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Throwing the Mountains Into the Lakes: On the Perils of Nomothetic Conceptions of the Exercise–Affect Relationship

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Traditional conceptions of the exercise–affect relationship postulate that moderate-intensity exercise leads to positive affective changes in all or most individuals, and it can, therefore, be prescribed for all individuals involved in exercise programs. This study investigated whether this assumption is true, not only at the level of group averages but also at the level of individuals. Affect was assessed before, during, and after a session of moderate-intensity cycle ergometry using a dimensional conceptualization of affect. Examination of individual responses revealed a diversity of patterns that was masked by aggregate-based analyses. Mean ratings of affective valence were shown to remain stable during exercise, but in actuality almost half of the individuals experienced progressive improvement, whereas the other half experienced progressive deterioration. The diversity of individual affective responses must be taken into account in formulating conceptual models of the exercise–affect relationship and deriving public health physical activity recommendations.

Key words: exercise, affect, nomothetic models, interindividual variability

In 1889, in a book entitled *Natural Inheritance*, famed English anthropologist, geneticist, statistician, psychologist, and psychometrician Sir Francis Galton (1889) wrote,

It is difficult to understand why statisticians commonly limit their inquiries to Averages, and do not revel in more comprehensive views. Their souls seem as dull to the charm of variety as that of the native of one of our flat English counties, whose retrospect of Switzerland was that, if its mountains could be thrown into its lakes, two nuisances would be got rid of at once. (p. 62)

In almost 3 decades of descriptive research on the affective responses associated with acute exercise, the “charm of variety” has yet to be appreciated. Researchers have been generally content with the now extensively documented finding that, *on average*, acute exercise is associated with significant improvements in a

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wide range of affective states (Ekkekakis & Petruzzello, 1999; Gauvin & Spence, 1996; Scully, Kremer, Meade, Graham, & Dudgeon, 1998; Tuson & Sinyor, 1993; Yeung, 1996). Thus, investigations continue to have an exclusively nomothetic scope. The issue of interindividual variation in affective responses has rarely been given substantive consideration.

Some sporadic calls for increased research attention to individual differences have yet to materialize into a systematic reconsideration of the traditional concepts and methods. For example, Gauvin and Brawley (1993) noted the “very large variability” found in self-ratings of mood and called for “some way to account for large individual differences in mood, which may contribute to abnormal distributions in the typically small samples” (p. 150). Yeung (1996) also noticed that “the role of personality traits in the determination of acute responses to exercise [has] been neglected” and suggested that future research should “examine these factors in relation to the preferences of individuals” (p. 137). Similarly, Morgan (1997) argued that “future research should take both the individual’s psychological and physiological profiles into account” (p. 11). As noted above, these exhortations have yet to inspire a conceptual and methodological shift.

Arguably, the task is not an easy one. Preliminary attempts to develop individual profiles that could predict affective changes associated with either acute (Pistacchio, Weinberg, & Jackson, 1989) or chronic (Simons & Birkimer, 1988) exercise have met with very limited success. The only consistent finding was that the participants who were more likely to experience positive affective changes were those who reported being in a less positive or in a negative affective state at baseline (also see Gauvin, Rejeski, & Norris, 1996; Gauvin, Rejeski, Norris, & Lutes, 1997; Raglin & Wilson, 1996; Rejeski, Gauvin, Hobson, & Norris, 1995). An examination of the possible role of participant characteristics across studies also failed to reveal any noticeable consistencies (Tuson & Sinyor, 1993). Clearly, these early failures to account for interindividual variation in affective responses to exercise do not provide a sufficient basis for making any definitive statements on the topic. They do, however, offer a glimpse of the complexity of the issue from a conceptual and a data-analytic standpoint.

