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Exercise Makes People Feel Better But People Are Inactive: Paradox or Artifact?

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The exercise psychology literature includes an intriguing, albeit not frequently discussed, paradox by juxtaposing two conclusions: (a) that exercise makes most people feel better and (b) that most people are physically inactive or inadequately active. In this article, we propose that this might be an artifact rather than a paradox. Specifically, we question the generality of the conclusion that exercise makes people feel better by proposing that (a) occasional findings of negative affective changes tend to be discounted, (b) potentially relevant negative affective states are not always measured, (c) examining changes from pre- to postexercise could miss negative changes during exercise, and (d) analyzing changes only at the level of group aggregates might conceal divergent patterns at the level of individuals or subgroups. Data from a study of 12 men participating in a 90-min walk–run protocol designed to simulate the demands of sports games (e.g., soccer) are used to illustrate these points.

Key Words: physical activity, adherence, pleasure, affect, circumplex, methodology

The literature dealing with the affective changes that accompany single bouts of exercise, now spanning more than 35 years, supports the consensus that “exercise makes you feel better” (Fox, 1999, p. 413; also see Biddle, 2000; Morgan, 1985). This message emanates from nearly all literature reviews and textbooks and, consequently, this is what is being disseminated to students, exercise practitioners, the media, and the public. The frequency with which this conclusion has been repeated and the definitive tone in which it has been stated for so many years, however, might have produced some unintended consequences. These include a lack of systematic

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attention to other aspects of the—by most indications—complex and multifaceted relationship between exercise and affect.

One issue that has arisen as a by-product of having limited the focus on the "feel-better" effect is the apparent incongruity between the notion that "exercise makes people feel better" on the one hand and the high rates of physical inactivity on the other. If exercise indeed had the touted "feel-better" effect, and only this effect, would two thirds of adults (Jones et al., 1998) avoid regular exercise? This is certainly not the case with other activities that most people find pleasant, such as eating when hungry, resting after a tiring day, or engaging in sexual relationships. Considerable evidence from fields as diverse as social psychology (Emmons & Diener, 1986), behavioral economics (Kahneman, 1999; Loewenstein & Lerner, 2003; Mellers, 2004), and neuroscience (Bechara, Damasio, & Damasio, 2000; Damasio, 1996) shows that affect plays a central role in human decision making. Preliminary data suggest that the same might also hold true for the decision to engage in exercise behavior (Berger & Owen, 1992; Carels, Berger, & Darby, 2006; Kiviniemi, Voss-Humke, & Seifert, 2007; Williams et al., in press). Usually (though not always) people tend to gravitate toward behavioral choices that make them feel better. On the contrary, they tend to avoid options that make them feel worse or those that, even if somewhat pleasant, cannot compete successfully with other, more pleasant alternatives.

Although the contradiction between "exercise makes people feel better" and "people are inactive" is puzzling, it is not frequently discussed. In one of the few cases in which the issue was directly addressed, Morgan and O'Connor (1988) expressed the opinion that the inconsistency might be more apparent than real because "it is quite probable that many or most individuals who discontinue exercise programs do so even though they too enjoy an improved mood state following exercise" (p. 116). Specifically, they estimated that 50% drop out even though "roughly 80 to 90%" of exercise participants feel better. The source of the estimate that 80 to 90% of exercise participants feel better appears to be based on anecdotal accounts collected after a 6-week exercise intervention from a sample of healthy male professors (Morgan, Roberts, Brand, & Feinerman, 1970). This intervention failed to lower depression. Nevertheless, approximately 85% of the participants "spontaneously volunteered to participate in subsequent exercise studies" because they reported that they "felt better" (p. 216). These figures (80–90% or 85%) have since been cited several times (Dishman, 1982; Morgan, 1981, 1982). However, their validity seems questionable given the known susceptibility of informal retrospective accounts to a variety of biases (Henry, Moffitt, Caspi, Langley, & Silva, 1994).

Therefore, it seems that the need for a convincing resolution of the apparent paradox remains. One possibility is that exercise can produce other affective changes, beyond the "feel-better" effect, including changes that are unpleasant. Likewise, it is possible that the "feel-better" effect is not as generalized as Morgan and O'Connor (1988) suggested. A perusal of the portrayal of exercise in the popular media would suggest that this is not a far-fetched possibility. Marketing messages are replete with suggestions that, with the consumption of various concoctions or use of various contraptions, weight loss or other health and fitness benefits could be achieved without the need for "painful" or "uncomfortable" exercise. Here, we consider four factors that might have played a role in maintaining the research focus solely on the "feel-better" effects of exercise over the years. These factors pertain to every aspect of the research process, including the conceptualization, methods, and interpretation of data.

Issue Number 1: It's Not There If We Don't Talk About It

The study of the relationship between exercise and affect has been typically approached with an emphasis on its implications for mental health; only recently has the focus been expanded to include the implications of this relationship for motivation and adherence. Given this emphasis, the issue has usually been framed as whether a bout of exercise can improve how people feel compared with their preexercise state, regardless of when this happens or what other changes might precede it. Thus, occasional findings of transient changes in a negative direction did not receive substantive attention, as long as, eventually, there were positive changes from baseline. For example, findings of increased state anxiety scores during vigorous exercise, because they were followed by "a sudden decrease in state anxiety during the postexercise recovery period," were characterized as reflecting a "*eustress* rather than *stress*" reaction (Morgan & Ellickson, 1989, p. 172; for the typical definition of the term *eustress*, namely, "pleasant or curative stress," see Selye, 1976, p. 466). Likewise, it has been said that these transient increases in state anxiety "delay, but do not eliminate, postexercise anxiety reductions" (Raglin, 1997, p. 117).

It is important to recognize that these examples (and others) essentially reflect an interpretational choice. Of the two observed phenomena, namely, the during-exercise increase and the postexercise decrease in state anxiety scores, only the positive one has been treated as important. Similarly, it is also noteworthy that all mechanistic hypotheses that have been proposed as underlying the exercise–affect relationship (e.g., Morgan, 1985) deal with the phenomena of "affective beneficence" or "exercise-induced anxiolysis," even though these are not the only aspects of the relationship that research has uncovered.

