HHS Public Access
Author manuscript
J Sport Exerc Psychol. Author manuscript; available in PMC 2016 October 01.

Published in final edited form as:
J Sport Exerc Psychol. 2015 October ; 37(5): 534–546. doi:10.1123/jsep.2015-0104.

Examination of the consistency in affective response to acute exercise in overweight and obese women

Jessica L. Unick[1], **Kelley Strohacker**[2], **George Papandonatos**[3], **David Williams**[4], **Kevin C. O'Leary**[1], **Leah Dorfman**[1], **Katie Becofsky**[1], and **Rena R. Wing**[1]

[1]Weight Control and Diabetes Research Center, The Miriam Hospital and Brown Medical School, Providence, RI

[2] Department of Kinesiology, Recreation, and Sport Studies, University of Tennessee, Knoxville, TN

[3]Department of Biostatistics, Brown University

[4]Department of Behavioral and Social Sciences, Brown University, Providence, RI

Abstract

This study examined whether inactive, overweight/obese women experience consistent affective responses to moderate-intensity exercise. Twenty-eight women participated in 3 identical (same treadmill grade and speed within a subject), 30-minute exercise sessions. The Feeling Scale (FS), Positive and Negative Affect Schedule and Subjective Exercise Experience Scale were administered pre- and post-exercise and FS was also administered every 5 minutes during exercise. All measures exhibited less than optimal agreement in pre-to post-exercise change within an individual across the 3 sessions (ICCs=0.02-0.60), even after controlling for within-subject variations in heart rate. Only FS exhibited 'good' consistency when controlling for pre-exercise values (ICC=0.72). However, the mean FS score *during* exercise was highly consistent within an individual (ICC=0.83). Thus an individual's affective response to an exercise session does not provide reliable information about how they will respond to subsequent exercise sessions. Taking the average of FS measurements *during* exercise may yield more consistent findings.

Keywords

physical activity; affect; obesity

Introduction

Acute affective responses to exercise (*e.g.*, pleasure or displeasure, tension or relaxation, energy or tiredness (Ekkekakis, 2013)) have been increasingly studied over the last several decades. Although affective responses have been shown to vary by exercise intensity,

Contact information for Corresponding Author: Jessica Unick, Ph.D., Weight Control and Diabetes Research Center, The Miriam Hospital and Brown Medical School, 196 Richmond Street, Providence, RI 02903, Telephone: 401-793-8966, Fax: 401-793-8944, junick@lifespan.org.

Clinical Trials Identifier: NCT01330329

duration, and subject characteristics (Ekkekakis, Parfitt, & Petruzzello, 2011), countless studies have reported positive shifts in hedonic valence in response to an acute bout of moderate-intensity exercise (Ekkekakis et al., 2011; Ekkekakis & Petruzzello, 1999). Further, investigators have also noted that affective responses *during* exercise may differ from those *following* exercise (Backhouse, Ekkekakis, Bidle, Foskett, & Williams, 2007; Ekkekakis, Hall, & Petruzzello, 2005; Rose & Parfitt, 2007), and thus it is important to examine both pre- to post-exercise changes as well as changes in affect throughout the exercise bout. Additionally, the overwhelming majority of findings from these studies stem from examination of group level means. This is problematic because more recent research has shown that acute affective responses to exercise are highly variable between individuals (Backhouse, Ekkekakis, Bidle, Foskett, & Williams, 2007; K. L. Schneider, Spring, & Pagoto, 2009; Unick, Michael, & Jakicic, 2012).

Van Landuyt, Ekkekakis, Hall, and Petruzzello (2000) was one of the first to examine inter-individual variability in affective responses to exercise and found a striking disparity when comparing group averages and individual affective responses *during* moderate-intensity cycling exercise (using the Feeling Scale; FS [Hardy & Rejeski, 1989]) measured at 5-minute intervals). At the group level there was no change in affective valence when measured during exercise; however only 14% of participants actually had no change in affect. Forty-five percent of participants reported improvements in affective valence and the remaining 41% reported deterioration in affect following exercise. This individual variability in affective response to exercise has been noted by others (Rose & Parfitt, 2007; Welch, Hulley, Ferguson, & Beauchamp, 2007) and these individual responses have also been linked to important health behaviors. For example, subjects with more favorable affective responses during or following an acute exercise bout also exhibited greater short- and long-term exercise adherence (M. Schneider, Dunn, & Cooper, 2009; D. M. Williams, Dunsiger, Jennings, & Marcus, 2012; D.M. Williams et al., 2008) and consumed fewer calories post-exercise compared to those who have less favorable affective responses to exercise (K. L. Schneider, Spring, & Pagoto, 2009; Unick, Michael, & Jakicic, 2012). However, these studies which have linked exercise-induced affective responses to important health behaviors are limited in that they have relied on the measurement of affective changes following a single exercise bout. This is of concern because it is not yet known whether an individual's affective response to exercise changes from day to day. For example, if affective responses to exercise prove to be inconsistent, future studies may want to assess affect at multiple time points at baseline and use that as a composite measure to predict future health behaviors.

Similarly, there is a large body of research which seeks to understand how affect is influenced by exercise and how these affective responses may differ by various demographic variables, exercise intensities, or modes of exercise. To date, the overwhelming majority of these studies have either utilized a single exercise session or a within subjects cross-over design comparing affective responses between two different exercise bouts (*e.g.*, low vs. high intensity exercise). However again, the usefulness of these study findings hinge on a question that has been unaddressed to date: if an individual experiences a change in affect following a single bout of exercise on one occasion (as measured via the traditional laboratory paradigm), will this individual experience the same change in affect if he/she engaged in an identical exercise bout at a later time point? Understanding the consistency (or inconsistency) of affective response to exercise is not only important for interpreting previous research findings, but also for designing future studies. For example, if an individual's affective response to a single exercise bout is not a consistent characteristic, it may be less important to investigate *who* experiences positive or negative changes in affect with exercise, and more important to investigate the *circumstances* that facilitate pleasurable versus unpleasurable exercise experiences within an individual.

