HHS Public Access

Author manuscript

J Behav Med. Author manuscript; available in PMC 2024 March 14.

Published in final edited form as:

J Behav Med. 2024 February ; 47(1): 111–122. doi:10.1007/s10865-023-00442-6.

Unpacking differences in post-exercise affective experiences between physically underactive and active individuals

Margarita Sala, Ph.D.[1], **David Rosenfield, Ph.D.**[2], **Austin S. Baldwin, Ph.D.**[2]

[1]Ferkauf Graduate School of Psychology, Yeshiva University, Bronx, NY

[2]Department of Psychology, Southern Methodist University, Dallas, TX

Abstract

Background: Affective response to exercise (i.e., how individuals feel during- and post-exercise) as well as post-behavioral evaluations of affective experiences with exercise (i.e., reflecting on experience after engaging in exercise) may be important determinants of regular exercise.

Purpose: We compared post-exercise affective response and post-behavioral evaluations of exercise between a physically active and underactive group. Physically active (n = 32) and underactive (n = 25) participants completed a 10-minute treadmill bout of vigorous exercise and reported affective valence, positive activated affect, negative activated affect, calmness, fatigue and relief at various points during and/or after the bout.

Results: As expected, both groups reported an improvement in affective valence immediately post-exercise (ps < .001). This improvement in affective valence was associated with a concurrent decrease in negative affect (ps < .05) for the physically underactive group and was only associated with a concurrent increase in positive affect (ps < .02) for the active group. There were significant differences between physically active and underactive groups in pre-post exercise changes in positive activated affect (ps <.005). The underactive group reported greater relief than the active group at all-post exercise time-points (ps < .05).

Conclusions: These findings have implications for understanding post-exercise affective response and post-behavioral evaluations of exercise and for interventions directed at influencing the post-exercise affective response and behavioral evaluations of exercise in physically underactive individuals.

Keywords

post-behavior evaluations; exercise; physical activity; affect

*Correspondence to: Margarita Sala, Ferkauf Graduate School of Psychology, Yeshiva University, margarita.sala@yu.edu.

Authors' contributions: **Margaret Sala:** Conceptualization, Methodology, Investigation, Writing– Original Draft, Writing – Review & Edit, Statistical Analysis, Visualization, Supervision, Project Administration **David Rosenfield:** Writing – Review & Edit **Austin Baldwin:** Conceptualization, Methodology, Investigation, Writing – Review & Edit, Supervision, Project Administration

Declarations

Ethics approval: All study materials and procedures were reviewed and approved by the Southern Methodist University Institutional Review Board.

Consent to participate: All participants gave informed consent.

Code availability: Available from the corresponding author [MS] on request.

Conflicts of interest: Not applicable

Substantial evidence indicates that regular physical activity is associated with various benefits for health and well-being (United States Department of Health and Human Services, 2018). Yet, fewer than half of U.S. adults engage in recommended levels of regular activity (Carlson et al., 2010; Center for Disease Control Prevention, 2015; Tucker et al., 2011). Research examining predictors of physical activity behavior has been guided primarily by theoretical models that focus on cognitive factors (e.g., behavioral intentions, expected outcomes, perceived benefits) such as the health belief model (Rosenstock, 1974), the theory of planned behavior (Ajzen, 1991), social-cognitive theory (Bandura, 1986) and the trans-theoretical model (Prochaska & Velicer, 1997). However, interventions grounded in these models have only been modestly effective (Dishman & Buckworth, 1996; Oman & King, 1998). It is thus necessary to move beyond cognitive processes and identify other important predictors of exercise behavior. According to dual-processes theories, affective factors also influence health behaviors (Friese, Hofmann, & Wänke, 2008; Hofmann, Friese, & Wiers, 2008). Consistent with dual-process and hedonic theory (Kahneman et al., 1999), which is grounded in Bentham's utilitarianism (Bentham, 1789) and Kahneman's experience utility (Kahneman et al., 1997), the better people feel during exercise, the more likely they are to engage in future regular exercise.

Research indicates that the more positive an individual's affective response *during* exercise, the more likely they are to engage in regular exercise (Baldwin et al., 2016; Kwan & Bryan, 2010; Parfitt et al., 2012; Rhodes & Kates, 2015; Schneider et al., 2009). Evidence for the relation between *post*-exercise affective response and exercise behavior, however, has been less conclusive, with some studies demonstrating a significant prospective association (Kwan & Bryan, 2010; Schneider et al., 2009) and others demonstrating no association (Williams et al., 2012). This pattern of mixed results was confirmed in a narrative review showing that although many of the studies reviewed did not report significant effects, 1/3 of the studies in the review reported a significant relation between post-exercise affective response and future exercise behavior (Rhodes & Kates, 2015).

A large body of research has established that affective experiences *during* exercise differ by current physical activity level (Bixby & Lochbaum, 2006; Lochbaum et al., 2004; Magnan et al., 2013; Petruzzello et al., 1997). Affective experiences during exercise can be characterized by two dimensions: *valence* and *activation* (i.e., low activation vs. high activation) (Russell, 1980). These two dimensions create four quadrants in the affective circumplex: high activation unpleasant affect (i.e., negative activated affect), high activation pleasant affect (i.e., positive activated affect), low activation pleasant affect (i.e., calmness), and low activation unpleasant affect (i.e., fatigue). Affective experiences during exercise are more positive for physically active individuals compared to those who are underactive, particularly when engaging in exercise at higher intensities (Bixby & Lochbaum, 2006; Lochbaum et al., 2004; Magnan et al., 2013; Petruzzello et al., 1997). These differences can be explained by physical (e.g., VO_2 max, body mass index, temperature during exercise) and cognitive factors (e.g., exercise self-efficacy) during exercise that differ between those who are physically active and those who are underactive (Magnan et al., 2013).

However, the extent to which *post*-exercise affective responses differ between underactive and active individuals is not well understood. Only a few studies have assessed differences in post-exercise affective states among underactive and active individuals. Bixby & Lochbaum (2006) as well as Lochbaum, Karoly, & Landers (2004) compared underactive and active individuals in their affective response during and post-exercise, and found that active individuals reported greater positive affect than underactive individuals in response to exercise at all time-points. Bixby & Lochbaum (2006) also found that whereas underactive individuals experienced an initial improvement in positive affect soon after exercise, they only experienced a small enhancement in positive affect throughout the recovery period compared to their baseline affect value. In contrast, active individuals reported a substantial improvement in positive affect throughout the exercise recovery period. Lochbaum et al. (2004) found that active individuals experienced an increase in positive affect during the exercise, that their positive affect peaked immediately after ending exercise, and then began returning to baseline levels. In contrast, underactive individuals experienced a reduction in positive affect during the high-intensity exercise followed by a rebound to more positive affective states during recovery. Hallgren et al. (2010) found that active individuals experienced improvements in mood and reductions in state anxiety at 10 and 25 minutes after a vigorous exercise bout, whereas underactive individuals reported an initial decline in mood and increased anxiety at 10-minutes post-exercise, followed by a rebound to baseline 25 minutes post-exercise.