Individual Variation in the Context of Dose–Response Investigations

The advent of new physical activity recommendations (National Institutes of Health Consensus Development Panel on Physical Activity and Cardiovascular Health, 1996; Pate et al., 1995; United States Department of Health and Human Services, 1996) and the emergence of dose–response models theorized to reflect the relationship between physical activity and biological health (Blair, Wells, Weathers, & Paffenbarger, 1994; Haskell, 1994a, 1994b) have sparked renewed interest in the relationship between different “doses” of exercise (i.e., intensity, duration) and affective responses (Ekkekakis & Petruzzello, 1999; Rejeski, 1994). Responding to this trend, Rejeski emphasized that “it is critical to remember that people respond [to exercise] as ‘active’ rather than ‘passive’ agents” (p. 1040). In a similar vein, Morgan (1997) and Berger and Berger and associates (Berger, 1994; Berger & McInman, 1993) proposed that individual preferences for exercise of different intensities might be an important mediator in the dose–response relationship.

In spite of these critical caveats, however, the currently pervasive assumptions about dose–response reflect a unitary and nomothetic conception of the exercise–affect relationship (see Ekkekakis & Petruzzello, 1999, for a review). More specifically, the common theme underlying traditional assumptions is that “too little” exercise is unlikely to have a significant impact on affect (e.g., Dishman, 1986; International Society of Sport Psychology, 1992; Morgan, 1979, 1982, 1984; Morgan, Horstman, Cymerman, & Stokes, 1980; Raglin & Morgan, 1985), whereas “too much” exercise is likely to be aversive (Berger & Owen, 1988, 1992; Kirkcaldy & Shephard, 1990; Morgan, 1979; Morgan et al., 1980; Ojanen, 1994). Consequently, the generally held assumption is that “moderate” exercise is likely to lead to positive affective changes in all or most individuals (e.g., Berger, 1994; Kirkcaldy & Shephard; Ojanen), an obvious legacy of the intuitively appealing, yet highly disputed (Apter, 1976; Svebak, 1991; Zuckerman, 1991), notion of an “optimal” level of stimulation (Hebb, 1955). For instance, Berger and Owen (1998) asserted that “moderate-intensity exercise consistently has been associated with mood benefits” (p. 612). Motivated by a similar rationale, Morgan (1997) argued that “it may be possible to defend a single exercise prescription for all individuals (e.g., 70% VO_{2max} [maximal aerobic capacity])” (p. 11).

Although these deep-rooted beliefs evidently continue to permeate both theory and practice in the exercise sciences, the role of individual variation in the context of dose–response investigations in affective psychology is gaining acceptance. According to Davidson and Irwin (1999), “one of the most striking features of emotion is the profound variability among individuals in the quality and intensity of response to the identical stimulus” (p. 16). Furthermore, Davidson (1998) argued that

there are likely individual differences in the *threshold* for eliciting components of a particular emotion, given a stimulus of a certain intensity. Thus, some individuals are likely to produce facial signs of disgust on presentation of a particular intensity of noxious stimulus, whereas other individuals may require a more intense stimulus for the elicitation of the same response at a comparable intensity. This suggestion implies that dose–response functions may reliably differ across individuals. (p. 309)

Acknowledging the role of individual differences when studying the effects of different exercise doses on affect is very important, given the direct connection between research findings of this kind and the physical activity recommendations that are being disseminated to the public. It is critical to remember that, unlike Davidson’s example, exercise has the potential for *bidirectional* effects on affect. Thus, the issue is not simply which dose of exercise will lead to a *positive* affective change as opposed to *no change at all* in a given individual but also whether a given dose will lead to a *positive* or a *negative* change in that individual. It is not clear whether this fact is fully appreciated. According to the dose–response assumptions reviewed by Ekkekakis and Petruzzello (1999), exercise performed at low to moderate intensities (below 60% VO_{2max} according to Raglin & Morgan, 1985, or below 70% VO_{2max} according to Dishman, 1986) is believed to constitute a stimulus of insufficient strength to elicit positive affective changes (see also Kirkcaldy & Shephard, 1990; Ojanen, 1994). Therefore, when Morgan (1997)

claims that 70% VO_{2max} can be used as an exercise prescription for all individuals, the implication is that this dose is believed to induce positive affective responses in most individuals while perhaps leaving a small percentage of individuals unaffected. In this framework, the role of individual differences is to merely shift the hypothetical threshold of affective beneficence slightly higher or lower along the exercise-intensity continuum. The possibility that an exercise stimulus of this or lower intensity can also lead to negative affective changes in some individuals is generally not taken into serious consideration. According to traditional assumptions, the capacity to induce negative affective changes is limited to highly strenuous exercise (Berger & Owen, 1988, 1992; Kirkcaldy & Shephard; Morgan, 1979; Morgan et al., 1980; Ojanen).