Issue Number 2: It's Not There If We Don't Measure It

The assessment of affective responses to exercise has been and continues to be a hotly debated issue within exercise psychology. This is not surprising given the multitude of available measurement options and the degree of dependence of the knowledge-development process upon the measures being used. Obviously, knowledge about the affective changes that accompany exercise bouts can reflect only the affective variables that have been assessed, not the ones that have not. Therefore, the extent to which a measure offers comprehensive coverage of the content domain of interest is critical, particularly in descriptive studies (e.g., studies investigating dose–response effects). Domain underrepresentation (i.e., a measure missing certain relevant sectors of the affective domain) could lead to erroneous generalizations (e.g., that no affective change occurred when a change actually did occur, albeit in a sector of the affective domain not tapped by the measure).

Until the mid-1990s, information on the exercise–affect relationship was based mainly (although not exclusively) on the assessment of seven distinct variables, namely: the six mood states tapped by the Profile of Mood States (i.e., tension, depression, anger, vigor, fatigue, and confusion; McNair, Lorr, & Droppleman,

1971) and state anxiety, as measured by the state anxiety subscale of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970). However, as Morgan pointed out in 1984, because "the extent to which these inventories can tap the psychometric domain of significance to the exerciser has not been evaluated," it follows that "an investigator may employ an objective, reliable, valid test of anxiety or depression to quantify the psychologic effects of exercise only to find that no 'effects' have taken place when, in fact, there may have been numerous effects" (p. 134).

Since the mid-1990s, many researchers have adopted questionnaires consisting of items selected to be relevant and, therefore, sensitive specifically to the stimulus properties of exercise. These are the Exercise-Induced Feeling Inventory (EFI; Gauvin & Rejeski, 1993), the Subjective Exercise Experiences Scale (SEES; McAuley & Courneya, 1994), and the Physical Activity Affect Scale (PAAS; Lox, Jackson, Tuholski, Wasley, & Treasure, 2000). The PAAS was the result of a merger of scales from the EFI and the SEES. However, questions have been raised about the extent to which the structure and item content of these measures can capture the full "psychometric domain of significance to the exerciser" (e.g., Ekkekakis & Petruzzello, 2000).

Notably, the development samples that were used in the item generation and content validation phases of these questionnaires consisted of young and healthy college students, limiting the generalizability of the domain of content reflected in the final item pool. Presumably, affective responses would reflect the great diversity of exercisers (e.g., elderly, overweight), exercise stimuli (e.g., painful, toilsome), and exercise conditions (e.g., medically prescribed, performed in socially evaluative conditions). Thus, the assumption that the domain of content considered relevant by a select sample would reflect "the phenomenology of people involved in exercise in the real world" (Gauvin & Rejeski, 1993, p. 408) might not be tenable. Likewise, it seems precarious to assume that, despite the complexity of the interactions among exercisers, exercise stimuli, and exercise environments, "the primary forms of affect that are directly influenced by physical activity" (Rejeski, Reboussin, Dunn, King, & Sallis, 1999, p. 98) ultimately amount to no more than a handful of distinct states (such as positive engagement, revitalization, tranquility, and physical exhaustion).

It is important to point out that positively and negatively valenced items that are accompanied by unipolar response scales cannot have a perfect negative correlation and, thus, do not produce redundant information (Russell & Carroll, 1999). In other words, it is impossible to infer what *negative* changes might have occurred (e.g., an increase in tension) simply from the absence of or the reduction in *positive* responses (e.g., a decrease in tranquility). Thus, unless the measure directly taps the negative responses that accompany a given bout of exercise, one might assume that no such responses occurred. For example, in studies involving previously sedentary adults (Gauvin, Rejeski, Norris, & Lutes, 1997) or older, obese patients with knee osteoarthritis (Focht, Gauvin, & Rejeski, 2004), researchers could only comment on the absence of widespread positive effects. Whether any negative effects beyond physical exhaustion were also present could not be directly assessed from the measures that were used and remained unknown.

It is also important to note that tiredness or fatigue (states tapped by the Physical Exhaustion scale of the EFI, or the Fatigue scale of the POMS, SEES, and PAAS) probably do not suffice to capture the entire range of negatively valenced states induced by exercise. As several studies have recently shown, exercise intensities that exceed the ventilatory or lactate threshold produce a response characterized by unpleasant high activation (Ekkekakis, Hall, & Petruzzello, 2004; Hall, Ekkekakis, & Petruzzello, 2002; Parfitt, Rose, & Burgess, 2006), an affective state not tapped by any of the measures developed to be sensitive to what were presumed to be the stimulus properties of exercise.

Issue Number 3: It's Not There If We Miss It When It Happens

The vast majority of the studies conducted before the 1990s, and many conducted since, assessed affect only before and at various time points after the exercise bout—not during. By this point, this practice has become so common that most researchers do not question it or feel compelled to provide a rationale for it. Upon reflection, there are probably three reasons that might have contributed to the propagation of this practice.

First, most popular self-report measures of affective variables used in exercise psychology consist of multiple items (from 12 to 65). Furthermore, it is not uncommon for two or three such measures to be administered within the same study. Thus, it is possible that repeated administrations of multi-item questionnaires during exercise were deemed impractical or were suspected of causing such problems as acting as a distraction, irritating the participants, or prompting response carryovers. Although these are valid methodological concerns, by limiting the sampling of the affective response to "before" and "after" time points, they might have also precluded the more complete description of the trajectory of the response (i.e., what changes intervened between "before" and "after" the bout).

Second, it is possible that, consistent with Issue Number 1, many researchers did not have a substantive interest in the entire trajectory of the affective response but were rather preoccupied with demonstrating robust postexercise improvements in affect. This again seems problematic because, presumably, the phenomenon of interest is the affective response to exercise in its entirety. We are unaware of specific arguments that the during-exercise and postexercise phases of the response constitute distinct phenomena. To the contrary, we are aware of credible suggestions that the postexercise phase of the response is fundamentally dependent upon processes initiated during exercise (e.g., as postulated in the opponent–process model; Solomon, 1991).