It is important to examine post-exercise affective response because, according to reinforcement principles, changes in affective states after engaging in behaviors such as exercise could reinforce or deter further behavior. Based on in Gollwitzer's Model of Action Phases (Gollwitzer, 1990), the evaluation of progress that occurs after engaging in a behavior is an important phase in determining further action. Annesi (2006) found that changes in affective experiences (e.g., physical exhaustion, revitalization) pre-to-post exercise were associated with attendance at exercise sessions. In a meta-analysis of changes in positive activated affect from pre-to-post exercise, there was a strong effect for increases in positive activated affect immediately post high-intensity exercise (Reed & Ones, 2006). However, at more distal assessment times (e.g., 30 minutes post-exercise), there was a more variable pattern of response, which may be explained by individual differences such as current physical activity level. It is important to compare changes in affective response from pre-to-post exercise among physically active vs. underactive individuals to understand where there may be important differences between these two groups that may be reinforcing or deterring future exercise behavior and driving the differences in exercise levels among these two groups. Understanding these differences can inform the design of interventions targeting affective expectations and experiences among physically underactive individuals.

Drivers of the Rebound Effect

Previous studies comparing physically active and underactive individuals have found a "rebound effect", showing that both groups report similar improvements in affective response immediately post-exercise, as compared to during exercise (Bixby & Lochbaum, 2006; Lochbaum et al., 2004; Petruzzello et al., 1997). However, these improvements have been observed as changes in unidimensional affective valence (typically using a difference

score between positive and negative affective states). It is not clear whether the immediate post-exercise improvement in affective response reflects *different* changes in specific affective states for physically underactive and active individuals. Increases in affective valence could occur due to increases in positive activated affect or decreases in negative activated affect. There may be important differences among the physically active and underactive individuals regarding which specific affective states may be driving the rebound effect. Solomon (1980) postulated that the brain seeks to maintain affective homeostasis through an "opponent process" that suppresses departures from the affective equilibrium. In the case of exercise, Solomon's theory would predict that some individuals experience aversion and discomfort during exercise, which would arouse an opponent process (e.g. 'feeling better', or a reduction in negative affect) to achieve affective equilibrium (i.e., a rebound effect).

Pre-Post Changes in Affect

In addition to post-exercise rebound effect, differences in specific post-exercise affective states (e.g., positive activated affect, negative activated affect, calmness, fatigue) as compared to *before beginning exercise* among physically active and underactive individuals (i.e., pre-post changes in affect) are important to understand. Whereas the rebound effect is typically examined compared to how individuals felt while they were exercising, it is important to examine differences in post-exercise affective states relative to how individuals felt *before* the exercise (i.e., at baseline) because, according to reinforcement principles, affective states relative to before engaging in a behavior would reinforce or deter further behavior. Examining pre-post changes in affect would further elucidate post-exercise affective experiences and their reinforcing effects on future exercise. However, no research to date has systematically compared affective experiences post-exercise among physically active vs. physically underactive individuals relative to before exercising.

Because individuals who exercise regularly tend to report increases in positive activated affect and decreases in negative activated affect during exercise (compared to before exercise) (Annesi, 2002; Magnan et al., 2013), they may continue experiencing higher positive activated affect and lower negative activated affect during the post-exercise period relative to baseline. In contrast, because inactive individuals tend to report increases in negative activated affect and minimal changes in positive activated affect during exercise (compared to before exercise) (Annesi, 2002; Magnan et al., 2013), they may experience a slower return to baseline negative affect levels relative to before exercising and continued minimal changes in positive activated affect in the post-exercise period.

There also may be differences in calmness and fatigue between physically underactive and physically active individuals. Because physically underactive individuals experience decreases in calmness and increases in fatigue during exercise (relative to before exercise) (Magnan et al., 2013) and are not physically accustomed to exercise, the decreases in calmness and increases in fatigue induced by the exercise might persist throughout the post-exercise period. In contrast, because physically active individuals experience no changes in calmness and actually experience *decreases* in fatigue during exercise (relative to before

exercise) (Magnan et al., 2013), they may experience minimal changes in fatigue and calmness in the post-exercise period.

Relief

A related factor that has recently emerged as a potential determinant of regular physical activity is post-behavior evaluations of affective experiences with exercise, or reflecting on affective experiences with exercise after engaging in exercise behavior (Kwan et al., 2018). Post-behavior evaluations can include reflective evaluations of the exercise, such as feelings of relief that the exercise is over. The Model of Action Phases (Gollwitzer, 1990, 2012; Heckhausen & Gollwitzer, 1987) proposes that post-behavior evaluations influence future intentions to continue engaging in the behavior, and intentions in turn predict increased subsequent exercise behavior. Notably, there is some empirical evidence supporting this theory, such that affective post-behavior evaluations predict exercise intentions as well as subsequent exercise (Kwan et al., 2018). Post-exercise relief is a reflective evaluation that relates to how individuals remember the exercise. To the extent that individuals remember feeling negatively during the exercise, it is likely the case that they would feel relief that the exercise is over. Notably, it has been suggested that for physically underactive individuals, the post-exercise rebound effect might reflect relief that the exercise is over (Bixby & Lochbaum, 2006). However, this possibility has not been directly tested. Furthermore, no research to date has not examined how post-exercise relief might differ by current exercise level.

Current Study

The objective of the current study was to compare post-exercise affective response and behavioral evaluations between a physically active and a physically underactive group. We sought to evaluate differences in a physically underactive vs. physically active group in: (1) understanding the drivers of the rebound effect, including changes from end-of-exercise to immediately post-exercise in: (a) a unidimensional valence measure, (b) negative activated affect, (c) positive activated affect, and (d) the extent to which changes in affective valence are associated with changes in negative activated affect and positive activated affect; (2) pre-post changes in affect (i.e., positive activated affect, negative activated affect, fatigue, calmness) relative to baseline; and (3) post-exercise relief (i.e., post-behavior evaluation).

Method

Participants

Healthy young adults ($N = 57$) who were undergraduate college students enrolled in the study in exchange for course credit. Given the aims of the study, we recruited a sample of this size as this sample size would be large enough to detect medium-large size effects (alpha = .05, power = .80). Interested participants completed a short, online screening where they reported their current physical activity using the International Physical Activity Questionnaire (IPAQ; Marshall & Bauman, 2001). Participants (n = 32) who reported at least 75 minutes per week of vigorous activity were classified as physically active, as this amount of vigorous activity meets the threshold for current public health recommendations

for regular activity (United States Department of Health and Human Services, 2018). Of note, we made decisions on who was physically active based on vigorous activity because we asked participants to complete a vigorous exercise bout in the study, and thus wanted to recruit individuals who engaged in regular vigorous activity. Participants (n = 25) who reported less than 30 minutes per week of vigorous exercise, and less than 60 minutes of moderate-to-vigorous activity per week were classified as physically underactive per current guidelines (United States Department of Health and Human Services, 2018). We restricted the sample to participants who met these two thresholds, rather than participants across the range of physical activity levels, in order to clearly test for differences between physically underactive and active individuals. Sampling from distinct levels of the variable of interest is most efficient to detect such differences should they exist (McClelland, 1997). All participants gave informed consent and all study materials and procedures were reviewed and approved by the Southern Methodist University Institutional Review Board.