The Nomothesis Versus Idiography Debate in Historical Context

On a general plane, it is uncontested that the affective changes accompanying acute exercise are the products of highly complex interactions. It is widely acknowledged that, in all likelihood, biological and psychological individual difference variables, the physical and social environment, the objective and perceived attributes of the exercise stimulus, and several psychological states all interact and codetermine how an individual will respond to an exercise stimulus. Most researchers would probably agree with this general thesis. However, there appears to be significant hesitation in acknowledging the logical corollary that nomothetic models that do not take this complexity into account (i.e., postulate no mediators or a very limited number of interacting mediators) are bound to provide woefully inadequate representations of the diversity encountered in actual affective responses to exercise.

Viewed from a historical perspective, this attitude is not surprising. Nomothetic conceptions, often limited to singular stimulus–response causal hypotheses, have pervaded psychology throughout its history. Psychologists aspire to understand individuals but, more often than not, attempt to do so by deriving laws with an ecumenical scope. Ever since Windelband (1900/1998) used the terms *nomothetic* and *idiographic* and Allport (1937) adopted them in his writings on personality, the (often acrimonious) debate over the most “appropriate” approach has continued almost uninterrupted.

Nomotheticists have defended their beliefs mainly by raising issues of scientific orthodoxy (e.g., Eysenck, 1954; Skaggs, 1945; but see Allport, 1946; Beck, 1953). In this view, the purpose of science is to infer general laws. This entails that the study of individual cases falls outside the scope of scientific research, a dogma whose origin can be traced back to the days of medieval scholasticism (hence the dictum “*scientia non est individuorum*,” cited in Allport, 1961). According to Nunnally (1967), for instance, “idiography is an anti-science point of view; it discourages the search for general laws and instead encourages the description of particular phenomena (people)” (p. 472). Proponents of idiography, on the other hand, do not disavow the value of nomothetic methods (Lamiell, 1981, 1986). Instead they argue, as did Allport (1937), that “it is more helpful to regard the two methods as overlapping and as contributing to one another” (p. 22). From the

idiographic viewpoint, nomothetic principles are bound to provide poor accounts of individual behavior. As Hermans (1988) noted, in nomothetic research, "general-type" and "aggregate-type" propositions are often confused. A general-type proposition holds true for each member of a given group. An aggregate-type proposition is true of a given group of people *as a group*. Because most conventional statistical methods are based on aggregates, it is impossible to ascertain whether a conclusion is true of every individual in a group (Hermans; Lamiell, 1981, 1986). In this context, idiographic methods might prove instrumental by identifying and dissecting individual variation subsumed within those aggregates.

Although psychology has, through the years, taken steps toward recognizing the contributions of both generality and individuality, at least on a conceptual level, the nomothesis versus idiography debate retains some of its earlier emotional charge, as it continues to be viewed by some as a debate over what is legitimately "scientific" versus "unscientific" or even "antiscientific" in psychological research. We believe that framing the issue in these terms is anachronistic and ultimately infertile. Instead, we are more concerned with the possible practical implications of the inherent inadequacy of unitary and nomothetic conceptions of the exercise-affect relationship. These models cannot adequately account for complex individual patterns in affective responses to exercise. Nonetheless, they continue to serve as the basis for educating practitioners and for deriving public health guidelines that ultimately affect individuals.

The Present Study

The main objective of this study was to examine the veracity of the nomothetic assumption that a bout of exercise of moderate intensity will lead to positive affective responses in all or most individuals. This question mainly stems from Morgan's (1997) proposition that a single exercise prescription for all individuals might be a defensible practice, as long as exercise intensity is moderate. This proposition seems to reflect a generalized belief among researchers and practitioners, namely that moderate intensity is the "safest bet" for exercise prescription, given the numerous research findings linking moderate-intensity exercise to positive affective changes (Berger & Owen, 1998). The present study investigated whether this finding holds true when examined not at the level of aggregates but at the level of individuals.