Third, it is possible that the decision to sample the affective response only before and after exercise reflects the assumption that any change taking place in the interim would be linear. Two points can only define a straight line. So, assuming that the accurate representation of the shape of the affective response is the goal, it would not seem appropriate to limit sampling to only these two time points unless researchers believed that affect would change in a linear fashion from pre- to postexercise. However, it has been shown that moderate-intensity exercise (in some individuals) and high-intensity exercise (in nearly all individuals) can cause a decrease in pleasure during the bout, followed by a rapid and robust rebound during the first few seconds or minutes after the bout is terminated (e.g., Bixby, Spalding, & Hatfield, 2001; Hall et al., 2002; Parfitt et al., 2006; Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). Even when the workload is continuously adjusted to maintain oxygen uptake at a steady state, pleasure can show a quadratic (i.e., nonlinear) decline over the course of the bout (followed by a precipitous rebound upon termination; see Acevedo, Gill, Goldfarb, & Boyer, 1996). Given this pattern, it is possible that changes assumed to have been the direct result of the exercise itself (e.g., a decrease in tension from before to after vigorous exercise) more accurately reflected the effects of the *cessation* of exercise (i.e., took place during the short period of time that intervened between the end of the bout and the postexercise assessment, typically including the removal of measurement instruments, a cool-down, or both).

A compelling demonstration of the interpretational pitfalls associated with pre-to-post assessment protocols was presented by Bixby et al. (2001). They showed that, although responses to a visual analogue scale measuring pleasure–displeasure were not significantly different before and after bouts of stationary cycling performed at or below the ventilatory threshold, with both intensities leading to postexercise improvements, the response trajectories *during* the bouts were significantly different. The intensity below the ventilatory threshold led to a significant during-exercise increase in pleasure, whereas the intensity at the ventilatory threshold led to a significant during-exercise decrease. Clearly, had this study protocol lacked the assessments during exercise, the results from the pre-to-post comparisons would have painted a very different picture (Figure 1).

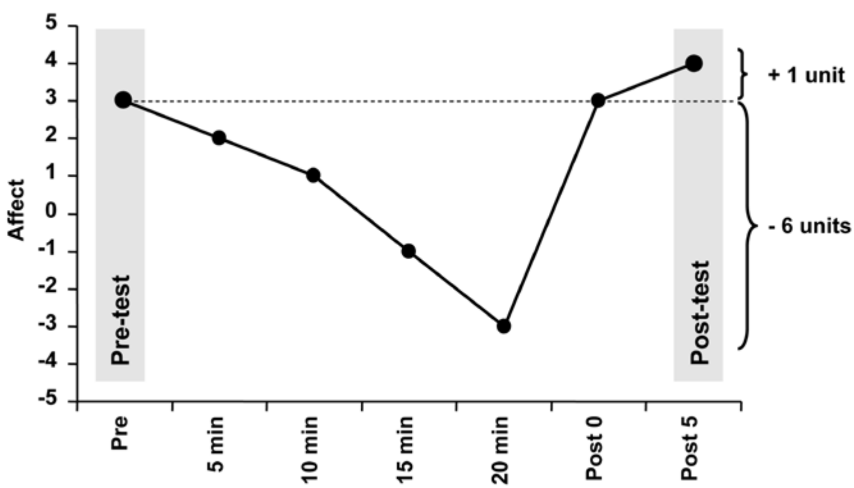

Figure 1 — Hypothetical illustration of the different conclusions that could be drawn from a sampling protocol limited to pre- and postexercise assessments of affect (i.e., 1-unit improvement) and another involving multiple during-exercise assessments (i.e., 6-unit during-exercise decrease, followed by 7-unit postexercise rebound). For actual empirical illustrations, see Bixby et al. (2001) and Hall et al. (2002).

Both as the intensity of exercise increases (e.g., Ekkekakis et al., 2004; Hall et al., 2002) and as the duration progresses (e.g., Acevedo et al., 1996; Bixby et al., 2001; Parfitt et al., 2006), affect responds in a dynamic fashion (i.e., it changes, often nonlinearly). At this point, there is no empirical evidence that the changes during exercise (in either a positive or a negative direction) are any less influential for shaping a participant's motivation for future participation than the postexercise state (although the postexercise phase of the affective response might last longer). Therefore, to fully understand the dynamics of the affective response to an exercise bout, repeated assessments during and after the bout seem necessary.

Parenthetically, it should be noted that, in other domains of psychological research, when the goal is to study the experiences generated during episodes lasting for several minutes, repeated sampling, most commonly with single-item rating or visual analogue scales, is the norm. The rationale presented in these literatures is entirely consistent with the argument presented here, namely that, because experiences could change dynamically, it would be impossible for a pre-to-post assessment protocol to capture the shape and diversity of response profiles over time. Examples come from areas as diverse as the study of marital interactions (Gottman & Levenson, 1985), medical procedures (Redelmeier & Kahneman, 1996), panic induction (Feldner, Zvolensky, Eifert, & Spira, 2003), or binge eating (Deaver, Miltenberger, Smyth, Meidinger, & Crosby, 2003).

Admittedly, sampling affect more frequently (i.e., several times during exercise bouts typically lasting for 15–30 min) does pose methodological challenges. As noted, multi-item measures become less practical as sampling frequency increases. In some situations, such as during incremental exercise tests, during which affect should be sampled at least once during each stage (typically lasting 1 to 4 min), multi-item measures are not a realistic option. On the other hand, single-item measures, such as the Feeling Scale (Hardy & Rejeski, 1989), permit sampling with excellent "temporal resolution" (even every 1 min), but, because scores are based on a single response, they are more susceptible to random measurement error (i.e., unreliability) than are multi-item measures. There is no perfect solution, so compromises should be sought that produce measurements that are reasonably reliable and valid while also yielding complete and accurate representations of the entire trajectory of the affective response, during and after the exercise bout.