Measures

Affective valence.—Affective valence was assessed with the Feeling Scale (FS; Hardy & Rejeski, 1989), a single item measure of core affect. Participants were asked to rate their current feelings on an 11-point scale ranging from −5 (*very bad*) to 5 (*very good*).

Affective states.—Affective states were assessed with the Physical Activity Affect Scale (PAAS; Lox, Jackson, Tuholski, Wasley, & Treasure, 2000), as this measure captures distinct affective states (i.e., incorporating both valence and arousal). The PAAS has 12 items across four subscales that reflect the four quadrants of the affective circumplex: positive activated affect (‘enthusiastic’, ‘energetic’, ‘upbeat’), negative activated affect (‘miserable, ‘discouraged’, ‘crummy’), fatigue (‘tired’, ‘worn-out’, ‘fatigued’), and calmness (‘peaceful’, ‘relaxed’, ‘calm’). The PAAS has been shown to be invariant across sedentary and active populations (Carpenter et al., 2010). Participants responded to each of the items using a scale ranging from 0 (*do not feel*) to 4 (*feel very strongly*). In the current study, internal consistency for the subscales was adequate to excellent (positive activated affect αs = .82 - .92, negative activated affect αs =.79 - .91, fatigue αs = .76 - .94, calmness αs = .84 - .92).

Relief.—We developed an item for this study in order to assesses post-exercise relief as no extant measure exists. At each post-exercise assessment, participants were asked, “To what extent do you feel relieved the exercise is done?” and rated their feeling of relief on a scale ranging from 1 (*not at all relieved*) to 5 (*extremely relieved*).

Procedure

After participants consented to participate, they completed a baseline questionnaire followed by a 10-minute, vigorous-intensity exercise bout on a treadmill. This study was conducted using vigorous-intensity exercise because differences in affective experiences between physically underactive and active individuals are larger during vigorous-intensity than lower-intensity exercise or very intense exercise (Bixby & Lochbaum, 2006; Ekkekakis, 2003; Ekkekakis et al., 2011).

Participants wore a heart rate monitor with a chest strap (Polar, Inc.) during the exercise session in order to accurately monitor intensity. Participants first completed a warm-up consisting of walking / jogging at 4.0 mph for the first 2 minutes and a run-in period during which a research assistant directed increases in speed (increasing in increments of .5 miles per hour every 30 seconds) until the participant reached vigorous intensity as measured by estimated maximum heart rate (220-age, 77% of estimated HR_{max}) (American College of Sports Medicine, 2013). The run-in period lasted a minimum of 1 minute, but went longer if needed for the participant to reach the target estimated $HR_{max.}$ Once participants reached a vigorous intensity, they were asked to maintain a heart rate of 80–85% estimated HR_{max} for 10 minutes. We chose a duration of 10 minutes to ensure that everyone could complete the exercise bout (i.e., underactive and active individuals). Participants were instructed to exercise in this range to minimize the likelihood their heart rate went below the vigorous intensity range. Participants used an iPad which was securely attached to the treadmill such that they could report their affective experiences (FS, PAAS) themselves just prior to the treadmill bout (baseline), after the warm-up and run-in period, during the exercise bout (at 5- and 10-minutes), 1-minute after ending the exercise bout (during a cool down), 3-minutes after the bout (end of cool down), and at 10-, 20-, and 30-minutes after the cool-down. Participants also reported how relieved they felt at each of the post-exercise time points. Participants were asked to sit quietly without doing anything else (e.g., use their phones) during the 30-minute post-exercise period to prevent other stimuli from influencing their responses.

Analysis Approach

Data were analyzed using SPSS Version 21.0. To compare changes in the rebound effect among the physically underactive and active groups, we used mixed effects models with an unstructured covariance matrix to conduct repeated measures analysis of covariance (ANCOVAs). In these models, we tested whether changes in FS, positive activated affect and negative activated affect differed between the physically underactive and active groups at each post-exercise time point. The independent variables in the models were exercise group (2 levels: physically active, underactive) and time (6 levels: baseline, post warm-up, mid-exercise, end-of-exercise, 1-, 3- minutes post-exercise). We included the baseline and during-exercise time points in the model to improve estimates of variances and covariances. The group difference contrasts are reported as “group x time contrasts”, with time representing the change from end-of-exercise to the relevant assessment point for FS, positive and negative activated affect. For example, when reporting group differences in changes from end-of-exercise to the 3-minute follow-up, we report it as the group x time contrast at 3-minutes post-exercise. Pre-post changes in affect were analyzed with the same analytical approach. The only differences were the additional time intervals (i.e., 10-, 20-, and 30-minutes post-exercise), and that time represented changes from baseline instead of end-of-exercise. Effect sizes were computed by transforming the *t*-statistic from the model into a *d* effect size.

To address the extent to which changes in affective valence are associated with changes in negative activated affect and positive activated affect, we directly tested the extent to which the *associations* between post-exercise changes in affective valence (i.e., FS) and

post-exercise changes in positive activate affect and negative activated affect differed for each group, using multilevel mixed effect models. We created a change in the affective valence variable by calculating the difference between FS scores at each of the post-exercise time periods and the FS score at the end-of-exercise. These change scores were modeled as the outcome variable. Change in positive activated affect and change in negative activated affect variables were calculated using the same approach, and the change scores in positive activated affect and negative activated affect were used as time-varying predictors of concurrent changes in FS in the same model. For example, change in negative activated affect from end-of-exercise to 1-minute post-exercise was used to predict changes in FS for the same time period. The model also included group (2 levels: physically active, physically underactive). All predictor variables were entered simultaneously into a single model.

To address differences in relief between the physically underactive and active groups throughout the post-exercise period, we used mixed effect models.

Results

Sample Characteristics

Sample characteristics and demographics are included in Table 1 organized by group. Overall, the sample was young, normal BMI, mostly White, and majority female. The physically active group reported an average of 220.5 minutes per week (*SD* = 115.6) of vigorous-intensity activity (plus an additional 238.5 minutes per week [*SD* = 265.5] of moderate-intensity activity). The physically underactive group reported an average of 0 minutes per week of vigorous intensity activity (plus 12.5 minutes per week [*SD* = 20.86] of moderate intensity activity). The proportion of women was significantly higher in the physically inactive group (96.0%) than the active group (68.9%); therefore, we tested sex as a moderator in all models but it did not significantly moderate any of the reported relations (*ps* = .08 - .94). Bivariate correlations among the dependent variables at each of the post-exercise time point are included in Table 2.