In several respects, our methodology was intended to control for potential sources of response heterogeneity. The purpose of these controls was to create an experimental condition that would theoretically increase the likelihood of a uniform response across individuals. If response homogeneity failed to emerge under these favorable conditions, then it would be reasonable to assume that it would also fail under less favorable, more diverse conditions. First, we recruited a highly homogeneous sample of young, healthy, and mostly physically active university students, thus limiting possible variability as a result of varying age, health status, activity history, and educational level.

Second, we employed a generally familiar exercise mode (stationary cycling), thus minimizing variability that could have resulted from a novel or less familiar task such as treadmill running, swimming, aerobics, or stair climbing.

Third, we used an exercise intensity (i.e., 60% VO_{2max}) that is well within the "moderate" range (defined as 50–74% VO_{2max} by the American College of Sports

Medicine, 1995), as opposed to Morgan's (1997) suggestion of using 70% VO_{2max} as an exercise prescription "for all individuals." Exercise at 70% VO_{2max} would probably place some individuals above and some below the anaerobic threshold, thus potentially introducing variability stemming from the different metabolic requirements of the exercise stimulus. In contrast, in our young, healthy, and generally physically active sample, exercise at 60% VO_{2max} was more likely to represent an entirely aerobic stimulus.

Fourth, by selecting a relatively mild and easy-to-complete exercise task, we aimed to minimize variability arising from cognitive states, such as self-efficacy, that are known to be engaged in the face of challenging stimuli, including acute exercise, and to influence affective responses in such conditions. In previous research involving exercise intensity of 60% VO_{2max} or less (i.e., 45–50% of maximal heart rate reserve, roughly equivalent to 45–50% VO_{2max} , in Treasure & Newbery, 1998; 70% of age-predicted maximal heart rate, roughly equivalent to 60% VO_{2max} , in McAuley & Courneya, 1992), self-efficacy was found to be either unrelated or marginally related to affective responses (i.e., accounting for only 6% of the variance in negative affect and at only one of three assessments during exercise at 55% VO_{2max} ; Tate, Petruzzello, & Lox, 1995). According to McAuley and Courneya, the relationship between self-efficacy and affect is expected to be stronger when exercise intensity exceeds 70% of maximal heart rate (approximately 60% VO_{2max}).

Finally, we sought to minimize variability that could result from social factors that have been shown to influence affective responses to exercise (Turner, Rejeski, & Brawley, 1997). Therefore, the study was conducted in solitary conditions in the laboratory, the same experimenter (LMVL) collected all the data, and interactions between the participants and the experimenter were limited to communications necessary for the conduct of the experiment. With all these factors considered, adopting a unitary and nomothetic view of the exercise–affect relationship would lead to the assumption that the potential for interindividual consistency in affective responses would be maximized. Therefore, these methodological features enable a strong test of the hypothesis that affective responses to moderate-intensity exercise *do vary* among individuals. This is because, as a result of the methodological features discussed above, this hypothesis is rendered improbable and falsifiable (on the concept of "degrees of testability," see Popper, 1962, pp. 219–220, 256, 287).

Our methodological approach was further characterized by two elements that were shown to be important in Ekkekakis and Petruzzello's (1999) analysis of the dose–response literature. First, we combined an examination of affective changes from pre- to postexercise with repeated assessments of affective responses during the exercise bout. By limiting the investigative scope to changes from baseline to various time points postexercise, previous research has disregarded the dynamic nature of affective change. It could be argued that, in essence, previous research has examined the effects of several seconds or several minutes of exercise recovery rather than the effects of exercise *per se*. Instead, in the present study, we aimed to examine the direct affective impact of the exercise stimulus itself by including assessments of affect during the exercise bout.