Issue Number 4: It's Not There If Our Analyses Don't Show It

The final issue refers to the way of dealing with interindividual differences in exercise-induced affective changes. Unlike most other affect-induction procedures, which typically produce changes in the same direction (i.e., either toward pleasure or toward displeasure) among different individuals, albeit perhaps to varied degrees, exercise can produce positive affective changes in some but negative affective changes in other individuals. This is so even if the exercise stimulus is of the same mode, duration, and intensity and the participants are of the same gender, age, and health or fitness level. An analysis of these individual trends has shown that interindividual variability is reduced when the intensity of exercise is either low (when most individuals report positive affective changes) or high (when most individuals report negative affective changes) but is quite prevalent over a fairly broad range of intensities between these two extremes (Ekkekakis, Hall, & Petruzzello, 2005a).

The problem that this phenomenon creates is twofold. First, if one subsample of participants reports a positive change over time, whereas another subsample reports a negative change of equal magnitude over the same period, the analysis of change at the level of the group aggregate would indicate, falsely, that the exercise produced no change in affect. This problem was highlighted in a study by Van Landuyt et al. (2000), in which approximately 40% of the participants reported a gradual improvement in affective valence over the course of 30 min of cycling at 60% of estimated maximal aerobic capacity, whereas another 40% reported a gradual decline. These two divergent trends led to a seemingly unchanged group average during the bout, even though this did not represent more than a very small portion of the sample. Combined with the finding of a robust, unified positive trend once the bout ended, this aggregate-level pattern of change could have led to the conclusion that this type of exercise has a positive, and only positive, effect.

Secondly, inattention to individual response patterns can potentially impede knowledge development. It is reasonable to assume that these individual differences, at least to some extent, are nonrandom but are, instead, of possible psychological significance, reflecting the effects of situational appraisals (e.g., McAuley, Talbot, & Martinez, 1999) or relevant traits (e.g., Ekkekakis, Hall, & Petruzzello, 2005b). For these reasons, analyses of change should complement the traditional focus on changes at the level of group aggregates with an examination of patterns at the level of individuals or subgroups.

An Empirical Illustration

To summarize the points made above, the strong emphasis on the "feel-better" effects of exercise as the singular aspect of the exercise–affect relationship could have come about as a result of (a) researchers not having a substantive interest in nonpositive effects, thus downplaying their significance when they occur; (b) the measures that are used not reflecting the full range of affective responses to exercise; (c) the sampling protocols missing the dynamic affective changes in response to the exercise itself and only depicting postexercise changes; and (d) the inattention to changes at the level of individuals or subgroups that might be incongruent with those of other individuals or subgroups, particularly *during* exercise.

Here, we provide an empirical illustration of these points, with the intention of demonstrating that affective responses to exercise are dynamic and multifaceted, exhibiting a richness that extends beyond the "exercise makes people feel better" phenomenon. Because typical laboratory-based exercise stimuli (i.e., continuous activity, at a steady intensity, over a relatively short period of time) tend to be rather poor models of real-world activity patterns, we opted to use an activity that involves repeated fluctuations in intensity and metabolic demands. We selected a test designed to simulate the activity pattern of sports games that involve repeated shuttle runs interspersed with brief periods of rest over a prolonged duration (i.e., primarily soccer, but also basketball). The test is called the Loughborough Intermittent Shuttle Test (LIST: Nicholas, Nuttall, & Williams, 2000).

The selection of this test was guided mainly by two considerations. One was that sports games whose activity patterns are characterized by intermittent shuttle running are a substantial part of "exercise in the real world," even though their affective consequences have not received much research attention. According to data from the 1991 National Health Interview Survey (United States Department of Health and Human Services, 1996), 10.5% of adult men reported participation in basketball during the previous 2 weeks, 2.7% participated in football, and 1.4% in soccer. Collectively, these numbers are comparable to the percentage of those who reported participation in jogging or running (12.8%) and aerobics (2.8%). In Britain, according to data from the 1998 Health Survey for England (United Kingdom Department of Health, 1998), sport participation contributed 8% of the hours per week spent in physical activity among adults (men and women). Soccer and rugby made up 9% of these occurrences, a number equal to aerobics (9%) and not much lower than running (13%).

The second consideration was the varied nature of the physiological demands that the test itself and the activities it was designed to simulate entail. Specifically, we presumed that the LIST might induce at least two qualitatively distinct types of "fatigue," one associated with rate limitations (i.e., energy systems not being able to keep up with the demand) and one associated with the prolonged nature of the test (e.g., increase in core temperature, possible dehydration and hypoglycemia, accumulation of metabolic by-products, and the effects of repeated impacts on the skeletal and muscular system). Although research involving fatigue of the former type, as noted earlier, has already shown that its characteristic affective "signature" consists of an increase in perceived activation coupled with a decrease in pleasure (Ekkekakis et al., 2004; Hall et al., 2002), the affective "signature" of the latter type has not been established, as previous studies of prolonged exercise focused on only the pleasure–displeasure component of affective experience (e.g., Acevedo et al., 1996).

Our method was also characterized by the following features. Firstly, we chose to employ a broad, dimensional operationalization of affect. In contrast to categorical models of affect, which consider each affective state as a distinct entity, dimensional models assume that affective states are systematically interrelated, such that their similarities and differences can be modeled parsimoniously by as few as two basic dimensions (Ekkekakis & Petruzzello, 2000; Gauvin & Brawley, 1993). In this study, we employed the circumplex model of affect (Russell, 1980), which has been used in several recent studies in the exercise psychology literature (Ekkekakis & Petruzzello, 2002). According to this model (Figures 2 and 4a), the global affective space can be defined by two orthogonal and bipolar dimensions, namely, affective valence (pleasure–displeasure) and perceived activation (low–high). Depending on the extent to which they denote valence and activation, individual affective states can be represented as occupying various locations on the perimeter of the circle defined by these two dimensions, with similar states (e.g., happy, glad) situated close to each other and antithetical states (e.g., happy, sad) situated across from each other. Thus, the dimensions of valence and activation divide the circumplex space into four quadrants: (1) high–activation pleasant affect, which is characterized by energy or excitement; (2) high–activation unpleasant affect, characterized by tension or distress; (3) low–activation unpleasant affect, characterized by fatigue or depression; and (4) low–activation pleasant affect, characterized by calmness or relaxation.