During-Exercise Affect

Changes in affective response during- and post-exercise are depicted graphically by group in Figure 1. The physically active and underactive groups did not differ significantly at baseline in their reported affective valence, positive activated affect, or negative activated affect (*ts* = −0.46 to 1.16, *ps* = 0.25 to 0.64). As expected, the physically active group reported more positive affective valence and positive activated affect during-exercise than the physically underactive group (*ts* = −2.67 to −2.31, *ps* = .01 to .02). Although the underactive group reported higher negative activated affect during exercise, the differences were not statistically significant at any time point (*ts* = 1.78 to 1.94, *ps* = .06 - .08).

Post-Exercise Rebound Effect

Changes in Affective Valence.—All post-exercise findings are reported in Table 2. There was a significant and large improvements in affective valence from the end of the exercise bout to 1-minute and 3-minutes post-exercise for both the physically active and underactive groups (see Table 2, SE Column). The group x time contrast was not significant

at either 1- or 3-minutes post-exercise, indicating that the rate of improvement in affective valence immediately post-exercise (i.e., the rebound effect) did not differ between the two groups.

Changes in Negative Activated Affect.—The group x time contrast for negative activated affect was significant and medium-to-large effect at 1-minute post-exercise, indicating the decrease in negative activated affect was significantly greater for the physically underactive compared to the physically active group. However, the contrast was not significant at 3-minutes post-exercise. When the group effects were examined separately, the physically underactive group reported significant and medium-to-large sized decreases in negative activated affect from end-of-exercise to 1-minute and 3-minutes post-exercise, whereas the physically active group did not report significant changes (see Table 2, FS Column).

Changes in Positive Activated Affect.—Significant and medium-to-large sized group x time contrasts at 1- and 3-minutes post-exercise indicated that the increases in positive activated affect from end-of-exercise were significantly greater for the physically active group compared to the physically underactive group. When the group effects were examined separately, the physically active group reported an increase in positive activated affect immediately after the end-of-exercise that was not significant at 1-minute but was significant and a medium sized effect at 3-minutes. The physically underactive group, however, reported medium-to-large sized *decreases* in positive activated affect 1- and 3-minutes post-exercise, although the decrease was significant only at the 1-minute mark (Table 2, P Column).

Associations Between Changes in FS and Changes in Positive Activated Affect.—Immediately post-exercise, the positive activated affect change x group interaction was significant ($b = .57$, $SE = .23$, $t = 2.45$, $p = .02$, $d = .35$). Specifically, changes in positive activated affect were significantly associated with changes in affective valence for the physically active group ($b = .65$, $SE = .33$, $t = 4.49$, $p = .001$, $d = .62$), but not for the underactive group ($b = .08$, $SE = .20$, $t = .42$, $p = .67$, $d = .06$). Unexpectedly, the negative activated affect change x group interaction was not significant ($b = .29$, $SE = .39$, $t = .73$, $p = .47$, $d = .11$). Although changes in negative activated affect were significantly (negatively) associated with changes in FS for the underactive group ($b = -1.44$, $SE = .21$, $t = -6.73$, $p < .001$, $d = 1.04$), changes in negative activated affect were also significantly (negatively) associated with changes in FS for the physically active group ($b = -1.15$, $SE = .33$, $t = -3.50$, $p = .001$, $d = .55$).

Pre-Post Changes in Affect

Positive Activated Affect.—There were significant medium-to-large group x time contrasts indicating that the increase in positive activated affect from baseline to 1-minute (group x time $b\ (SE) = .66(.23)$, $t = 2.92$, $d = .77$, $p = .005$) and 3-minutes (group x time $b\ (SE) = .72\ (.23)$, $t = 3.18$, $d = .84$, $p = .002$) post-exercise was greater for the physically active group than for physically underactive individuals (see Table 3, PA Column). Only the physically active group experienced large increases in positive activated affect from baseline

to 1-minute (*b (SE)* = .42 (.15), *t* = 2.77, *d* = .74, *p* = .008) and 3-minutes (*b (SE)* = .47 (.15), *t* = 3.82, d = 1.01, *p* < .001) post-exercise. More distally, the physically underactive group reported significant medium-to-large sized decreases in positive activated affect at 10-, 20-, and 30-minutes post-exercise *(bs (SEs)* = −.63 (.16) - −44 (.16), *ts* = −3.88 - −2.75, *ds* = .70 – 1.03, *ps* = <.001 – .005), whereas the physically active group did not report changes in positive activated affect at those times, with the exception of a decrease in positive activated affect at 20-minutes post-exercise (see Table 3, PA Column).

Negative Activated Affect.—There were no significant group x time contrasts at any time point for negative activated affect, and neither the physically active group nor the underactive group experienced significant post-exercise changes in negative activated affect compared to baseline (see Table 3, NA Column).

Fatigue.—There were no significant group x time contrasts for fatigue, indicating that both groups experienced similar rates of decrease in fatigue at all points post-exercise (see Table 3, Fatigue Column).

Calmness.—There were also no significant group x time contrasts predicting distal differences in post-exercise calmness. Interestingly, the physically underactive group reported significant medium-to-large sized increases in calmness at all distal assessment points post-exercise (*bs (SEs)* = .40 (.17) - .57 (.20), *ts* = 2.38 – 2.91, *ds* = .63 - .77, *ps* = .005 - .02) compared to baseline, whereas the physically active group did not report significant distal changes in calmness (see Table 3, Calmness Column).

Relief

The physically underactive group reported greater relief than the physically active group immediately post-exercise at 1-minute (mean difference = .52, *t* = 2.01 *p* = .05) and 3-minutes (mean difference = .58, *t* = 2.50, *p* = .02, see Table 4 and Figure 1, Panel D). The difference between the two groups persisted at all the distal time points. Specifically, the physically underactive group continued to report significantly greater relief than the physically active group at 10- (mean difference = .60, *t* = 2.79, *p* = 0.008), 20- (mean difference = .77, *t* = 2.84, *p* = 0.006), and 30-minutes (mean difference = .81, *t* = 2.74, *p* = 0.008) post-exercise.

Discussion

Overall, our results extend the literature indicating that affective responses to exercise during exercise differ by physical activity level (Bixby & Lochbaum, 2006; Hallgren et al., 2010; Lochbaum et al., 2004; Magnan et al., 2013; Petruzzello et al., 1997) by elucidating how post-exercise affective responses and post-behavioral evaluations differ among physically active vs. underactive individuals. Our findings have implications for how researchers and interventionists measure post-exercise affective response and post-behavioral evaluations for future interventions directed at influencing the affective expectations and experiences of physically underactive individuals.