Second, we examined affect from a "dimensional," as opposed to "categorical," perspective (see also Ekkekakis, Hall, & Petruzzello, 1999; Ekkekakis, Hall, Van Landuyt, & Petruzzello, 2000; Ekkekakis & Petruzzello, 1999). Specifically,

we assessed affective responses within a circumplex framework, as described by Russell (1978, 1980, 1989, 1997). A dimensional model, like the circumplex, provides an unrestricted and balanced template for “mapping” responses to exercise in global affective space. As argued by Gauvin and Brawley (1993), “because the affective experience that accompanies exercise has not been thoroughly described,” by virtue of its “wider breadth,” a dimensional model 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). Previous research has examined distinct affective states, focusing primarily on state anxiety. There is no evidence, however, that state anxiety (or some other distinct affective state) will reflect the most salient affective change in a given situation. Therefore, assessing distinct affective states (i.e., using a categorical approach) might misrepresent or altogether conceal the impact of exercise on the global affective domain.

The basic premise of the circumplex model of affect (Larsen & Diener, 1992; Russell, 1978, 1980) is that the global affective space can be parsimoniously modeled by two orthogonal, bipolar dimensions: affective valence (pleasant–unpleasant) and activation (low–high). These two dimensions divide the affective domain into four meaningful quadrants: (a) activated pleasant affect, characterized by energy, excitement, and enthusiasm; (b) unactivated pleasant affect, characterized by calmness and relaxation; (c) activated unpleasant affect, characterized by tension and distress; and (d) unactivated unpleasant affect, characterized by fatigue, boredom, or depression (see Figure 1).

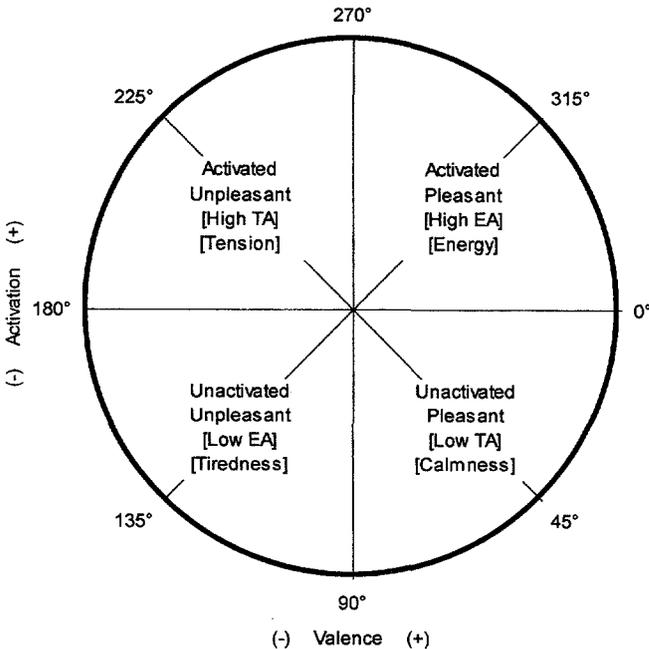


Figure 1 — The circumplex model of affect and the theorized locations of the scales of the Activation–Deactivation Adjective Checklist.

Methods

Participants

Participants were 82 university students (35 men and 47 women, mean age 19.9 ± 1.4 years) who were recruited for the study through announcements made in their classes. All participants read and signed an informed consent form approved by the university's institutional review board. They were randomly assigned to an exercise group ($n = 63$; 27 men, 36 women) or to a control group ($n = 19$; 8 men, 11 women). The 3-to-1 ratio between exercisers and controls was dictated by our intention to retain an exercise group of a size sufficient to yield meaningful response subpatterns. Demographic information for the exercise and control groups is shown in Table 1. There were no significant differences between the groups on any of the demographic variables.

Self-Report Measures

Affective responses were assessed with both multiple- and single-item scales. Although single-item measures are typically less reliable than multi-item measures are, they offer the advantage of being more practical for repeated administrations over a short period of time, such as during a bout of exercise. Both sets of scales were selected to represent a common dimensional space, namely the affect circumplex, thereby enabling comparisons of the data derived from the different measures.

