE was calculated by taking the average of these three data points. Measurement of perceived exertion provided a manipulation check for intensity of exercise.

Modes of Exercise

Two modes of exercise were used in this investigation. Treadmill jogging was controlled through the use of a Quinton 18-60 Treadmill. Stepping was controlled through the use of a Precor 714 Stationary Stepper.

Procedures

The procedures for this research may be grouped into four basic steps. For purposes of clarity, these steps will be explained in sequential order.

Orientation and Screening

During the orientation and screening session, participants filled out a prepared inventory which requested information about exercise habits. Based upon results of this inventory, participants who were either sedentary (no regular exercise) or who exercised vigorously on a daily basis for more than 90-min were excused from the study. Additionally, participants who reported taking medication for hypertension, epilepsy, or depression were excused from further participation in the study. This screening process resulted in excusing two prospective participants. Participants were informed that when they reported for subsequent testing they should avoid food, and beverages containing caffeine, for two hours prior to the exercise sessions. Participants who were retained for the investigation completed a consent form and were randomly assigned to a treatment condition involving exercise on a Quinton 18-60 treadmill (jogging), or a Precor 714 stationary stepper.

Habituation Training

Participants were randomly assigned to one of four treatment conditions: low intensity jogging, high intensity jogging, low intensity stepping, high intensity stepping. Based upon assignment to treatment condition, participants reported to the Exercise Physiology Laboratory (EPL) on a flexible schedule to practice on the exercise mode to which they were assigned. There was no time limit on the habituation training. Participants practiced on their assigned apparatus until they felt physically and psychologically comfortable while exercising on it.

Determining Target Heart Rate

Target heart rate (THR), equivalent to estimated VO_2max of 50% and 75%, was calculated using ACSM published guidelines (22). The first step in this process was to determine the participant's estimated maximum heart rate (MHR). For the treadmill participants, MHR was calculated as 220 minus age (220-age). For the stepper, MHR was calculated as 220 minus age minus 5 (220-age-5). According to ACSM guidelines, 50% VO_2max is equivalent to 67% MHR, and 75% VO_2max is equivalent to 83% MHR. Therefore, the estimated THR associated with 50% VO_2max was calculated to be 0.67 times MHR, and the estimated THR associated with 75% VO_2max was calculated to be .83 times MHR. For example, a 25 year old male exercising on the treadmill at 75% VO_2max would have an estimated MHR of 195 and a THR of 162. During exercise, for this example participant, a constant THR of 162 would have been maintained throughout the 30-min exercise period. The measurement error for estimating MHR is 10-12 b/min and for estimating submaximal exercise HR it is about 7-8 b/min (22).

Experimental Exercise Testing

Following habituation and estimation of THR, participants reported to the EPL for experimental testing. Prior to being fitted for HR monitoring, the participants completed the Subjective Experiences Inventory (SEES) relative to how they felt at that moment. The SEES was administered at a table in the EPL in the same room with exercise equipment. Following assessment of exercise related affect, participants were fitted for heart rate monitoring and prepared for exercise.

Consistent with assigned mode, each participant exercised for 30-min at one of two assigned exercise intensities (50%, or 75% of predicted VO_2max). These two exercise intensities were selected as being within the range prescribed for improving cardiovascular fitness (22). Mode of exercise and exercise intensity were between subject variables, with participants randomly assigned to a mode by intensity condition. Treadmill speed or stepper cadence was increased until the participant reached his THR criterion for 50% (67% maximum HR) or 75% (83% maximum HR) of predicted VO_2max. This was accomplished during the first 2-3 min of the 30 min bout. Heart rate was monitored and recorded at the end of each min of the 30 min exercise bout. Work load was monitored/adjusted in order to maintain exercise intensity at the prescribed intensity level (THR). During the 30 min exercise bout, the participant was asked to provide a rating of perceived exertion (RPE), using the Borg Scale, at 9, 19, and 29 min. Five, 30, and 60 min after the completion of the exercise bout, participants again completed the SEES. After the 30 min exercise bout, the heart rate monitor was removed and participants allowed to read or rest until the completion of the session.

Statistical Analyses

Multivariate data were analyzed using MANOVA procedures with univariate follow-up analyses where appropriate. Univariate data were analyzed using analysis of variance procedures (ANOVA). F-ratios were evaluated with an alpha level of 0.05 for all main effects and post-hoc comparisons. Effect size, or strength of relationship, associated with univariate analyses was reported using partial Eta squared (η^2_p). Partial Eta squared is a measure of variance accounted for and is interpreted like a squared multiple correlation (23). Multivariate effect size was reported using the squared multiple correlation (R^2) (24).