Drivers of the Rebound Effect

The findings from this study were the first to demonstrate that the immediate improvement in post-exercise affective valence (i.e., the rebound effect; Bixby & Lochbaum, 2006; Lochbaum et al., 2004; Petruzzello et al., 1997) reflects different changes in positive activated affect and negative activated affect for physically underactive individuals compared to those who are active. For physically underactive individuals, the immediate post-exercise rebound effect reflects the removal of negative feelings that occurs after completing physical activity and does not reflect any increase in positive feelings. In contrast, for physically active individuals, the post-exercise rebound effect reflects changes in both positive and negative feelings. Overall, these findings suggest that measuring the rebound effect with only affective valence (vs. using positive activated affect and negative activated affect measures) masks important differences in understanding the affective experiences of underactive individuals compared to those who are active. Physically active individuals may be indeed "feeling better" because they found the exercise rewarding; whereas physically inactive individuals may be "feeling better" because they are glad that the exercise is over. These differences in post-exercise affective states may differentially influence exercise behavior, due to different reinforcing properties. However, these important differences had not been previously captured because previous measures of the rebound affect had only assessed affective valence (e.g., the FS).

Pre-Post Changes in Affect

Consistent with literature that suggests that physically active individuals find exercise to be more pleasant than physically underactive individuals (e.g., Lochbaum et al., 2004), our findings indicated that immediately post-exercise, only physically active individuals experienced increases in positive activated affect relative to baseline. In contrast, physically inactive individuals (but not physically active individuals) experienced *decreases* in positive activated affect more distally, which may deter future exercise behavior. These findings are in line with a meta-analysis conducted by Reed & Ones (2006), who found that all participants experienced an increase in positive activated affect immediately post high-intensity exercise but that responses were more variable at distal time points. Future research should investigate the reasons as to why there may be differences more distally, and why physically inactive individuals may experience decreases in positive activated affect that can last up to 30 minutes. Surprisingly, there were no differences in negative activated affect between the two groups. However, it is important to note that our findings focus on the immediate effects of a single bout of vigorous intensity exercise and do not speak directly to the effects of exercise on longer-term affective outcomes (e.g., effects of regular exercise on depression levels) (Cooney et al., 2014) or exercise at different intensities (e.g., moderate intensity exercise, self-paced exercise).

The physically active and underactive groups reported similar patterns of decreases in fatigue and increases in calmness from baseline. Overall, it appears that both groups experienced similar benefits regarding decreases in fatigue and increases in calmness post-exercise. Our finding that both groups experience increases in calmness and decreases in fatigue post-exercise are consistent with Kwan & Bryan (2010), who found that, on average, calmness decreased during-exercise but significantly increased over baseline at the

post-task assessments. Notably, these findings stand in contrast to experiences of calmness and fatigue. During exercise, which differ among physically active and underactive groups (Magnan et al., 2013). Our findings and those of others suggest that future research should examine intervention efforts focusing on highlighting the de-stressing and energizing benefits that exercise can bring to physically underactive individuals after they finish exercise.

Relief

The findings from the study were also the first to demonstrate that underactive individuals report greater post-exercise relief than active individuals. To the extent relief with stopping exercise is interpreted as a removal of a negative stimulus (i.e., exercise), relief would be expected to predict lower engagement in future physical activity. This finding is consistent with our findings on post-exercise changes in negative activated affect in suggesting that, for physically underactive individuals, the immediate increase improvement in post-exercise affective valence more accurately reflects a sense of relief that the exercise is over, an idea that has been previously suggested but not directly tested (Bixby & Lochbaum, 2006). Differences in relief between the two groups persisted throughout the 30-minute follow-up period and the differences were even larger in the distal time points compared to more immediately post-exercise. In addition, these differences might signal that reported relief reflects a lack of confidence and evaluative concerns about physical exercise among physically inactive individuals (Gammage et al., 2004), in addition to a feeling of relief. In other words, post-exercise relief might be a type of post-behavior evaluation that captures a broader set of thoughts and feelings about the experience of the activity than solely about the physical exercise itself (Kwan et al., 2018).

Limitations

There are important limitations of the current study that need to be considered. First, our study had a relatively small and homogenous sample (i.e., healthy young adults with a normal BMI range, on average). However, we conducted power analyses a priori and were appropriately powered to detect several medium-large sized effects in this study. Nevertheless, we may have been unable to detect other smaller size effects. Due to our homogenous sample, the generalizability of the results may be limited. Future research in larger, more diverse samples should be conducted. For example, it would be interesting to see the extent to which these findings may replicate in individuals who are older, overweight, and in worse health. However, the homogeneity of the sample strengthens confidence that the findings are not related to other variables that are typically different among physically active and underactive individuals (e.g., BMI). A second limitation is the imbalance of male participants between the two groups. Although 31.3% of the physically active group was male, only 4.0% of the physically underactive group was male. Although sex did not moderate any of the reported relationships, there was only 1 male who was physically underactive, limiting the power of the moderation analyses.

A third limitation is that the intensity threshold was based on the percentage of estimated maximum heart rate rather than ventilatory threshold (VT). Although estimated HR is less precise than VT, that pattern of affective responses during and after the exercise that

we observed was consistent with expected affective responses following vigorous activity. For example, we found a pattern of lower FS during exercise for physically underactive individuals compared to physically active individuals and we found that FS increased immediately post-exercise for both groups (Ekkekakis et al., 2011). Fourth, we did not examine the extent to which these differences in post-exercise affective response and post-behavior evaluations are associated with future exercise behavior. Future research should examine whether certain evaluations are more strongly correlated with future exercise behavior than others (e.g., positive activated affect vs. relief). There may also be limited direct clinical implications given that we chose to use vigorous exercise, as underactive individuals may have difficulties engaging in vigorous exercise and may be more likely to choose to engage in moderate exercise instead. Future research should investigate if these findings are applicable at lower intensity exercise. Fifth, we developed the relief measure for use in this study and, although it has clear face validity, the measure did not undergo a thorough validation process. Sixth, it is not clear the extent to which these results would replicate with a longer exercise bout. We chose a relatively short exercise bout (10 minutes) so that underactive individuals could finish the exercise bout. However, it is likely the case that active individuals exercise for longer durations than 10 minutes. While it is possible that the results of this study may change with longer duration exercise bouts, the results of our study are in line with findings of others who used longer durations exercise bouts (e.g., 30 minutes; Kwan & Bryan, 2010; Magnan et al. 2013).

Research Implications and Future Directions

The findings have important implications for the assessment of post-exercise affective response and for how post-exercise affective response following vigorous exercise might influence future behavior. When affective response is assessed only with affective valence, it is reasonable to expect mixed or null effects in predicting future physical activity. Improvements in post-exercise affective valence (e.g., FS scores) would be expected to predict greater physical activity among those who are physically active, but not among those who are underactive because the improvement in affective valence reflects decreases in negative activated affect and greater relief that the exercise was over. Measures of post-exercise affective response that capture distinct affective states considered together with individuals' current physical activity levels may provide clearer tests in predicting future physical activity than affective valence alone. Interestingly, the few studies that have demonstrated significant relations between post-exercise affective experiences and future physical activity have used measures of distinct affective states rather than unidimensional measures of affective valence (Annesi, 2002; Berger & Owen, 1992; Kwan & Bryan, 2010). Future research addressing these issues should consider the specific measure of affective response and the physical activity level of the participants in the study design and analysis.