It is reasonable to hypothesize that individuals may not respond uniformly in terms of affective responses to the same repeated exercise stimulus. This could be due to several factors. First, researchers have suggested that perception of exercise is not a passive process, but an active one where internal (e.g., ventilation, muscular strain) and external (e.g., environment, distractions) factors can interact to influence how one feels (Rejeski, 1985). Second, theory suggests that affective responses to a stimulus or behavior may shift with repetition. For example, according to the mere exposure effect (Zajonc, 2001), affective responses to exercise may become more positive over time as a participant becomes more familiar with the exercise stimulus, as well as the physical and social setting of the exercise laboratory. Conversely, participants may become bored with repetition of the exercise protocol which could lead to negative shifts in affective response.

Therefore, this study examined whether affective responses during exercise and following a single exercise session result in consistent and similar responses *within* an individual if assessed at a later time point. To answer this question, participants completed 3 identical (i.e., same duration, treadmill speed, and treadmill grade per individual) moderate-intensity exercise sessions, each separated by at least 1 week. This study focuses on overweight and obese, inactive women, a population who may be more likely to experience displeasurable responses to exercise (Ekkekakis & Lind, 2006; Ekkekakis, Lind, & Vazou, 2010), but also a subset of individuals who may be most likely to benefit from regular exercise. Further, few studies have investigated the affective responses to exercise in overweight/obese sedentary individuals, despite these individuals being most representative of the 'average' adult population (Ekkekakis, Parfitt, & Petruzzello, 2011). While the best measurement methods for assessing affect remain controversial (Ekkekakis, 2013; Ekkekakis & Petruzzello, 2001; Lox, Jackson, Tuholski, Wasley, & Treasure, 2000), a handful of questionnaires and measurement methods continue to be widely utilized (Ekkekakis, Parfitt, & Petruzzello, 2011). This paper focuses on three of these commonly used measures: 1) Feeling Scale (FS), 2) Positive and Negative Affect Schedule (PANAS), and 3) Subjective Exercise Experience Scale (SEES). Further, we examine whether individuals can be reliably classified based upon their pre- to post-exercise or during exercise changes in affect (*e.g.,* increase, decrease or no change in affect).

Methods

Participants

Individuals responded to flyers for the parent study, which was advertised as “a study to examine how exercise and eating affect the way one thinks and feels”. To be eligible, participants had to be female, between the ages of 18 and 45, and have a BMI of 25 to <35kg/m^2. All participants reported being inactive (<60 min/wk of moderate-intensity exercise), weight stable (± 10 lbs over past 6 months) and relatively healthy (*e.g.*, free of heart disease and diabetes, not taking any medications that would alter heart rate (HR) or metabolism, and no reported orthopedic conditions that would impact exercise). Subjects provided written consent and study procedures were approved by the site’s Institutional Review Board.

Study Overview

The current paper presents a secondary analysis from the parent study, which examined the consistency in compensatory eating responses to exercise. All participants completed an initial assessment visit, 3 exercise testing days, and 3 resting testing days. Study details have been published previously (Unick et al., 2015). Only methods and measures relevant to the current research question are described below.

During the initial assessment visit, height and weight were measured, body composition was assessed using bioelectrical impedance (RJL Systems, Clinton Township, MI), and subjects completed a submaximal graded exercise test (GXT) to 75% of age-predicted maximal HR. The American College of Sports Medicine’s prediction equations for the energy expenditure of walking were used to estimate the exercise workload [i.e., metabolic equivalent (MET) value] at each stage and at test termination (American College of Sports Medicine, 2010). Maximal fitness (measured in METs) was estimated by extrapolating the HR/MET relationship to the person’s age-adjusted maximal HR. Heart rate data collected during the GXT was used to approximate the starting treadmill grade for each individual’s first exercise session. Further, the GXT served as a means of acclimating participants to walking on the treadmill in a laboratory setting.

Following the assessment visit, participants reported to the laboratory for 3 exercise testing sessions, all consisting of identical study procedures. Each exercise session was separated by 1-2 weeks and all exercise sessions were performed at the same time of day (±30 min) and in the morning hours (08:15 to 10:15). Prior to each exercise session, subjects were instructed to fast overnight and upon arrival at the laboratory, they were provided with a standardized meal replacement bar (210 kcals, 47% CHO, 26% fat, 27% protein) which was consumed 45 minutes prior to exercise. Participants completed the SEES and PANAS approximately 30 minutes prior to the start of exercise and immediately following each exercise bout. The FS was assessed before, during (at 5 minute intervals), and 5 minutes following the cessation of exercise (see descriptions below).

Exercise Sessions

During the first of three exercise sessions, subjects walked on a treadmill for 30 minutes at 3.0 mph and at a grade that elicited a HR between 70-75% of age predicted maximal HR. This exercise duration and intensity was chosen because it is consistent with the American College of Sports Medicine's exercise guidelines, it is feasible and often prescribed for inactive and overweight/obese individuals (Carnero et al., 2014; Donnelly et al., 2013), and it is at the upper end of the moderate-intensity range and thus likely to result in greater changes in cardiorespiratory fitness if continued over time (American College of Sports Medicine, 2010). The starting treadmill grade for each participant was estimated using HR data from the GXT. Heart rate was monitored every minute via Polar HR monitors and the grade of the treadmill was adjusted appropriately if the subject's HR fell outside the target HR range for two consecutive minutes. If the subject's HR was above the target HR range at a 0% treadmill grade, the speed of the treadmill was also reduced. Any adjustments made to the grade or speed of the treadmill were noted so that an identical exercise protocol could be employed during the second and third exercise sessions (i.e., changes in speed/grade from session 1 were duplicated in sessions 2 and 3, regardless of HR response). Ratings of perceived exertion (RPE) were assessed every 5 minutes during exercise using Borg's 6-20 RPE scale and 15 seconds prior to the end of the exercise bout (Borg & Linderholm, 1967).

Measures of Affective Response

Numerous questionnaires and measures exist for assessing affective responses to exercise. Previously, investigators have discussed the strengths and weaknesses of each of these measures, including those used within the present study (Ekkekakis, 2013; Ekkekakis & Petruzzello, 2001). Although each measure has limitations, we chose to use three of the most widely used measures (FS, PANAS, SEES), each of which are described in detail below.