RESULTS

Baseline Analyses

Multivariate and univariate analyses indicated that significant differences did not exist for baseline measures of positive and negative affect or for age of participants across different intensity and exercise mode conditions. An intensity by mode of exercise (2x2) multivariate analysis of variance (MANOVA) on SEES subscales revealed insignificant main effects for intensity, mode, and the intensity by mode interaction. An intensity by mode of exercise (2x2) ANOVA on the dependent variable of age of participant also revealed insignificant main effects for intensity, mode, and the intensity by mode interaction. These results confirm that the intensity and mode groups started out equal in terms of baseline SEES scores and that groups did not differ as a function of age. Table 1 presents SEES means and standard deviations displayed as a function of exercise intensity, exercise mode, and time of measurement.

Manipulation Check for Intensity

Participants were randomly assigned to a 50% or a 75% predicted VO_2max exercise intensity condition. It was expected that these two conditions would differ as a function of HR and RPE measured during the 30 min acute exercise bout. Heart rate and RPE monitored during exercise were subjected to ANOVA procedures. The results of these univariate variance analyses (ANOVA) confirmed that HR and RPE recorded during exercise for the 75% predicted VO_2max group was significantly higher than for the 50% predicted VO_2max exercise group.

Details of these analyses are recorded in a separate report associated with state anxiety changes during exercise (20).

Table 1: SEES Means±Standard Deviations Associated with Mode and Exercise Intensity (% estimated VO_2max).

			Time			
SEES	**Mode**	**Intensity**	**Baseline**	**+5min***	**+30min**	**+60min**
Well-being	Stepper	50%	20.5±1.5	23.8±1.2	21.8±1.9	20.8±4.3
		75%	19.8±3.7	21.7±2.3	21.8±1.9	22.5±2.5
	Treadmill	50%	20.0±3.7	20.3±3.8	20.5±3.4	22.0±3.8
		75%	20.2±7.6	21.8±7.5	22.5±4.7	23.0±3.6
Distress	Stepper	50%	05.7±1.5	05.0±0.6	05.2±1.5	04.7±0.8
		75%	08.2±4.8	05.5±1.5	05.3±1.5	04.2±0.4
	Treadmill	50%	07.0±3.8	05.5±2.0	04.8±1.6	04.3±0.8
		75%	06.7±6.1	05.7±3.2	04.2±4.0	04.8±1.6
Fatigue	Stepper	50%	13.3±3.4	11.8±2.6	12.2±3.2	10.5±3.5
		75%	11.3±5.8	15.2±5.3	12.7±5.8	10.3±5.1
	Treadmill	50%	11.2±2.8	09.5±3.4	08.2±3.3	07.3±1.8
		75%	09.2±4.5	09.7±5.9	08.7±4.3	07.3±3.9

*after end of 30-min exercise bout

Intensity by Mode by Time Analysis for Exercise Related Affect

An intensity by mode by time (2x2x4) MANOVA on SEES subscales revealed a borderline significant main effect for mode, $F(3,18)=3.03$, $p=0.056$ ($R^2=0.34$); and a significant main effect for time, $F(9,141)=2.75$, $p=0.005$ ($R^2=0.32$). All other main effects and interactions were not significant at the 0.05 level. Follow-up ANOVAs and mean comparisons revealed a significant difference between exercise modes for perceived fatigue, $F(1,20)=7.57$, $p<0.025$ ($\eta^2_p=0.23$), but not for psychological distress ($\eta^2_p=0.001$) or positive well-being ($\eta^2_p=0.003$). The mean perceived fatigue score for the stepper was 12.2±4.4, while for the treadmill it was 8.9±3.8). Follow-up univariate ANOVAs and mean comparisons for the time main effect are explained separately for each SEES subscale.

Positive Well-being

As seems apparent in Figure 1, a significant linear trend for time was observed for positive well-being ($p=0.037$, $\eta^2_p=0.07$). Planned mean comparisons revealed significant differences between baseline and +5 min ($p=0.04$, $\eta^2_p=0.07$), between baseline and +60 min ($p=0.02$, $\eta^2_p=0.08$), but not between baseline and + 30 min ($p=0.07$, $\eta^2_p=0.05$). These results suggest that positive well-being increased, following an acute bout of aerobic exercise, and remained elevated for at least 60 min. The actual means and standard deviations involved in these comparisons are illustrated in Table 2. To avoid inflated familywise type I error, only planned comparisons among positive well-being means were made.