The main advantage of the circumplex, which makes it an appropriate choice for the present study, is its broad scope (theoretically, representing a map of the entire domain of affect, providing equal coverage to pleasant and unpleasant states) in conjunction with its parsimony (requiring the assessment of only two variables).

Of course, the breadth of scope and parsimony come with the unavoidable loss of some specificity. Although the circumplex can provide a meaningful indication of the general phenomenological nature of the affective responses to various exercise stimuli in studies with a descriptive aim, delineating their exact nature (e.g., the difference between anxiety and anger) is beyond its reach. For this, follow-up research must adopt a categorical approach (Ekkekakis & Petruzzello, 2002).

Secondly, we employed repeated assessments of the circumplex dimensions over the course of the test. As noted previously, compared with pre-to-post assessments, this sampling protocol can provide a more complete depiction of the trajectory of affective responses to exercise over time.

Thirdly, in addition to analyzing change at the group level, we present the changes reported by individual participants. By doing so, we intend to illustrate the possible incongruence between aggregate-level and individual-level response patterns.

Method

Participants. Twelve recreationally active men (*M* ± *SEM*; age 20.8 ± 0.5 years; height 175 ± 2 cm; body mass 74.7 ± 2.5 kg; VO_{2max} 57.5 ± 1.3 $mL·kg^{-1}·min^{-1}$) volunteered to participate. They all read and signed an informed consent form approved by a university ethics advisory committee.

Measures. The affective valence and perceived activation dimensions of the circumplex model were assessed by single-item scales. The affective valence dimension was assessed by the Feeling Scale (FS; Hardy & Rejeski, 1989), an 11-point, bipolar measure of pleasure–displeasure, ranging from +5 (*I feel very good*) to −5 (*I feel very bad*). The perceived activation dimension was assessed by the Felt Arousal Scale (FAS; Svebak & Murgatroyd, 1985), a 6-point scale ranging from 1 (*low arousal*) to 6 (*high arousal*). Both the FS and FAS have been used in several previous exercise studies conducted by various laboratories around the world and have exhibited satisfactory convergent and discriminant validity.

Procedures. The Loughborough Intermittent Shuttle Test (LIST; Nicholas et al., 2000) consists of running or walking between two lines, 20 m apart, at various speeds related to estimated individual VO_{2max} values. The running and walking speeds are dictated by a computer. The test consists of two parts. Part A is of fixed duration and involves five 15-min exercise periods separated by 3 min of recovery. In turn, one cycle of the 15-min exercise period includes (a) 3 × 20 m at walking pace, (b) 1 × 20 m at maximum running speed, (c) 4 s of recovery, (d) 3 × 20 m at a running speed corresponding to 55% of estimated VO_{2max}, and (e) 3 × 20 m at a running speed corresponding to 95% of individual VO_{2max}. This cycle is repeated 11 times during the 15-min exercise period. Part B involves continuous shuttle running, alternating between 20 m at a speed corresponding to 55% and 20 m at a speed corresponding to 95% of estimated VO_{2max}. This pattern is repeated until the participant is unable to maintain the required speed for two consecutive shuttle runs at 95% VO_{2max}. Part B lasts approximately 10–15 min, so, in addition to the 75 min of Part A, the total duration of the LIST is approximately 85–90 min, mimicking the duration of a soccer match (90 min). For additional information on the physiological demands of the LIST, readers are referred to Nicholas et al. (2000).

In the present study, the participants completed the LIST in a sports hall and the percentage VO_{2max} averaged 81.0% ± 1.9% during the trial. The FS and FAS were administered before, every 15 min during the LIST (at the end of each of the five 15-min blocks of Part A), upon termination (end of Part B), and 15 min postexercise (total of eight times).

Statistical Analysis. In order to compare the conclusions that would be drawn from a typical pre-to-post analysis of change with those that would emerge from a protocol involving multiple during-exercise assessments, we conducted separate repeated-measures ANOVAs. One set of analyses compared the preexercise to the postexercise ratings on the FS and FAS and the other examined changes over the during-exercise time points. Greenhouse-Geisser epsilon corrections of the degrees of freedom were applied when the sphericity assumption was violated. Significant effects were followed-up by Bonferroni-adjusted multiple comparisons and calculation of effect sizes, [$d = (M_i - M_j)/SD_{pooled}$]. Values are presented as means ± *SEM*.

Results

Analyses From Pre- to Postexercise. A repeated-measures ANOVA (pre, post-15) on the FS and FAS showed no significant time effects. Thus, affective valence and perceived activation reported postexercise did not differ from preexercise levels (Table 1).

Analyses of During-Exercise Time Points. A repeated-measures ANOVA (pre, Minute 15, Minute 30, Minute 45, Minute 60, Minute 75, and end) on FS showed a significant main effect for time, $F(2, 25) = 5.0$, $p < .05$. Follow-up analyses revealed a significant decline in valence ratings, with medium effect sizes from min 60 onward (Table 1). A similar repeated-measures ANOVA (pre, Minute 15, Minute 30, Minute 45, Minute 60, Minute 75, and end) on FAS also showed a significant main effect for time, $F(6, 60) = 8.41$, $p < .001$. Follow-up analyses revealed significant moderate-to-large increases in perceived activation from preexercise to all time points during exercise (Table 1).

Table 1 Effects Sizes, [$d = (M_i - M_j)/SD_{pooled}$], and Results of Pairwise Comparisons Between the Means for the Feeling Scale and Felt Arousal Scale

	Minute 15	Minute 30	Minute 45	Minute 60	Minute 75	Fatigue	Post 15
			Feeling Scale				
Pre	−.16	.26	.39	.47*	.51*	.47*	.09
			Felt Arousal Scale				
Pre	−.73*	−.66*	−.60*	−.82*	−.70*	−.48*	−.21

*The pairwise comparison was statistically significant after Bonferroni correction.