Feeling scale—The FS is a single measure of the valence dimension of affect (Hardy & Rejeski, 1989) and was administered immediately prior to the start of exercise, every 5 minutes during exercise, and 5 minutes post-exercise. Participants rated how they felt "at the present moment" using the 11-point FS which ranges from −5 (very bad) to +5 (very good). The FS has been used as a measure of affective valence in a number of physical activity studies (for a review, see [Ekkekakis, 2003]), has been shown to be related to other measures of affective valence (Hall, Ekkekakis, & Petruzzello, 2002), and is distinct from ratings of perceived exertion (Hardy & Rejeski, 1989). Pilot testing by other researchers demonstrates correlations ranging from 0.51 to 0.81 with the Valence scale of the Self Assessment Manikin and from 0.41 to 0.59 with the Valence scale of the Affect Grid (Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). In the current study, pre- to post-exercise changes in FS scores were calculated for each exercise bout, as well as the mean FS response throughout the exercise session.

Positive and negative activated affect—Positive activated and negative activated affect (Feldman Barrett & Russell, 1998; Watson, Wiese, Vaidya, & Tellegen, 1999) were measured pre- and post-exercise using the PANAS (Watson, Clark, & Tellegen, 1988), which is a 20-item measure that lists affect-related adjectives and asks participants to relate how they are feeling "right now". The responses cluster into two, 10-item subscales for positive activated affect and negative activated affect, with scores ranging from 10-50 for each subscale. Positive activated affect reflects affective states that are positive in valence (i.e., good) and high in activation, such as enthusiastic and alert, whereas negative activated affect includes affective states that are negative in valence (i.e., bad) and high in activation, such as distressed and irritable. Higher scores indicate greater positive activated affect and greater negative activated affect. The PANAS has been shown to exhibit excellent reliability with Cronbach's alpha coefficients ranging from 0.86-0.90 for the positive affect scale and 0.84-0.87 for the negative affect scale (Watson, Clark, & Tellegen, 1988).

Subjective exercise experience—The Subjective Exercise Experience Scale (SEES) is a 12-item questionnaire that was specifically designed to assess subjective responses to exercise (McAuley & Courneya, 1994). Participants were asked to indicate "how they are feeling right now", using a 7-point Likert scale, pre- and post-exercise. Responses cluster into 3 subscales: positive well-being (*e.g.*, great or positive), psychological distress (*e.g.*, miserable or discouraged), and fatigue (*e.g.*, tired or exhausted). Scores for each subscale range from 4-28, with higher scores indicating more positive well-being, greater psychological distress, and greater feelings of fatigue. The positive well-being subscale has been shown to be highly correlated (r=0.71) with PANAS-positive affect and the psychological distress subscale is correlated (r=0.61) with PANAS-negative affect (McAuley & Courneya, 1994). All three subscales of the SEES have demonstrated excellent reliability (0.84-0.92).

Statistical Analyses

Random intercept linear mixed effects models estimated via restricted maximum likelihood (REML) as implemented in the Splus 8.2 statistical software package (TIBCO Software Inc, 2010) were used to test whether mean HR and mean RPE during exercise differed across the 3 exercise sessions. Intraclass correlation coefficients (ICC) were used to examine whether mean HR or mean RPE during one exercise session produced a consistent response *within* an individual across the other exercise sessions.

Paired samples t-tests were used to examine whether the FS, PANAS, and SEES measures changed from pre- to post-exercise for each exercise session. Random intercept linear mixed effects models were used to assess whether any FS, PANAS, or SEES subscales differed across the 3 exercise sessions. To examine the consistency in affective responses to exercise, pre- to post-exercise changes in all six measures (FS, PANAS-positive activated affect, PANAS-negative activated affect, SEES-positive well-being, SEES-psychological distress, and SEES-fatigue) were computed and ICCs were calculated to examine whether the pre- to post-exercise change on one exercise session was consistent within an individual across the other exercise sessions, with and without controlling for pre-exercise affective level, mean HR, and mean RPE. To examine the consistency in FS during exercise, the mean FS throughout each 30-minute exercise session was computed and an ICC was calculated. For this analysis, a higher ICC value (range 0.0-1.0), indicates greater reliability of the measure.

Of note, reliable measurement is usually associated with ICC>0.75 (Streiner & Norman, 1995), a level that may be hard to reach with a single observation. However, reliability increases in a predictable manner with repeated measurement according to the Spearman-Brown prophecy formula: ICC(N)=N*ICC(1)/[1+(N-1)*ICC(1)], where ICC(N), is the reliability of the average of N measurements (Stanley, 1971). Hence, if the reliability of a single measurement falls short of the 0.75 threshold, one can at least calculate how many additional observations would be needed to either meet or exceed this threshold.

For each of our measures, individuals were additionally classified based upon whether they experienced an increase (*e.g.*, $affect_{pre} < affect_{post}$), decrease (*e.g.*, $affect_{pre} > affect_{post}$), or no change (*e.g.*, $affect_{pre} = affect_{post}$) from pre- to post-exercise. For FS, participants were also classified into one of three categories (i.e., increase, decrease, no change) based upon their FS response at 5, 15, and 25 minutes into the exercise bout, in relation to pre-exercise levels. A Fleiss kappa coefficient (range 0.0 – 1.0) was calculated for each measure to indicate the degree to which individuals fell into the same category (*e.g.*, ‘increase’, ‘decrease’, ‘no change’) across the three exercise sessions (Fleiss, 1971). Kappa values <0.40 indicate "poor" agreement, values between 0.40 and 0.59 indicate “fair” agreement, values between 0.60 and 0.74 indicate "good" agreement and values between 0.75 and 1.00 indicate “excellent” agreement (Cicchetti, 1994). Based on these guidelines, we will assume that kappa coefficients >0.60 indicate that a particular categorization is consistent within persons across the three pairs of trials (Cicchetti, 1994). All values are reported as means ± SD. Statistical significance was set at $p<0.05$.

Results

Subjects

Twenty-eight women completed all 3 exercise sessions and thus were included in the analyses. On average, participants were 33.1 ± 9.6 years of age, had a BMI of 30.3 ± 2.9 kg/m^2, had a body fat percentage of 37.9 ± 5.4%, and 61% were Caucasian. Maximal fitness was estimated to be 8.4 ± 1.6 METs.