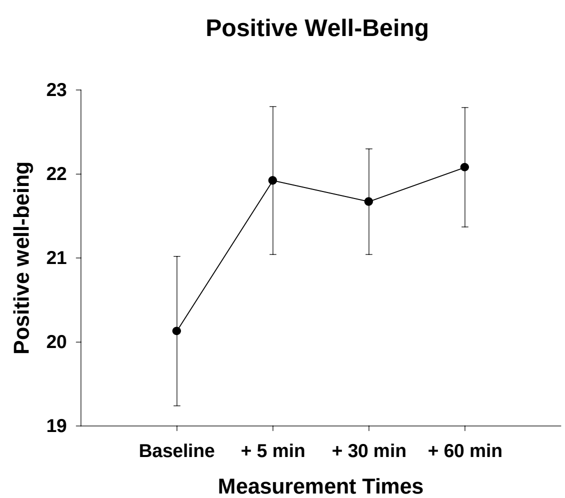

Figure 1: Positive well-being means and standard errors plotted across four measurement times. Significant difference observed between baseline and +5 min and +60 min post exercise.

Psychological Distress

As seems apparent in Figure 2, a significant linear trend for time was observed for psychological distress ($p=0.001$, $\eta^2_p=0.17$). Planned mean comparisons revealed a significant difference between baseline and +5 min ($p=0.04$, $\eta^2_p=0.07$), between baseline and + 30 min ($p=0.005$, $\eta^2_p=0.12$), and between baseline and + 60 min ($p=0.001$, $\eta^2_p=0.17$). These results suggest that psychological distress decreased, following an acute bout of aerobic exercise, and continued to decrease for at least 60 min. Actual means and standard deviations associated with mean comparisons are displayed in Table 2.

Perceived Fatigue

As seems apparent in Figure 3, a significant linear trend for time was observed for perceived fatigue ($p=0.003$, $\eta^2_p=0.13$). Planned mean comparisons revealed a significant difference between baseline and +60 min ($p=0.007$, $\eta^2_p=0.11$), but not between baseline and +5 min ($p=0.73$, $\eta^2_p=0.002$), nor between baseline and +30 min ($p=0.33$, $\eta^2_p=0.016$). These results suggest that perceived fatigue decreased following an acute bout of aerobic exercise, but not until after 30 min post exercise. The actual means and standard deviations associated with mean comparisons are displayed in Table 2.

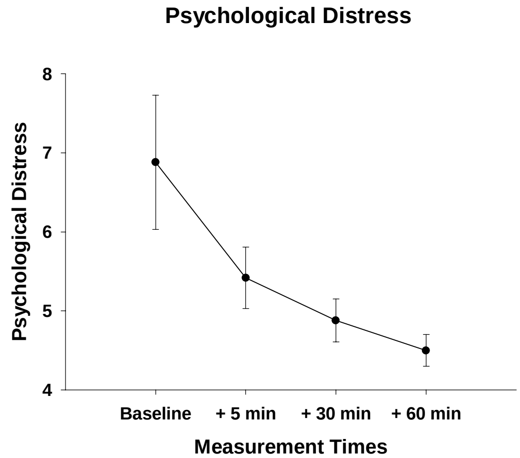

Figure 2: Psychological distress means and standard errors plotted across four measurement times. Significant difference observed between baseline and all three post exercise times.

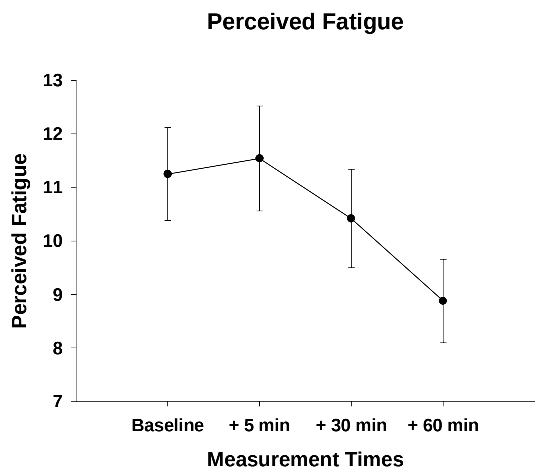

Figure 3: Perceived fatigue means and standard errors plotted across four measurement times. Significant difference observed between baseline and + 60 min.

Table 2: Subjective Exercise Experiences Scale (SEES) Means±Standard Deviations Associated with Time of Measurement (Collapsing Across Mode and Intensity of Exercise).