The findings from this study can also inform the design of interventions targeting affective response among physically underactive individuals. Vigorous physical activity can be particularly unpleasant for individuals who are not physically active (Bixby & Lochbaum, 2006; Lochbaum et al., 2004; Magnan et al., 2013) and our findings suggest the improvement in affective response that occurs post-exercise actually reflects a removal of negative feelings that is unlikely to reinforce future exercise. Rather than

setting-up expectations of feeling good post-exercise, future interventions should focus on improving during-exercise affective response and/or intervening on individuals' post-behavior evaluations (e.g., reflective self-evaluations [Kwan et al., 2018]; remembered affect [Kwan at al., 2018; Kwan et al., 2017; Zenko et al., 2016]) to promote thinking about and evaluating the positive aspects of the exercise. Alternatively, future interventions for physically underactive individuals could highlight that they might experience improved calmness and less fatigue later on.

Availability of data and material:

Raw data were generated at Southern Methodist University. Derived data supporting the findings of this study are available from the corresponding author [MS] on request.

References

Ajzen I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. 10.1016/0749-5978(91)90020-t

ACSM's health-related physical fitness assessment manual. Fourth edition. Philadelphia, Wolters Kluwer.

Annesi JJ (2002). Relationship between changes in acute exercise-induced feeling states, self-motivation, and adults' adherence to moderate aerobic exercise. Perceptual and Motor Skills, 94(2), 425–439. 10.2466/pms.2002.94.2.425 [PubMed: 12027334]

Annesi JJ (2006). Relations of Self-Motivation, Perceived Physical Condition, and Exercise-Induced Changes in Revitalization and Exhaustion with Attendance in Women Initiating a Moderate Cardiovascular Exercise Regimen. Women & Health, 42(3), 77–93. 10.1300/J013v42n03_05

Baldwin AS, Kangas JL, Denman DC, Smits JA, Yamada T, & Otto MW (2016). Cardiorespiratory fitness moderates the effect of an affect-guided physical activity prescription: A pilot randomized controlled trial. Cognitive Behaviour Therapy, 45(6), 445–457. 10.1080/16506073.2016.1194454 [PubMed: 27310568]

Bandura A. (1986). Social foundations of thought and action: A social cognitive theory. Prentice-Hall, Inc.

Bentham Jeremy, 1789 [PML]. An Introduction to the Principles of Morals and Legislation, Oxford: Clarendon Press, 1907.

Berger BG, & Owen DR (1992). Mood alteration with yoga and swimming: Aerobic exercise may not be necessary. Perceptual and Motor Skills, 75(3 suppl), 1331–1343. 10.2466/pms.1992.75.3f.1331 [PubMed: 1484805]

Bixby WR, & Lochbaum MR (2006). Affect responses to acute bouts of aerobic exercise in fit and unfit participants: An examination of opponent-process theory. ResearchGate, 29.

Carlson SA, Fulton JE, Schoenborn CA, & Loustalot F. (2010). Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. American Journal of Preventive Medicine, 39(4), 305–313. 10.1016/j.amepre.2010.06.006 [PubMed: 20837280]

Carpenter LC, Tompkins SA, Schmiege SJ, Nilsson R, & Bryan A. (2010). Affective response to physical activity: Testing for measurement invariance of the physical activity affect scale across active and non-active individuals. Measurement in Physical Education and Exercise Science, 14(1), 1–14. 10.1080/10913670903454952

Center for Disease Control Prevention. (2015). Behavioral risk factor surveillance system survey data. National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity. Data, Trend and Maps.

Cooney G, Dwan K, & Mead G. (2014). Exercise for depression. Jama, 311(23), 2432–2433. [PubMed: 24938566]

Dishman RK, & Buckworth J. (1996). Increasing physical activity: A quantitative synthesis. Medicine &Amp Science in Sports &Amp Exercise, 28(6), 706–719. 10.1097/00005768-199606000-00010

Ekkekakis P. (2003). Pleasure and displeasure from the body: Perspectives from exercise. Cognition & Emotion, 17(2), 213–239. 10.1080/02699930302292 [PubMed: 29715726]

Ekkekakis P, Parfitt G, & Petruzzello SJ (2011). The pleasure and displeasure people feel when they exercise at different intensities: Decennial update and progress towards a tripartite rationale for exercise intensity prescription. Sports Medicine (Auckland, N.Z.), 41(8), 641–671. 10.2165/11590680-000000000-00000 [PubMed: 21780850]

Friese M, Hofmann W, & Wänke M. (2008). When impulses take over: Moderated predictive validity of explicit and implicit attitude measures in predicting food choice and consumption behaviour. British Journal of Social Psychology, 47(3), 397–419. 10.1348/014466607×241540 [PubMed: 17880753]

Gammage KL, Hall CR, & Ginis KAM (2004). Self-presentation in exercise contexts: Differences between high and low frequency exercisers. Journal of Applied Social Psychology, 34(8), 1638–1651.

Gollwitzer PM (1990). Action phases and mind-sets. Handbook of Motivation and Cognition: Foundations of Social Behavior, 2, 53–92.

Gollwitzer PM (2012). Mindset theory of action phases. Handbook of Theories of Social Psychology, 1, 526–545.

Hallgren MÅ, Moss ND, & Gastin P. (2010). Regular exercise participation mediates the affective response to acute bouts of vigorous exercise. Journal of sports science & medicine, 9(4), 629–637. [PubMed: 24149790]

Hardy CJ, & Rejeski WJ (1989). Not what, but how one feels: The measurement of affect during exercise. Journal of Sport and Exercise Psychology, 11(3), 304–317. 10.1123/jsep.11.3.304

Heckhausen H, & Gollwitzer PM (1987). Thought contents and cognitive functioning in motivational versus volitional states of mind. Motivation and Emotion, 11(2), 101–120.

Hofmann W, Friese M, & Wiers RW (2008). Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. Health Psychology Review, 2(2), 111–137. 10.1080/17437190802617668

Kahneman D, Diener E, & Schwartz N. (1999). Well-being: The foundations of hedonic psychology. Russell Sage Foundation.

Kahneman D, Wakker PP, & Sarin R. (1997). Back to bentham? explorations of experienced utility. The Quarterly Journal of Economics, 112(2), 375–406. 10.1162/003355397555235

Kwan BM, & Bryan A. (2010). In-task and post-task affective response to exercise: Translating exercise intentions into behaviour. British Journal of Health Psychology, 15(Pt 1), 115–131. 10.1348/135910709X433267 [PubMed: 19397847]

Kwan BM, Bryan AD, & Sheeran P. (2018). The dynamics of success and failure: How post-behaviour evaluations relate to subsequent exercise intentions and behaviour. Psychology & Health, 33(7), 888–905. [PubMed: 29368959]

Kwan BM, Stevens CJ, & Bryan AD (2017). What to expect when you're exercising: An experimental test of the anticipated affect–exercise relationship. Health Psychology, 36(4), 309. [PubMed: 27991804]

Lochbaum MR, Karoly P, & Landers DM (2004). Affect responses to acute bouts of aerobic exercise: A test of opponent-process theory. Journal of Sport Behavior, 27(4), 330.