Exercise Session Details

Each subject completed 3 identical exercise bouts in which the treadmill speed (between-subjects mean = 2.92±0.14 mph), treadmill grade (between-subjects mean = 2.16±1.98%), and estimated energy expenditure (between-subjects mean = 172.6±39.8 kcals) were held constant within individuals across the 3 trials, with the goal of achieving a HR of 70-75% of age-predicted maximal HR (HR_{max}). While the study was designed to ensure that participants exercised at the same absolute intensity (*i.e.*, same treadmill grade and speed) across the three sessions, this meant that that there was a possibility that the relative exercise intensity *(i.e.*, HR) could vary within an individual. Analyses revealed that averaged across participants, the mean HR for Sessions 1 through 3 was 72.3±1.8%, 70.0±3.6%, and 70.6±5.4% of age predicted HR_{max} respectively, with Sessions 1 and 2 differing significantly from one another (p=0.001). The ICC for the mean HR *within* an individual across the 3 exercise sessions was 0.69. Similar analyses were repeated for RPE. Averaged across participants, the mean RPE for Sessions 1 through 3 was 12.0±2.0, 11.3±2.0, and 11.3±2.3 respectively, with Session 1 being statistically different from the other two sessions *(p*<0.05). Further, there was ‘excellent’ agreement (ICC = 0.77) in RPE *within* an individual across the 3 exercise sessions.

Group-level Affective Responses to Exercise

Table 1 presents the pre- and post-exercise FS, PANAS, and SEES scores for each exercise session. These group-level means suggest that PANAS-positive activated affect increased from pre- to post-exercise on Sessions 2 and 3 (*p’s*<0.05) and there was a trend for SEES-positive well-being to also increase from pre- to post-exercise (*p’s* = 0.06-0.08). There was no pre- to post-exercise change for the remaining measures. Further, there was no evidence of between-session differences in pre- to post-exercise change scores across the 3 exercise sessions for all measures assessed (*p*’s>0.05). In addition to examining pre- to post-exercise changes, participants reported their FS response every 5 minutes during exercise and responses are shown in Table 2. In general, FS scores decreased following the start of exercise and began to rise again nearing the end of the exercise bout.

Consistency in Affective Responses to Exercise *within* an Individual

Table 3 presents the ICCs for pre- to post-exercise changes in all measures of affect, with and without controlling for pre-exercise values. Unadjusted ICC’s ranged from 0.02-0.60, thus all falling below the threshold for ‘excellent consistency’ (ICC ≥ 0.75). This suggests that for most individuals, using a single session to examine pre- to post-exercise changes will not result in consistent affective responses if assessed at a later time point when the FS, PANAS, and SEES are used. The ICCs were relatively unaltered after adjusting for mean HR and RPE during the exercise bout (results not presented). However, after adjusting for pre-exercise values in the analyses, the ICC increased for all measures of affect. Nonetheless, ICCs remained well-below the threshold for ‘excellent’ consistency, with only the ICC for the FS (ICC=0.72) nearing this threshold.

In addition to assessing the consistency in pre- to post-exercise change scores, the FS also assessed affective valence in 5-minute increments *during* exercise. Findings reveal that the mean FS score averaged across the entire exercise session exhibited ‘excellent’ consistency within an individual across all 3 sessions both with (ICC=0.76) and without controlling for pre-exercise scores (ICC=0.83).

Classification of an Individual Based Upon Their Affective Response to Exercise

Individuals were characterized based upon whether they reported an increase, decrease, or no change on the FS, PANAS, and SEES measures from pre- to post-exercise or at intermediate time points (*e.g.*, 5 min, 15 min, etc.) during exercise. The percentage of participants falling into these categories for each exercise session is displayed in Table 4. Although there was ‘no change’ at the group level for the majority of affect measures (Table 1), a large proportion of individuals reported an ‘increase’ or ‘decrease’ for PANAS-negative activated affect (45.3%), SEES-psychological distress (41.7%), SEES-fatigue (82.2%), and FS (59.5%); thus not following the pattern of the mean.

An additional aim was to examine the consistency in this classification structure (i.e., if an individual reported an increase in positive affect from pre- to post-exercise on Session 1, did she also report an increase in positive affect on Sessions 2 and 3). As shown in Table 4, there was a lack of consistency for all measures of affect, as indicated by low Kappa coefficients (Kappa range = 0.03 – 0.48). In fact, the percentage of participants classified into the same category on *all* 3 sessions was low for PANAS-positive activated affect (28.6%), PANAS-negative activated affect (35.7%), SEES-positive well-being (28.6%), and SEES-fatigue (14.3%), but slightly higher for SEES-psychological distress (46.4%) and the FS (50.0%).

Similar analyses were conducted to examine whether individuals consistently fell within the same category (i.e., increase, decrease, no change) across all 3 exercise sessions when assessed using the FS at 5, 15, and 25 minutes into the exercise bout. Again, the low Kappa coefficients (range: 0.15 – 0.40) suggest little consistency in this classification structure. The percentage of participants classified into the same category on all 3 sessions was also low: 32% at 5 minutes, 29% at 15 minutes, and 43% at 25 minutes.

Discussion

This study assessed affective responses to exercise in inactive, overweight and obese women using three, moderate-intensity exercise bouts that were identical, in that they were performed at the same absolute intensity within an individual, for the same duration and at the same time of day. Study findings indicate that an individual's affective response to a single exercise session does not provide reliable information about how they will respond to subsequent exercise sessions. This lack of consistency was also observed even after controlling for within-person variability in pre-exercise affect levels as well as the relative intensity and perceptual response to the exercise bouts (i.e., HR and RPE). Further, these data suggest that using a single exercise session to classify an individual based upon their pre- to post-exercise change in affect (i.e., increase, decrease, or no change) will not result in a similar classification if assessed at a later time point. In fact, at most, half of all participants fell into the same category for all 3 exercise sessions.