For the assessment of affect during exercise, we used the Feeling Scale (FS; Hardy & Rejeski, 1989) as a measure of valence and the Felt Arousal Scale (FAS) of the Telic State Measure (Svebak & Murgatroyd, 1985) as a measure of perceived activation.

Table 1 Demographic and Physical Activity Characteristics ($M \pm SD$)

Characteristic	Exercise group ($n = 63$)	Control group ($n = 19$)
Age (years)	19.90 ± 1.52	19.84 ± 0.96
Height (cm)	173.03 ± 10.17	173.47 ± 11.41
Weight (kg)	69.79 ± 15.56	70.58 ± 18.68
Estimated VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$)	43.51 ± 10.62	39.65 ± 10.51
Regular exercise participation (% of sample)	79	74
Frequency (days per week)	3.29 ± 2.13	2.79 ± 2.10
Intensity ^a	4.57 ± 2.80	4.95 ± 3.49
Duration (min/session)	45.79 ± 34.63	50.79 ± 43.44
Months of participation	46.11 ± 47.92	43.16 ± 41.40

^aBased on Borg's (1998) Category Ratio 10 (CR-10) scale, on which 0.5 = *very, very light*, 5 = *hard*, 10 = *very, very hard*.

The FS is a single-item, 11-point, bipolar scale ranging from -5 to $+5$, with anchors at all odd integers and at the zero point ($+5 = \text{very good}$, $+3 = \text{good}$, $+1 = \text{fairly good}$, $0 = \text{neutral}$, $-1 = \text{fairly bad}$, $-3 = \text{bad}$, and $-5 = \text{very bad}$). The FS has been used extensively to assess affective valence during exercise (see Ekkekakis & Petruzzello, 1999, for a review). Hardy and Rejeski (1989) have provided detailed information on the development of the scale. In pilot testing in our laboratory, the FS has exhibited correlations ranging from .51 to .88 with the Valence scale of the Self Assessment Manikin (Lang, 1980) and from .41 to .59 with the Valence scale of the Affect Grid (Russell, Weiss, & Mendelsohn, 1989).

The FAS is a single-item, 6-point scale of perceived activation, with anchors at 1 (*low arousal*) and 6 (*high arousal*). The scale has been used extensively in reversal theory research, including research in the exercise context (Kerr & Van den Wollenberg, 1997; Kerr & Vlaswinkel, 1993). In pilot testing in our laboratory, the FAS has exhibited correlations ranging from .45 to .70 with the Arousal scale of the Self Assessment Manikin (Lang, 1980) and from .47 to .65 with the Arousal scale of the Affect Grid (Russell, Weiss, & Mendelsohn, 1989).

The Activation–Deactivation Adjective Checklist (AD ACL; Thayer, 1989) is a multi-item measure of the bipolar dimensions of Energetic Arousal (EA) and Tense Arousal (TA). Each dimension is represented by ten 4-point Likert-type items. The EA dimension ranges from *energy* to *tiredness*, whereas the TA dimension ranges from *tension* to *calmness*. For greater specificity, Thayer (1989) recommended that energy, tiredness, tension, and calmness also be scored separately (each subscale consisting of 5 items). Thayer (1978, 1986, 1989) has provided extensive validity and reliability information on the AD ACL. In extensive previous research in the context of physical activity, the scales of the AD ACL have exhibited satisfactory internal consistency, with Cronbach's alphas typically higher than .80 (Ekkekakis et al., 1999, 2000). In the present study, the AD ACL was used within a circumplex framework. As shown in Figure 1, the Energy subscale is theorized to map the activated-pleasant-affect quadrant of the circumplex, Tension maps the activated-unpleasant quadrant, Calmness maps the unactivated-pleasant quadrant, and Tiredness maps the unactivated-unpleasant quadrant (see also Thayer, 1989, on this topic). The validity of AD ACL as a measure of the circumplex affective space has been demonstrated by Ekkekakis et al. (1999, 2000) by comparing responses on the AD ACL with concurrent responses on the Affect Grid (Russell, Weiss, & Mendelsohn, 1989) and the Self Assessment Manikin (Lang, 1980).