	Time			
SEES	**Baseline**	**+5min***	**+30min**	**+60min**
Well-being	20.1±4.4	21.9±4.3	21.7±3.1	22.1±3.5
Distress	06.9±4.2	05.4±1.9	04.9±1.3	04.5±1.0
Fatigue	11.3±4.2	11.5±4.8	10.4±4.5	08.9±3.8

*after end of 30-min exercise bout

DISCUSSION

All three research hypotheses were either supported or partially supported. Participants assigned to the 50% and 75% VO_2max conditions exhibited the same beneficial positive and negative affect post exercise scores. For both exercise intensity conditions, beneficial positive and negative affect persisted for up to 60 min post exercise. A difference in perceived fatigue was observed between the two exercise modes, with higher scores noted for the stepper. No such difference between treadmill jogging and stepping was observed for psychological distress or positive well-being.

As observed in Figure 1, the effect of a 30 min acute bout of aerobic exercise, regardless of exercise intensity, was to increase the perception of positive well-being above baseline. This perception of an increase in positive well-being persisted for up to 60 min post exercise. This result differed from that reported by Bixby et al. (15) in that their research showed an increase in positive affect during exercise with a decline to baseline immediately after exercise. Ekkekakis et al. (17) reported a similar post-exercise result to Bixby et al., but they also reported differential effects of exercise intensity upon positive affect during exercise. The results of the present investigation, however, are consistent with the vast majority of research associated with positive affect and exercise (6). Specifically, an acute bout of aerobic exercise results in an increase in positive affect that persists for at least 60 min post exercise.

As observed in Figure 2, the effect of exercise upon psychological distress was to decrease psychological distress below baseline. Following cessation of exercise, this decrease in distress was linear in nature for up to 60 min post exercise. This finding suggests that psychological distress decreases following an acute bout of aerobic exercise and continues to decrease for at least 60 min. The post exercise pattern for psychological distress illustrated in Figure 2 is very similar to the pattern observed in research involving post exercise state anxiety (20). The difference, however, is that in the case of state anxiety a significant difference is often not observed between baseline and post-exercise until approximately 30 min have elapsed. This has been referred to as the delayed anxiolytic effect. In the current study we note that a significant decrease in psychological distress is observed immediately after the cessation of exercise and continues to decrease to 60 min post-exercise. Most studies that have looked at the effects of exercise on psychological affect have noted a decrease in negative affect following exercise (6,15,16,17), but this investigation clarifies that the effect is maintained for up to 60 min.

As observed in Figure 3, the effect of an acute bout of aerobic exercise upon perceived fatigue was to decrease it over time. However, the effect was not significantly below baseline until 60 min post exercise. If the last measurement of perceived fatigue had taken place at 30 min post-exercise, one would conclude that an acute bout of exercise has no effect upon perceived fatigue. Because, the SEES was administered a fourth time at 60 min post-exercise we were able to observe the beneficial effect of exercise on reducing negative affect in the form of perceived fatigue. This is an important finding, because one should not expect a perceived fatigue score to drop below baseline when the participant has not yet exercised. A previous investigation by Szabo et al. (11) administered the EFI and SEES three hours post exercise, but the data were not analyzed because of missing observations.

In terms of perceived fatigue, the results of this investigation showed that participants perceived exercising on the stepper to be more fatiguing than exercising on the treadmill. This is true despite the fact that exercise intensity was objectively controlled across modes. The notion that certain modes of exercise might elicit differential affective responses has been documented elsewhere (7,18). Berger and Owen (7) went so far as to propose an exercise taxonomy to promote greater stress reduction. This finding suggests that the psychological benefits of exercise might be associated with the way we choose to exercise as well as in the intensity of exercise. Finally, it should be noted that the indirect estimation of submaximal target intensities could have confounded the results of this study. It is likely, however, that underestimates and overestimates of target intensity would be evenly distributed in mode groups. Thus, the indirect estimation of exercise intensity should not affect the comparisons between the two modes of exercise.

In summary, the results of this research demonstrate the beneficial effects of an acute bout of aerobic exercise on positive and negative mood states as measured by the Subjective Exercise Experiences Scale. Additionally, these beneficial effects were observed to persist for up to 60 min post exercise. Finally, evidence from this investigation suggests that from the perspective of perceived fatigue, jogging on the treadmill is preferred to exercising on the stepper. This last finding has important implications relative to the type of exercise apparatus selected by exercisers.

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