Although there is some debate in the field regarding the best measurement tool to assess changes in affect (Ekkekakis, 2013; Ekkekakis & Petruzzello, 2001; Lox, Jackson, Tuholski, Wasley, & Treasure, 2000), there is evidence to suggest that the examination of pre- to post-exercise changes may elicit biased results given that some participants may feel very different *following* exercise (*e.g.*, relieved) versus how they felt *during* exercise (Backhouse, Ekkekakis, Bidle, Foskett, & Williams, 2007; Ekkekakis et al., 2005). Thus, it is also important to examine whether affective responses during exercise are consistent within an individual. Findings from the current study indicate that the mean FS score throughout the exercise session exhibited "excellent" consistency within an individual. This suggests that taking the mean FS response during a single exercise session would likely result in a similar response if that individual were assessed again at a later time point using the same exercise stimulus. Additionally, FS responses at any given 5-minute interval during exercise also exhibited 'good' to 'excellent' consistency (ICCs ranging from 0.69-0.85) within an individual.

The current findings also demonstrate that one's affective state prior to exercise may influence the consistency in the pre- to post-exercise change within an individual. For example, when pre-exercise affect was controlled for in the analyses, the ICC substantially increased for the FS, SEES, and PANAS measures. This finding is consistent with previous studies demonstrating the importance of controlling for baseline affect when assessing affective response to exercise (Ekkekakis, 2013). However in the current study, even after controlling for pre-exercise levels, only the FS exhibited decent agreement within an individual across the 3 exercise sessions, with the remaining measures exhibiting poor agreement.

Whenever affective responses to exercise are assessed, especially in a laboratory setting, there is always the possibility that participant responses to the initial exercise session are influenced by either the novelty of the exercise itself or the novelty of exercising in a foreign environment. However in the current study, it is important to note that all participants attended an initial assessment visit in which they underwent a graded exercise test to 75% of their HR_{max}, prior to Session 1. Thus, this should have familiarized participants with walking on the treadmill in a laboratory setting, prior to the start of the testing sessions. Further, we conducted several exploratory analyses to rule out the possibility that Session 1 was more of an 'acclimation trial', particularly given that mean HR and RPE during Session 1 were found to be slightly higher than that observed in Sessions 2 or 3. When ICCs were computed, controlling for within subject differences in HR and RPE, the results were unaltered. Moreover, we examined the ICCs for Sessions 2 and 3 only to rule out the possibility that Session 1 served as an ‘acclimation trial’. When Session 1 was removed from the analyses, ICCs ranged from 0 to 0.54, with the ICCs for all measures still falling well below the threshold for 'excellent' consistency. For these reasons, we do not believe that Session 1 served as an 'acclimation trial' in the current study. Nonetheless, when designing future studies researchers should always consider whether the use of an ‘acclimation trial’ is appropriate.

An important clinical application to consider is how the current findings may impact the interpretation of previous studies or the design of future studies in this area of research. Based upon our data, it may still be appropriate to utilize a single exercise bout to examine affective responses to exercise when the research question at hand is primarily focused on understanding group-level differences. However, for studies which seek to examine the individual variability in affective responses to exercise or to explore characteristics of individuals who respond in one manner (*e.g.*, increase in positive affect from pre to post-exercise) versus those who respond in the opposite manner (*e.g.*, decrease in positive affect), the current data suggest that an individual’s affective response to a single exercise session does not provide reliable information about how they will respond if assessed at a later time point using an identical exercise stimulus. This may suggest that future studies should also begin to investigate the circumstances that lead to pleasurable versus unpleasurable affective states *within* a person. However, for researchers who remain interested in understanding the differences between individuals who generally experience favorable vs. unfavorable changes in affect in response to exercise, an alternative approach would be to measure individuals on several occasions and take the average across sessions, which will result in more reliable estimates. Appendix 1 (which can be viewed online as a Supplementary file) can be used to calculate the number of exercise sessions that would be needed, dependent upon the assessment tool used. For example, the average of two exercise sessions would be needed to ensure that the pre- to post-exercise change score for the FS was reliable (Appendix 1, Table b, ICC=0.84 after controlling for pre-exercise values). However, for PANAS-negative activated affect, three sessions would be needed (Appendix 1, Table c, ICC=0.81 after controlling for pre-exercise values).

This study also provided a unique opportunity to examine the between-subjects variability in affective response to a moderate-intensity exercise bout in overweight/obese women, significantly contributing to the scant body of literature in this area. While group-level data revealed that PANAS-positive activated affect and SEES-positive well-being were modestly increased from pre- to post-exercise, with no change in any of the other measures assessed, individual-level findings seem to suggest that a different conclusion may be in order. Take for example the pre- to post-exercise change in the FS as measured during Session 1. At the group level, there was no change from pre- to post-exercise; however further examination of the individual data revealed that 32.1% of participants reported an increase in the FS while 39.3% reported a decrease. Thus, the smallest proportion of individuals (28.6%) followed the pattern described by the group mean (i.e., no change from pre- to post-exercise), which is similar to Van Landuyt et al. (Van Landuyt et al., 2000), despite the very different subject sample utilized by both studies (normal weight, university students who exercised regularly vs. inactive, overweight/obese women).