Finally, the Rating of Perceived Exertion (RPE; Borg, 1998) scale was used to assess perceived effort during exercise. This 15-point scale ranges from 6 to 20, with anchors at all odd integers from 7 (*extremely light*) to 19 (*extremely hard*) and additional anchors at the extremes: 6 (*no exertion at all*) and 20 (*maximal exertion*).

Procedures

Session I

All participants attended two sessions. In the first session, each participant was briefed on the procedures for both sessions and signed the informed consent form. General demographic, health status, and physical activity information was collected. All participants then completed the YMCA cycle ergometer physical

working capacity test (Golding, Myers, & Sinning, 1989) on a Monark Ergomedic 818E. This is a submaximal test that is used to estimate VO_{2max} . It consists of a 3-min warm-up followed by two to three additional stages designed to elicit heart rates between 110 and 150 beat/min. Based on the linear relationship between heart rate, oxygen consumption, and workload between these limits, the obtained heart rates are used to estimate VO_{2max} . Heart rate was monitored throughout the test using a heart rate monitor (Model Accurex Plus, Polar Electro Oy, Finland).

Session II

The second session was the treatment session. On entering the lab, participants were briefed on the procedures, were fitted with a Polar heart rate monitor, and completed the first battery of self-report measures of affect consisting of the FS, the FAS, and the AD ACL (Pretest 1). The participants then sat quietly for a period of 30 min while noninvasive psychophysiological assessments took place (the hypotheses associated with these assessments were unrelated to the present study). After this, a second pretreatment battery of self-report measures of affect (identical to the first) was completed (Pretest 2). This initial period of quiet rest was associated with a decrease in perceived activation but did not influence affective valence (see the Results section). Participants were then randomly assigned to either the exercise or the control group.

During the treatment period, each participant in the control group sat in a comfortable chair, reading popular magazines for 30 min. The magazines had been extensively pretested to ensure that they did not include any references to exercise or any articles that could induce significant positive or negative affective responses (Ekkekakis et al., 2000). Participants in the exercise group engaged in 30 min of exercise at 60% of their estimated VO_{2max} on the same cycle ergometer used in Session I (see above). The first 3 min of the bout were used as a warm-up period, beginning with 0.5-kilopond resistance and increasing in 0.5-kilopond increments, so that by the end of the warm-up, the steady-state workload had been reached. The steady-state workload was that which elicited the heart rate corresponding to 60% of each participant's estimated VO_{2max} . This level was maintained throughout the exercise session by monitoring heart rate and adjusting the workload accordingly. During the final 2 min of the exercise period, the participants cooled down while pedaling against minimal (0.5-kilopond) resistance.

Heart rate, FS, and FAS were recorded during both the experimental and the control treatments at 5-min intervals, except for the first 3 and the last 2 min (i.e., the periods that corresponded to the warm-up and the cool-down of the exercise group). In addition, RPE was assessed in the exercise group at the same intervals. Specifically, heart rate, FS, and FAS in both groups, and RPE in the exercise group, were assessed at Minutes 7, 12, 17, 22, and 27 of the treatment periods. After the treatment periods, both groups sat quietly, reading magazines for a 20-min recovery period during which heart rate, FS, FAS, and AD ACL were administered at Minutes 0 (Posttest 0), 10 (Posttest 10), and 20 (Posttest 20).

Data Analysis

We conducted two parallel analyses of the data. First, we followed the “traditional” analytic approach of examining affective changes at the group level. To

determine whether affective changes occurred from pre- to during- to postexercise, group (control, exercise) by time MANOVAs with repeated measures on the last factor were conducted. Significant Group \times Time interactions were followed up with univariate ANOVAs and eventually with an examination of simple effects using Fisher–Hayter tests (Kirk, 1995). Effect sizes, $d = (M_i - M_j)/SD_{\text{pooled}}$, were also computed.

As a second step, we investigated individual response patterns by dividing the exercise sample into subgroups that exhibited increases, decreases, or no changes on the dependent variables (EA, TA, FS, and FAS). This analysis focused on frequency counts of individuals within each subgroup, as well as on the magnitude of change within each subgroup.