Individual Responses. Figure 2 represents the affective changes at the level of the group average, plotted in circumplex space. This figure illustrates a trajectory of change that proceeds through all four quadrants of the circumplex model. On average, participants started from a pleasant low-activation state, characteristic of calmness and relaxation, and by Minute 15 of exercise reported a high-activation pleasant state characteristic of energy and excitement. As the protocol progressed, however, by Minute 60, the average rating was within the high-activation unpleasant quadrant, characteristic of tension and distress. Upon termination of exercise, a decrease in activation was noted and, thus, participants reported a low-activation unpleasant state, characteristic of fatigue and exhaustion. Following a 15-min recovery period, participants returned to a low-activation pleasant state, no different from the one observed at the preexercise assessment.

Figure 3 shows the individual patterns of change, also plotted in circumplex space. An examination of these patterns reveals a diversity of individual responses that is masked by focusing on group-level responses. The different panels of the figure show that, although a roughly congruent pattern of change is evident for some participants (e.g., Participants 3, 7, 9, 11, 12), there are considerable differences in the magnitude and direction of affective change in other individuals (e.g., contrast Participants 9 and 10).

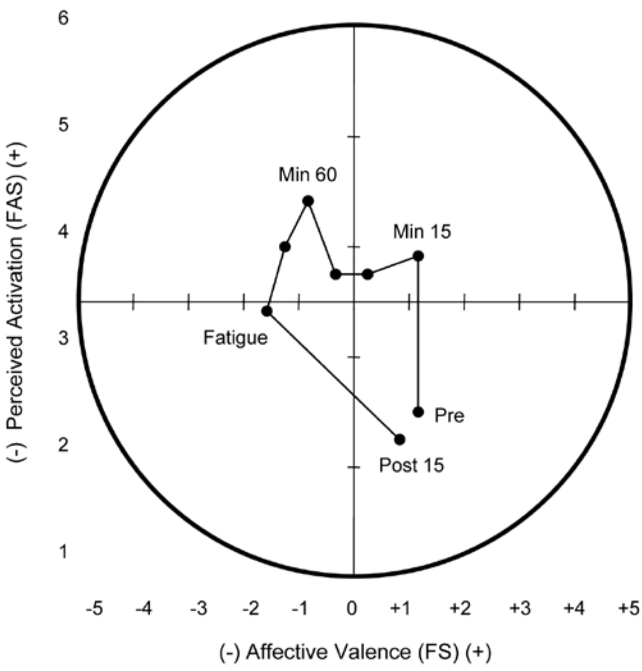

Figure 2 — Responses to the Feeling Scale (FS, see the horizontal dimension) and the Felt Arousal Scale (FAS, see the vertical dimension), plotted as a circumplex. The exercise protocol elicited movement through all four quadrants of the space defined by the circumplex model.

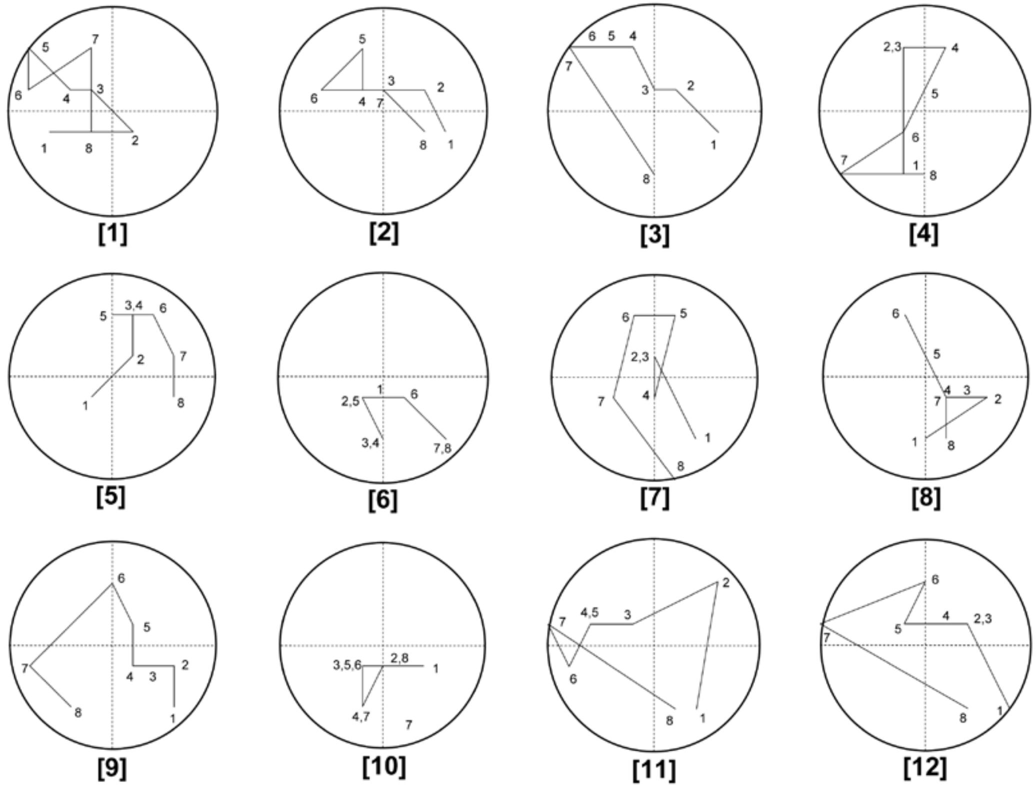

Figure 3 — The responses of the 12 participants, plotted in circumplex space. A comparison to the aggregate-level responses illustrated in Figure 1 shows that some individuals responded in a manner generally consistent with the group average, whereas others showed substantially different patterns of change over the course of the protocol and recovery. (Key: 1 = Preexercise, 2 = Minute 15, 3 = Minute 30, 4 = Minute 45, 5 = Minute 60, 6 = Minute 75, 7 = Fatigue, 8 = Post 15).