This study was strengthened by the use of a rigorous methodology which utilized 3 identical exercise sessions (as opposed to 2), a tightly controlled laboratory design which assessed changes in affect both pre- and post-exercise as well as during exercise, and the use of three commonly employed measures for assessing affective responses to exercise (versus using just one measure). However, it is not without limitations. First, given that the study sample consisted of inactive, overweight/obese women, it is unclear whether these findings would generalize to other populations, especially given that previous studies have demonstrated that overweight and inactive individuals experience more displeasure in response to acute exercise compared to more active and normal weight samples (*e.g.*, college students) (Ekkekakis & Lind, 2006; Hulens, Vansant, Claessens, Lysens, & Muls, 2003; Petruzzello, Hall, & Ekkekakis, 2001; Welch, Hulley, Ferguson, & Beauchamp, 2007). Further, the lack of familiarity with exercise in this population could have contributed to the lack of consistency in affective responses observed. It is possible that if this study were repeated after several weeks or months of exercise training (i.e., when the novelty of exercise was no longer present), that the affective responses to exercise may have been more or less consistent within an individual across sessions. Second, previous research has suggested that there is greater individual variability in affective responses to exercise between individuals when the exercise intensity is near one's ventilatory threshold (Ekkekakis et al., 2005). However, the current study did not assess the ventilatory threshold and the exercise intensity was set relative to an individual's age-predicted HR_{max} (which has some inherent limitations). Therefore, it is possible that these inactive participants were exercising at or near their ventilatory threshold, particularly given that the exercise was performed at the upper end of the moderate-intensity range (*i.e.*, 70-75% HR_{max}), and this may have contributed to the large degree of inter-individual variability observed. Further, it is unclear whether there may have been less or greater consistency within an individual if the exercise were performed at a different intensity (*e.g.*, below or above one's known ventilatory threshold). This should be examined in future studies. Third, there is the possibility that the differences observed in the ICCs between the SEES, PANAS, and FS may have been due to scaling differences between measures. For example, the FS consists of a smaller range of potential values (i.e., integer steps in the range from −5 to +5) whereas the PANAS scores may fall within a relatively larger range (*e.g.*, integer steps in the range of 10-50 for PANAS-positive affect). Hence, it is possible that the considerably higher ICC observed for the FS is an artifact of having fewer options to choose from in regards to rating affective responses and that an incremental change of 1-point on the FS may be more 'consequential' than a 1-point change on PANAS-activated affect. Given this possibility, we conducted exploratory analyses that examined whether rounding the larger scales (*e.g.*, PANAS-positive activated affect rounded to the nearest multiple of ten [i.e., 10, 20, 30, 40, 50]) significantly changed the ICC, compared to when these values were not rounded. Results suggest that the magnitude of bias due to the range of possible integer values in the scale (*e.g.*, 10-50 vs. −5 to +5) is likely very small. Finally, given previous criticisms of several of the affect measures used in this study (Ekkekakis, 2013; Ekkekakis & Petruzzello, 2001), we cannot rule out the possibility that measurement error, not true variability within a person, was responsible for the lack of consistency observed in pre- to post-exercise changes in affect within an individual.

In conclusion, this study demonstrates that affective responses to moderate-intensity exercise are not consistent within inactive, overweight/obese women when assessed using three identical exercise bouts. This suggests that even when using a tightly controlled laboratory paradigm (*e.g.*, all sessions were performed at the same time of day, in the same exercise facility, using identical exercise protocols, and with prior energy intake controlled for, etc.), an individual's affective response to exercise varied from session to session. Therefore, if individual-level (not group-level) responses to exercise are of greatest interest to an investigator, it may be advantageous to consider using multiple exercise sessions so that the average of these sessions can be utilized to characterize an individual's affective response to exercise. Further, the inconsistency in affective responses observed in the current study suggest that it may not be as important for future research to investigate *who* experiences positive or negative changes in affect, but rather an additional focus of research should be on understanding which circumstances may facilitate pleasurable versus unpleasurable exercise experiences *within* an individual, as this may help to improve rates of exercise adherence and favorably impact other health behaviors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

This research was funded by a grant awarded to Dr. Unick from the National Cancer Institute (1R03CA162965-01A1).

References

American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 8. Wolters Kluwer/Lippincott Williams & Wilkins; Philadelphia: 2010.

Backhouse SH, Ekkekakis P, Bidle SJ, Foskett A, Williams C. Exercise makes people feel better but people are inactive: Paradox or artifact? Journal of Sport & Exercise Psychology. 2007; 29:498–517. [PubMed: 17968050]

Borg GV, Linderholm H. Perceived exertion and pulse rate during graded exercise in various age groups. Acta Medica Scandinavica. 1967; 472(Suppl.):194–206.

Carnero EA, Amati F, Pinto RS, Valamatos MJ, Mil-Homens P, Sardinha LB. Regional fat mobilization and training type on sedentary, premenopausal overweight and obese women. Obesity (Silver Spring). 2014; 22:86–93. doi:10.1002/oby.20568. [PubMed: 23836493]

Cicchetti D. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychological Assessment. 1994; 6:284–290. doi: 10.1037/1040-3590.6.4.284.

Donnelly JE, Honas JJ, Smith BK, Mayo MS, Gibson CA, Sullivan DK. Aerobic exercise alone results in clinically significant weight loss for men and women: Midwest exercise trial 2. Obesity (Silver Spring). 2013; 21:E219–228. doi: 10.1002/oby.20145. [PubMed: 23592678]

Ekkekakis P. Pleasure and displeasure from the body: Perspectives from exercise. Cognition and Emotion. 2003; 17:213–239. doi: 10.1080/02699930302292.

Ekkekakis, P. The measurement of affect, mood, and emotion: A guide for health-behavioral research. Cambridge University Press; New York: 2013.

Ekkekakis P, Hall EE, Petruzzello SJ. Variation and homogeneity in affective responses to physical activity of varying intensities: An alternative perspective on dose-response based on evolutionary considerations. Journal of Sports Sciences. 2005; 23:477–500. doi:10.1080/02640410400021492. [PubMed: 16194996]

Ekkekakis P, Lind E. Exercise does not feel the same when you are overweight: The impact of self-selected and imposed intensity on affect and exertion. International Journal of Obesity (London). 2006; 30:652–660. doi:10.1038/sj.ijo.0803052.

Ekkekakis P, Lind E, Vazou S. Affective responses to increasing levels of exercise intensity in normal-weight, overweight, and obese middle-aged women. Obesity (Silver Spring). 2010; 18(1):79–85. doi:10.1038/oby.2009.204. [PubMed: 19556979]

Ekkekakis P, Parfitt G, Petruzzello SJ. 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. 2011; 41:641–671. doi: 10.2165/11590680-000000000-00000. [PubMed: 21780850]

Ekkekakis P, Petruzzello SJ. Acute aerobic exercise and affect: Current status, problems and prospects regarding dose-response. Sports Medicine. 1999; 28:337–374. doi: 0112-1642/99/0011-0337. [PubMed: 10593646]

Ekkekakis P, Petruzzello SJ. Analysis of the affect measurement conundrum in exercise psychology. III. A conceptual and methodological critique of the Subjective Exercise Experiences Scale. Psychology of Sport and Exercise. 2001; 4:202–232. doi:10.1016/S1469-0292(01)00022-X.