Lox CL, Jackson S, Tuholski SW, Wasley D, & Treasure DC (2000). Revisiting the measurement of exercise-induced feeling states: The Physical Activity Affect Scale (PAAS). Measurement in Physical Education and Exercise Science, 4(2), 79–95. 10.1207/S15327841Mpee0402_4

Magnan RE, Kwan BM, & Bryan AD (2013). Effects of current physical activity on affective response to exercise: Physical and social-cognitive mechanisms. Psychology & Health, 28(4), 418–433. 10.1080/08870446.2012.733704 [PubMed: 23088712]

Marshall A, & Bauman A. (2001). The international physical activity questionnaire: Summary report of the reliability & validity studies. IPAQ Executive Committee, 1–25.

McClelland GH (1997). Optimal design in psychological research. Psychological Methods, 2(1), 3. 10.1037/1082-989X.2.1.3

Oman RF, & King AC (1998). Predicting the adoption and maintenance of exercise participation using self-efficacy and previous exercise participation rates. American Journal of Health Promotion, 12(3), 154–161. 10.4278/0890-1171-12.3.154 [PubMed: 10176088]

Parfitt G, Alrumh A, & Rowlands AV (2012). Affect-regulated exercise intensity: Does training at an intensity that feels 'good' improve physical health? Journal of Science and Medicine in Sport, 15(6), 548–553. 10.1016/j.jsams.2012.01.005 [PubMed: 22658587]

Petruzzello SJ, Jones AC, & Tate AK (1997). Affective responses to acute exercise: A test of opponent-process theory. The Journal of Sports Medicine and Physical Fitness, 37(3), 205–212. [PubMed: 9407752]

Prochaska JO, & Velicer WF (1997). The transtheoretical model of Health Behavior Change. American Journal of Health Promotion, 12(1), 38–48. 10.4278/0890-1171-12.1.38 [PubMed: 10170434]

Reed J, & Ones DS (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. Psychology of Sport and Exercise, 7(5), 477–514. 10.1016/j.psychsport.2005.11.003

Rhodes RE, & Kates A. (2015). Can the affective response to exercise predict future motives and physical activity behavior? A systematic review of published evidence. Annals of Behavioral Medicine, 49(5), 715–731. 10.1007/s12160-015-9704-5 [PubMed: 25921307]

Rosenstock IM (1974). The health belief model and Preventive Health Behavior. Health Education Monographs, 2(4), 354–386. 10.1177/109019817400200405

Russell JA (1980). A circumplex model of affect. Journal of Personality and Social Psychology, 39, 1161–1178.

Schneider M, Dunn A, & Cooper D. (2009). Affect, exercise, and physical activity among healthy adolescents. Journal of Sport and Exercise Psychology, 31(6), 706–723. 10.1123/jsep.31.6.706 [PubMed: 20384008]

Solomon RL (1980). The opponent-process theory of acquired motivation: The costs of pleasure and the benefits of pain. American Psychologist, 35(8), 691–712. 10.1037/0003-066x.35.8.691 [PubMed: 7416563]

Tucker JM, Welk GJ, & Beyler NK (2011). Physical activity in U.S.: Adults compliance with the Physical Activity Guidelines for Americans. American Journal of Preventive Medicine, 40(4), 454–461. 10.1016/j.amepre.2010.12.016 [PubMed: 21406280]

United States Department of Health and Human Services, Physical Activity Guidelines Advisory Committee. (2018). Physical Activity Guidelines for Americans, 2nd edition.

Williams DM, Dunsiger S, Jennings EG, & Marcus BH (2012). Does affective valence during and immediately following a 10-min walk predict concurrent and future physical activity?. Annals of behavioral medicine : a publication of the Society of Behavioral Medicine, 44(1), 43–51. 10.1007/s12160-012-9362-9 [PubMed: 22532005]

Zenko Z, Ekkekakis P, & Ariely D. (2016). Can you have your vigorous exercise and enjoy it too? Ramping intensity down increases postexercise, remembered, and forecasted pleasure. Journal of Sport and Exercise Psychology, 38(2), 149–159. [PubMed: 27390185]