Discussion and Conclusions

The aim of this article was to propose that the "psychometric domain of significance to the exerciser" (Morgan, 1984, p. 134) and the "phenomenology of people involved in exercise in the real world" (Gauvin & Rejeski, 1993, p. 408) extend beyond the oft-cited observation that "exercise makes you feel better" (Fox, 1999, p. 413). Given the prevalence of marketing messages promising that certain products can provide health enhancement or weight loss without the need for "painful" or "uncomfortable" exercise, we aimed to highlight the possibility that exercise might also produce changes that are unpleasant. The investigation of such effects could help the field of exercise psychology resolve the apparent paradox of simultaneously arguing that (a) exercise makes all or nearly all people feel better (e.g., 80 to 90%, according to Morgan & O'Connor, 1988) but that (b) few people start to exercise and even fewer adhere in the long run (two thirds being inactive or inadequately active, according to Jones et al., 1998).

Before discussing the results of our empirical illustration, we should emphasize that we do not see these data as demonstrating "how people feel when they exercise." We believe that any such generalization is unjustified since there is no archetype "exercise" and no archetype "exerciser." We believe, instead, that affective responses to exercise are subject to multiple influences, including the physiological and psychological characteristics of the participants, the physiological demands of the exercise stimulus, the physical and social environment, and a multitude of situational appraisals, all of which probably form a complex web of interactions. Furthermore, the small-scale study we used to illustrate our points had several obvious limitations, including a small and nonrepresentative sample that did not include women, an exercise protocol that, although designed to simulate the *physiological* demands of popular sports games, lacked other important elements such as competition or social interaction, and the lack of a comparison group or condition. It is also important to point out that our postexercise assessments were limited to 15 min, allowing the possibility of additional changes in affect beyond this time point.

Despite these limitations, this example can still serve as a useful illustration of the four conceptual and methodological issues we raised and of the main point that the affective responses to exercise might encompass more than just the "feel-better" phenomenon. Firstly, we noted that, occasionally, possible negative effects (e.g., increases of state anxiety scores during vigorous exercise) have not received as much attention as positive changes observed within the same studies. In the present study, for example, it would be conceivable for us to focus on the large postexercise rebounds in affective valence, from the negative levels found at the termination of the LIST to the 15th minute of recovery (even though, in this case, postexercise scores were still not better than preexercise values). Clearly, had we chosen to do so, we would be looking at the phenomenon of exercise-induced affective changes through a keyhole, missing an important part of the overall picture.

Secondly, we commented on the issue of the assessment of affect and, more specifically, the extent to which the measures that are employed can capture all the variants of affective experience that might emerge during a given bout of exercise. In this study, we chose to assess affect from a dimensional perspective, using the circumplex model (Russell, 1980). This model was selected because it can theoretically offer an encompassing representation of the entire affective space by tapping only two key dimensions, valence and activation (Ekkekakis & Petruzzello, 2002). Of course, as we noted earlier, this breadth of scope comes at the expense of some specificity (the more one zooms out to capture a broader image, the more detail is lost). In descriptive studies such as this, where the primary concern is to ensure that no salient features of the response can escape detection, this appears to be a reasonable (and inevitable) trade-off.

The data from this study showed that, over the course of the exercise protocol and subsequent recovery, the participants, on average, traveled through all four of the circumplex quadrants, high-activation pleasure (e.g., energy or excitement), high-activation displeasure (e.g., tension or distress), low-activation displeasure (e.g., fatigue or exhaustion), and finally back to low-activation pleasure (e.g., calmness or relaxation). It is important to point out that, as illustrated in Figure 4b, none of the popular self-report measures (including the exercise-specific ones), if used separately, would be able to fully capture the affective changes that took place in this study, because none contains scales that tap all four of the quadrants of affective space. Therefore, it seems reasonable to suggest that, had we relied on any one of these measures, we would have missed at least some of the salient features of the response (e.g., the shift to a high-activation unpleasant state).

This observation has implications for the decision-making process that should be involved in selecting an affect measurement approach in descriptive studies (i.e., studies in which features of the exercise stimulus are manipulated to examine what the impact on affect might be), which still make up the majority of research in this area. As we noted earlier, categorical models enable a fine-grained analysis of the unique antecedents and experiential features of different affective states. Alternatively, dimensional models offer the advantage of a broad, balanced, and parsimonious coverage of the entire affective space (Ekkekakis & Petruzzello, 2000, 2002; Gauvin & Brawley, 1993). Their limitations notwithstanding, the data from the present study underscore the point that limiting the scope of the investigation to only a few distinct states in the context of a descriptive study is likely to miss some sectors of the broad domain of interest and is, therefore, not optimal. Gauvin and Brawley (1993) explain this as follows:

> [The dimensional] approach seems better suited to the understanding of exercise and affect because the models stemming from it are intended to be broad, encompassing conceptualizations of affective experience. Because the affective experience that accompanies exercise has not been thoroughly described, a model of affect that has a wider breadth is more likely to capture the essence of exercise-induced affect than a model that, at the outset, limits the focus of investigation to specific emotions. (p. 152)

Thirdly, we discussed the critical issue of the timing of assessments of affect. The analyses of change from preexercise to the 15th min postexercise showed that neither the affective valence nor the activation reported at these two time points differed significantly (as noted earlier, it is possible that, had we included additional postexercise assessments beyond the 15th min of recovery, we might have found an improvement in valence compared with preexercise). Had our assessment protocol been limited to these two time points, we would have concluded that a nearly 90-min-long bout of exercise had no significant impact on affect. However, this would have been inaccurate given the trajectory that self-reported affect followed