Feldman Barrett L, Russell JA. Independence and bipolarity in the structure of current affect. Journal of Personality and Social Psychology. 1998; 74:967–984. doi:10.1037/0022-3514.74.4.967.

Fleiss JL. Measuring nominal scale agreement among many raters. Pscyhological Bulletin. 1971; 76:378–382. doi:10.1037/h0031619.

Hall EE, Ekkekakis P, Petruzzello SJ. The affective beneficence of vigorous exercise revisited. British Journal of Health Psychology. 2002; 7:47–66. [PubMed: 14596717]

Hardy CJ, Rejeski WJ. Not what, but how one feels: The measurement of affect during exercise. Journal of Sport & Exercise Psychology. 1989; 11:304–317.

Hulens M, Vansant G, Claessens AL, Lysens R, Muls E. Predictors of 6-minute walk test results in lean, obese and morbidly obese women. Scandinavian Journal of Medicine & Science in Sports. 2003; 13:98–105. doi: 10.1034/j.1600-0838.2003.10273.x. [PubMed: 12641641]

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

McAuley E, Courneya CA. The subjective exercise experiences scale (SEES): Development and preliminary validation. Journal of Sport & Exercise Psychology. 1994; 16:163–177.

Petruzzello SJ, Hall EE, Ekkekakis P. Regional brain activation as a biological marker of affective responsivity to acute exercise: Influence of fitness. Psychophysiology. 2001; 38:99–106. doi: 10.1111/1469-8986.3810099. [PubMed: 11321625]

Rejeski WJ. Perceived exertion: An active or passive process. Journal of Sport Psychology. 1985; 7:371–378.

Rose EA, Parfitt G. A quantitative analysis and qualitative explanation of the individual differences in affective responses to prescribed and self-selected exercise intensities. Journal of Sport & Exercise Psycholology. 2007; 29(3):281–309.

Schneider KL, Spring B, Pagoto SL. Exercise and energy intake in overweight, sedentary individuals. Eating Behaviors. 2009; 10:29–35. doi:10.1016/j.eatbeh.2008.10.009. [PubMed: 19171314]

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

Stanley, J. Reliability. In: Thorndike, RL., editor. Educational Measurement. Second. American Council on Education; Washington DC: 1971.

Streiner, D.; Norman, G. Health measurement scales: A practical guide to their development and use. Oxford University Press; New York: 1995.

TIBCO Software Inc.. TIBCO Spotfire SPLUS 8.2 for Solaris/Linux User's Guide. TIBCO Software Inc.; Palo Alto, CA: 2010.

Unick JL, Michael JC, Jakicic JJ. Affective responses to exercise in overweight women: Initial insight and possible influence on energy intake. Psychology of Sport and Exercise. 2012; 13:528–532. doi:10.1016/j.psychsport.2012.02.012. [PubMed: 24039545]

Unick JL, O'Leary KC, Dorfman L, Thomas JG, Strohacker K, Wing RR. Consistency in compensatory eating responses following acute exercise in inactive, overweight and obese women. British Journal of Nutrition. 2015; 113:1170–1177. doi: 10.1017/S000711451500046X. [PubMed: 25778833]

Van Landuyt LM, Ekkekakis P, Hall EE, Petruzzello SJ. Throwing the mountains into the lakes: On the perils of nomothetic conceptions of the exercse-affect relationship. Journal of Sport & Exercise Psychology. 2000; 22:208–234.

Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology. 1988; 54:1063–1070. doi: 10.1037/0022-3514.54.6.1063. [PubMed: 3397865]

Watson D, Wiese D, Vaidya J, Tellegen A. The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. Journal of Personality and Social Psychology. 1999; 76:820–838. doi:10.1037/0022-3514.76.5.820.

Welch AS, Hulley A, Ferguson C, Beauchamp MR. Affective responses of inactive women to a maximal incremental exercise test: A test of the dual-mode model. Psychology of Sport and Exercise. 2007; 8:401–423. doi:10.1016/j.psychsport.2006.09.002.

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

Williams DM, Dunsinger S, Ciccolo JT, Lewis BA, Albrecht AE, Marcus BH. Acute affective response to a moderate-intensity exercise stimulus predicts physical activity participation 6 months and 12 months later. Psychology of Sport and Exercise. 2008; 9:231–245. doi:10.1016/j.psychsport.2007.04.002. [PubMed: 18496608]

Zajonc RB. Mere exposure: A gateway to the subliminal. Current Directions in Psychological Science. 2001; 10:224–228. doi:10.1111/1467-8721.00154.

Author Manuscript

Author Manuscript

Author Manuscript

Table 1

Description of Group-level, Affective Responses to Exercise

	Pre-exercise	Post-exercise	Pre- to post-exercise change	p-value for pre-to post-exercise change	Session effect
Feeling Scale					0.06
Session 1	2.64±1.5	1.93±1.8	−0.71±2.1	0.75	
Session 2	2.25±1.5	2.14±1.9	−0.11±1.7	0.63	
Session 3	2.23±1.7	2.21±2.0	−0.11±1.2	0.71	
PANAS – positive activated affect					0.28
Session 1	24.8±9.5	26.9±9.7	2.2±7.5	0.14	
Session 2	21.4±8.1	25.5±10.7	4.1±6.5	0.002	
Session 3	21.7±10.2	24.0±11.1	2.3±5.2	0.03	
PANAS – negative activated affect					0.96
Session 1	11.2±1.8	11.3±2.5	0.1±2.0	0.71	
Session 2	11.0±1.5	11.3±2.5	0.3±2.1	0.47	
Session 3	11.2±2.4	11.4±2.7	0.2±2.1	0.60	
SEES – positive well-being					0.93
Session 1	15.0±5.3	17.0±5.5	2.0±5.8	0.08	
Session 2	13.6±5.4	15.2±6.2	1.6±4.3	0.06	
Session 3	12.7±6.6	14.4±7.1	1.7±4.6	0.06	
SEES – psychological distress					0.77
Session 1	7.7±5.8	6.5±4.2	−1.2±5.7	0.27	
Session 2	6.6±4.0	5.8±4.0	−0.8±4.8 [a]	0.35	
Session 3	6.6±4.8	6.2±4.3	−0.4±3.6	0.56	
SEES - fatigue					0.96
Session 1	10.5±6.4	10.8±5.2	0.3±7.5	0.84	
Session 2	10.3±5.9	10.1±6.0	−0.2±5.6	0.87	
Session 3	9.2±6.5	9.3±6.5	0.1±4.4	0.93	

Repeated measures ANOVAs assessed whether the pre- to post-exercise change scores differed across the 3 sessions (‘Session effect’).