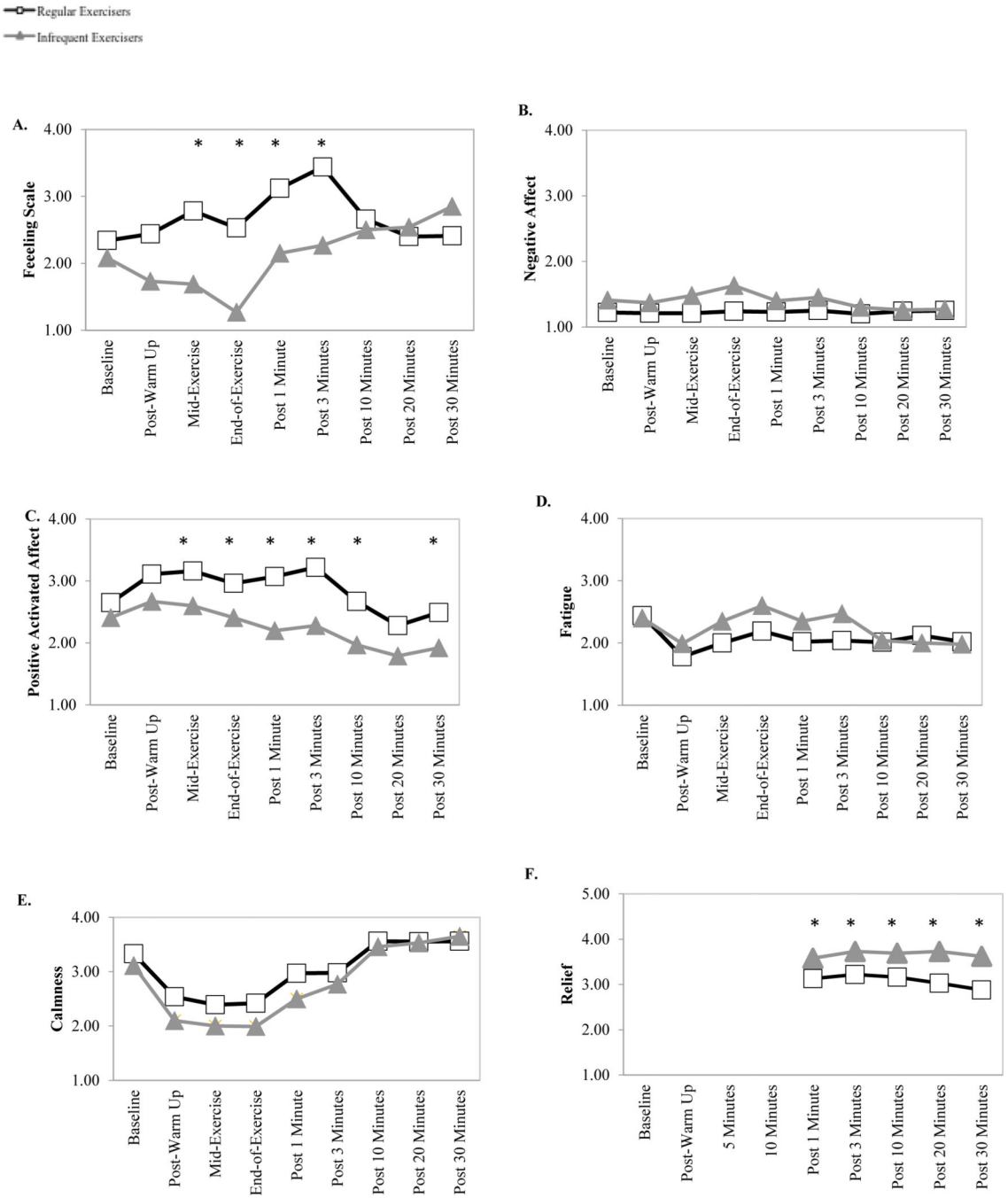

Figure 1.

Affective response during and post-exercise.

Note: Scale range for Feeling Scale is −5 to +5. Scale range for Positive Activated Affect, Negative Activated Affect, Fatigue and Calmness is 0 to 4. Scale range for Relief is 1 to 5. * denotes $p < .05$ for differences between groups

Table 1.

Sample Characteristics and Demographics

	Physically Active (*n* = 32)	**Physically Underactive (*n* = 25)**
Age (M, SD)	19.3 (1.5)	20.3 (2.4)
BMI *(M, SD)*	22.5 (2.0)	22.2 (3.6)
Gender (*n, %*)		
Female	22 (68.9%)	24 (96.0%)
Male	10 (31.3%)	1 (4.0%)
Race (*n, %*)		
White	25 (78.1%)	17 (68.0%)
African-American	0 (0.0%)	3 (12.0%)
Asian	4 (12.5%)	4 (16.0%)
Other	3 (9.4%)	1 (4.0%)
Ethnicity (*n, %*)		
Hispanic	6 (18.8%)	4 (16.0%)
Non-Hispanic	25 (81.3%)	21 (84.0%)
Physical Activity		
MVPA	679.3 (423.2)	12.5 (20.9)

Notes: M = Mean, SD = Standard Deviation; MVPA = Moderate-to-Vigorous Physical Activity.

Table 2.

Changes in affective valence and affective states in physically active and underactive groups from the end of the exercise characterizing the rebound effect.

	FS			NA			PA		
	b (SE)	***d***	***p***	***b (SE)***	***d***	***p***	***b (SE)***	***d***	***p***
1 minute									
Underactive	.92 (.23)	1.06	**<.001**	−.24 (.07)	−.94	**.001**	−.23 (.11)	−.55	**.042**
Active	.59 (.20)	.77	**.005**	−.01 (.06)	−.04	.86	.11 (.10)	.31	.25
Group x Time	−.33 (.31)	−.28	.29	.23 (.09)	.67	**.015**	.35 (.15)	.62	**.024**
3 minutes									
Underactive	1.00 (.25)	1.05	**<.001**	−.19 (.09)	−.55	**.044**	−.13 (.13)	−.27	.301
Active	.91 (.22)	1.09	**.001**	.01 (.08)	.03	.90	.27 (.11)	.63	**.020**
Group x Time	−.09 (.33)	−.07	.78	.19 (.12)	.43	.11	.40 (.17)	.63	**.021**

Note: FS = Feeling Scale; NA = Negative Activated Affect; PA = Positive Activated Affect; *b* = change from the end of the exercise; SE = standard error; Group x Time = Group x Time contrast. The 10-minute during-exercise time point (e.g., end-of-exercise) was used as the reference point. Bolded values reflect significant effects

Table 3.

Changes in affective valence and affective states in underactive and active groups from baseline.

	PA		NA		Fatigue		Calmness	
	b (SE)	***p***	***b (SE)***	***p***	***b (SE)***	***p***	***b (SE)***	***p***
1 minute								
Underactive	−.25(.17)	.15	.00 (.11)	1.00	−.03 (.24)	.91	−.60 (.19)	**.002**
Active	.42 (.15)	**.008**	.01 (.09)	.91	−.42 (.21)	**.050**	−.37 (.16)	**.030**
Group x Time	−.66 (.23)	**.005**	−.01 (.14)	.88	.39 (.31)	.22	−.24 (.25)	.35
3 minutes								
Underactive	.−15 (.17)	.39	.05 (.11)	.63	.11 (.24)	.65	−.36 (.17)	**.040**
Active	.57 (.15)	**<.001**	.03 (.10)	.75	−.40 (.21)	.06	−.35 (.15)	**.023**
Group x Time	−.72 (.23)	**.002**	.02 (.15)	.88	.50 (.31)	.12	−.01 (.23)	.98
10 minutes								
Underactive	−.44 (.16)	**.008**	−.11 (.08)	.20	−.36 (.19)	.07	.40 (.17)	**.02**
Active	.01 (.14)	.94	−.02 (.07)	.77	−.43 (.17)	**.016**	.23 (.15)	.12
Group x Time	−.45 (.21)	**.039**	−.09 (.11)	.43	.07 (.26)	.80	.17 (.22)	.44
20 minutes								
Underactive	−.63 (.16)	**<.001**	−.15 (.09)	.11	−.39 (.20)	.06	.43 (.18)	**.021**
Active	−.38 (.14)	**.011**	.02 (.08)	.79	−.31 (.18)	.08	.22 (.16)	.17
Group x Time	−.25 (.22)	.25	−.17 (.12)	.17	−.07 (.27)	.78	.21 (.24)	.39
30 minutes								
Underactive	−.49 (.17)	**.005**	−.13 (.10)	.18	−.43 (.19)	**.028**	.57 (.20)	**.005**
Active	−.17 (.15)	.27	.03 (.09)	.72	−.42 (.17)	**.015**	.23 (.17)	.19
Group x Time	−.33 (.23)	.16	−.16 (.13)	.22	−.01 (.25)	.97	.34 (.26)	.20

Note: FS = Feeling Scale; NA = Negative Activated Affect; PA = Positive Activated Affect;; b = change from baseline; SE = standard error; Group x Time = Group x Time contrast. The baseline category was used as the reference point. Bolded values reflect significant effect

Table 4.

Mean differences in relief between physically underactive and active groups

	Mean Difference	*t*
1-ninute	.52	2.01*
3-minutes	.58	2.50*
10-minutes	.60	2.79**
20-minutes	.77	2.84**
30-minutes	.81	2.74**

Note:

* p<.05

*** , p<.01. Mean difference reflects differences in relief between physically underactive and active groups, on a 5-point scale

J Behav Med. Author manuscript; available in PMC 2024 March 14.