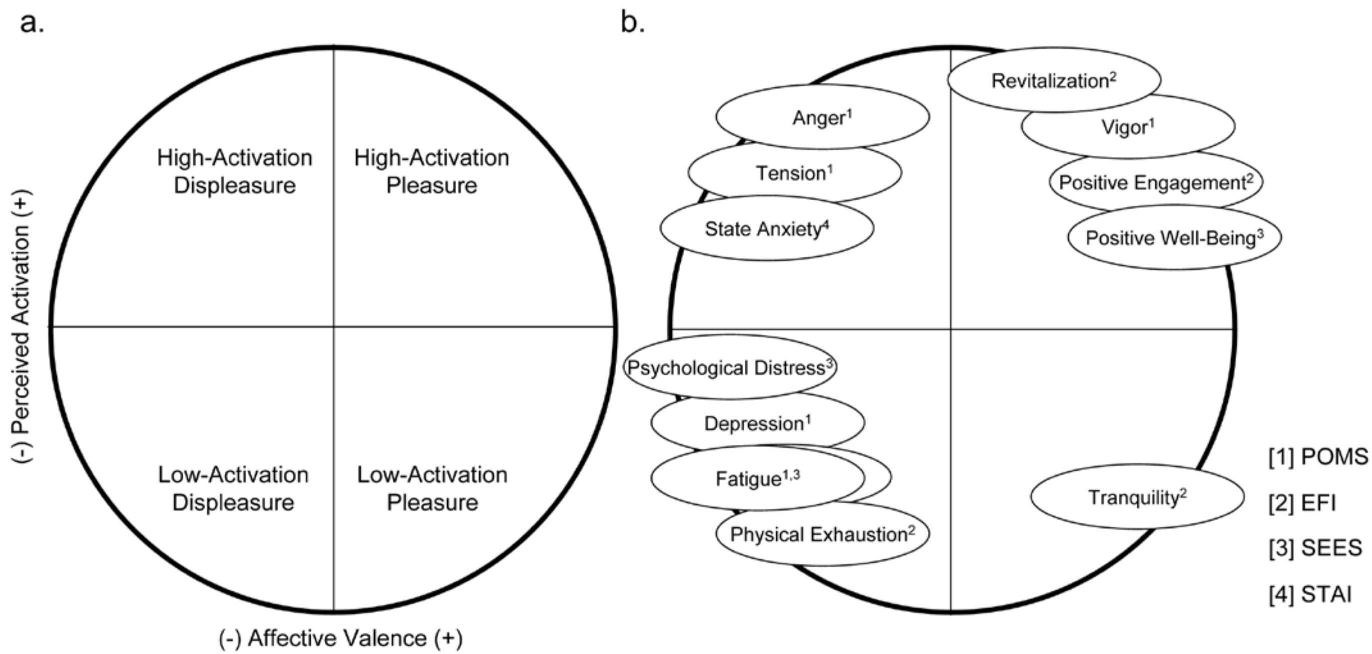

Figure 4 — Panel (a) shows a schematic representation of the affect circumplex, with the horizontal dimension representing affective valence and the vertical dimension representing perceived activation. Panel (b) shows the sectors of the circumplex space likely occupied by the scales of (a) the Profile of Mood States (POMS; McNair et al., 1971), (b) the Exercise-induced Feeling Inventory (EFI; Gauvin & Rejeski, 1993); (c) the Subjective Exercise Experiences Scale (SEES; McAuley & Courneya, 1994); and (d) the State Anxiety scale of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970).

between the preexercise and postexercise time points. Our data are in line with the perspective offered by Bixby et al. (2001), who characterized this problem as analogous to the "aliasing" phenomenon in psychophysiology—the "signal" must be sampled frequently enough to ensure that measurement can accurately reconstruct the shape of the underlying response. If the shape of the affective response is anything other than linear between two sampling time points, then the measurement protocol can misrepresent the true shape of the response, undermining the validity of the conclusions that are drawn.

Fourthly, we identified the potential for reaching misleading conclusions owing to disregarding possible divergent response patterns of individuals or subgroups. Within the confines of this study, our goal was not to provide a full account and analysis of individual patterns or to seek their causes among relevant cognitive appraisals and personality traits. We do, however, wish to highlight the striking variety of individual trends, as illustrated in Figure 3.

An obvious challenge for future research, and one of potentially great theoretical and practical significance, is the identification of the sources of this variability. One systematic line of inquiry in this direction pertains to the role of appraisals of efficacy (e.g., McAuley et al., 1999). Another examines the role of relevant traits, such as those related to arousability and somatosensory modulation (Ekkekakis et al., 2005b). Furthermore, other factors also warrant consideration but have yet to receive research attention within exercise psychology. For example, the extent to which individuals utilize the valence or the activation dimension in differentiating how their affective states evolve over the course of an exercise bout could be related to individual differences in valence versus arousal focus (Feldman, 1995).

Finally, we wish to raise two broader issues. First, we propose that it is time to expand the research agenda. Over the past four decades, the study of the exercise–affect relationship was primarily focused on the implications of this topic for mental health (e.g., anxiolytic and antidepressant effects or promotion of psychological well-being). The scientific and societal value of this line of inquiry remains self-evident. However, it is now time to also consider the implications of the exercise–affect relationship for the critical public health problems of exercise nonadherence and dropout. Although a relationship between affective responses to exercise and long-term adherence has long been assumed to exist, the dearth of direct empirical evidence is striking (Berger & Owen, 1992; Carels et al., 2006; Kiviniemi et al., 2007; Williams et al., in press). It is possible that this might be due to the "paradox" identified here having had an inhibitory effect. If exercise in fact made everyone, or nearly everyone, "feel better," this would not allow for enough variability to make the study of the affect–adherence link seem like a worthwhile investment of investigative effort. We hope that researchers will contemplate whether the four issues we identified could provide a basis for initiating a potentially fruitful line of research on the affect–adherence link.

Second, acknowledging that exercise can have effects that extend beyond the widely touted "feel-better" phenomenon and, therefore, acknowledging that the exercise–affect relationship is complex and multifaceted offer implications for the search for underlying mechanisms. As noted earlier, based on the assumption that the exercise–affect relationship is unitary (i.e., "exercise makes you feel better"), all the mechanistic hypotheses investigated so far have focused exclusively on the processes underlying the "feel-better" phenomenon (e.g., Morgan, 1985). It might be time to also consider the processes underlying other aspects of the exercise–affect relationship, including unpleasant effects (e.g., Ekkekakis & Acevedo, 2006).

Research over the past three decades has established, in a convincing manner, that exercise *can* make people "feel better" (e.g., during walking, during more vigorous exercise among certain participants, and during recovery from vigorous exercise among nearly all participants). It is now time to consider other aspects of the complex exercise–affect relationship and to contemplate whether diverse affective responses could account for part of the variability in physical activity behavior and adherence.

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