Table 2

Description of Group-level Feeling Scale Scores throughout Exercise

	Pre-ex	5 min	10 min	15 min	20 min	25 min	30 min	Mean during exercise*
Session 1 mean±SD	2.64±1.5	2.11±1.3	2.00±1.6	1.71±1.9	1.64±2.0	1.86±2.1	2.11±2.2	1.90±1.6
Session 2 mean±SD	2.25±1.5	2.07±1.5	2.00±1.6	2.04±1.6	1.82±2.1	1.96±2.1	2.11±2.4	2.00±1.8
Session 3 mean±SD	2.23±1.7	2.04±1.8	1.89±1.8	1.93±2.1	1.86±2.2	1.79±2.5	1.96±2.4	1.91±2.0
ICC: Sessions 1 thru 3	0.60	0.72	0.77	0.69	0.81	0.85	0.85	0.76

*Mean during exercise was computed as the sum of the FS scores measured at minutes 5, 10, 15, 20, 25, and 30 divided by 6.

Table 3

Examination of the Reliability of Pre- to Post-Exercise Change Scores

	ICC (Across all 3 sessions)	**Adjusted ICC* (Across all 3 sessions)**
Feeling Scale	0.60	0.72
PANAS – Positive Affect	0.38	0.46
PANAS – Negative Affect	0.27	0.58
SEES – Positive Well-Being	0.36	0.42
SEES – Psychological Distress	0.22	0.54
SEES – Fatigue	0.02	0.39

ICC = Intraclass correlations;

*controlling for pre-exercise score

Table 4

Classification of Participants Based upon their Pre- to Post-exercise and During Exercise Change in Affect

	Increase	Decrease	No change	Kappa
Pre- to post-exercise change				
Feeling Scale				
Session 1	9 (32.1%)	11 (39.3%)	8 (28.6%)	
Session 2	8 (28.6%)	6 (21.4%)	14 (50%)	
Session 3	8 (28.6%)	8 (28.6%)	12 (42.9%)	
Consistent across Sessions 1-3[‡]	3 (10.7%)	5 (17.9%)	6 (21.4%)	0.48
PANAS – positive affect				
Session 1	14 (50%)	14 (50%)	0 (0%)	
Session 2	19 (67.9%)	6 (21.4%)	3 (10.7%	
Session 3	18 (64.3%)	6 (21.4%)	4 (14.3%)	
Consistent across Sessions 1-3[‡]	8 (28.6%)	0 (0%)	0 (0%)	0.05
PANAS – negative affect				
Session 1	8 (28.6%)	7 (25.0%)	13 (46.4%)	
Session 2	5 (17.9%)	5 (17.9%)	18 (64.3%)	
Session 3	8 (28.6%)	5 (17.9%)	15 (53.6%)	
Consistent across Sessions 1-3[‡]	2 (7.1%)	1 (3.6%)	7 (25.0%)	0.26
SEES – positive well-being				
Session 1	16 (57.1%)	11 (39.3%)	1 (3.6%)	
Session 2	14 (50.0%)	7 (25.0%)	7 (25.0%)	
Session 3	14 (50.0%)	8 (28.6%)	6 (21.4%)	0.17
Consistent across Sessions 1-3[‡]	5 (17.9%)	3 (10.7%)	6 (21.4%) 0 (0%)	0.17
SEES – psychological distress				
Session 1	5 (17.9%)	8 (28.6%)	15 (53.6%)	
Session 2	4 (14.3%)	10 (35.7%)	14 (50.0%)	
Session 3	3 (10.7%)	5 (17.9%)	20 (71.4%)	
Consistent across Sessions 1-3[‡]	3 (10.7%)	0 (0%)	10 (35.7%)	0.35
SEES – fatigue				
Session 1	15 (53.6%)	12 (42.9%)	1 (3.6%)	
Session 2	10 (35.7%)	10 (35.7%)	8 (28.6%)	
Session 3	12 (42.9%)	10 (35.7%)	6 (21.4%)	
Consistent across Sessions 1-3[‡]	1 (3.6%)	2 (7.1%)	1 (3.6%)	0.03
During exercise change*				
Feeling Scale (5 min)				
Session 1	5 (17.9%)	14 (50%)	9 (32.1%)	
Session 2	1 (3.6%)	6 (21.4%)	21 (75.0%)	
Session 3	2 (7.1%)	7 (25%)	19 (67.9%)	
Consistent across Sessions 1-3[‡]	0 (0%)	1 (3.6%)	8 (28.6%)	0.15

	Increase	Decrease	No change	Kappa
Feeling Scale (15 min)				
Session 1	6 (21.4%)	16 (57.1%)	6 (21.4%)	
Session 2	5 (17.9%)	8 (28.6%)	15 (53.6%)	
Session 3	4 (14.3%)	9 (32.1%)	15 (53.6%)	
Consistent across Sessions 1-3[‡]	1 (3.6%)	3 (10.7%)	4 (14.3%)	0.21
Feeling Scale (25 min)				
Session 1	8 (28.6%)	14 (50.0%)	6 (21.4%)	
Session 2	7 (25.0%)	8 (28.6%)	13 (46.4%)	
Session 3	6 (21.4%)	10 (35.7%)	12 (42.9%)	
Consistent across Sessions 1-3[‡]	2 (7.1%)	6 (21.4%)	4 (14.3%)	0.40

n(%);

[*]During exercise change was calculated at 5, 15, and 25 minutes into the exercise bout, in relation to the pre-exercise Feeling Scale value.

[‡]These data represent the n(%) of individuals who fell into the same category across all 3 sessions.