Results

Manipulation Check

At the 5th min of the treatment period, the average heart rate ($\pm SD$) was 76 ± 16 beat/min in the control group and 127 ± 12 beat/min in the exercise group. At the 27th min, the value for the control group was 75 ± 14 beat/min, whereas the value for the exercise group was 141 ± 11 beat/min. By continuously monitoring the heart rate responses and adjusting the workloads in the exercise group, the attained heart rates were kept close to the target values (mean percentages $\pm SD$ were $89\% \pm 10\%$, $95\% \pm 10\%$, $96\% \pm 8\%$, $98\% \pm 7\%$, and $99\% \pm 7\%$ of the target heart rate at the 7th, 12th, 17th, 22nd, and 27th min, respectively). The average RPE ($\pm SD$) was 11.0 ± 1.6 (i.e., “light”) at the 5th min, 12.0 ± 1.7 at the 12th min, 12.7 ± 1.8 at the 17th min, 13.2 ± 2.0 at the 22nd min, and 13.5 ± 2.1 (i.e., “somewhat hard”) at the 27th min.

Group Responses

Pre- to Postexercise Changes in Energetic Arousal and Tense Arousal. The descriptive statistics for EA and TA responses are shown in Table 2. The MANOVA for EA and TA indicated a significant Group \times Time interaction, Wilks’s $\Lambda = .510$, $F(8,73) = 8.768$, $p < .001$. The interaction was significant for both EA, $F(4,77) = 19.46$, $p < .001$, and TA, $F(4,77) = 9.15$, $p < .001$. Follow-up Fisher–Hayter tests showed that, as a result of the initial 30-min resting period, the exercisers experienced a significant decrease in EA from Pretest 1 to Pretest 2, $p < .01$, $d = -0.52$. In contrast, in response to the exercise stimulus, there was a substantial increase in EA from Pretest 2 to Posttest 0, $p < .01$, $d = 1.56$, that was sustained through Posttest 10, $p < .01$, $d = 1.12$, and Posttest 20, $p < .01$, $d = 0.90$. An examination of changes in the two opposite poles of the EA dimension showed that the increase was accounted for both by increases in Energy compared with Pretest 2 (at Posttest 0: $p < .01$, $d = 1.7$; at Posttest 20: $p < .01$, $d = 0.81$) and by decreases in Tiredness (at Posttest 0: $p < .01$, $d = -1.3$; at Posttest 20: $p < .01$, $d = -0.86$). In contrast, the control group showed no changes in EA throughout the treatment period.

With respect to TA, the exercise group experienced an initial decrease from Pretest 1 to Pretest 2, $p < .01$, $d = -0.69$. The exercise stimulus was associated with a significant increase from Pretest 2 to Posttest 0, $p < .01$, $d = 1.08$, that lasted until Posttest 10, $p < .05$, $d = 0.46$, and finally reversed itself at Posttest 20, $p > .05$,

Table 2 Means \pm Standard Deviations of Scores in Measures of Affect Across Time in the Exercise and Control Groups

	Energetic Arousal		Tense Arousal	
	Exercise group	Control group	Exercise group	Control group
Pretest 1	22.08 \pm 8.11	20.47 \pm 8.97	18.67 \pm 4.27	19.10 \pm 5.04
Pretest 2	18.22 \pm 6.58	16.63 \pm 7.24	15.84 \pm 3.93	16.00 \pm 2.89
Posttest 0	29.06 \pm 7.32	15.84 \pm 5.61	19.79 \pm 3.75	14.47 \pm 2.65
Posttest 10	26.25 \pm 7.73	16.21 \pm 5.91	17.49 \pm 3.30	15.21 \pm 3.08
Posttest 20	24.82 \pm 7.97	17.21 \pm 4.92	16.52 \pm 3.10	15.42 \pm 2.75

	Feeling Scale		Felt Arousal Scale	
	Exercise group	Control group	Exercise group	Control group
Pretest 1	1.83 \pm 1.87	1.95 \pm 1.75	2.63 \pm 1.17	2.58 \pm 1.12
Pretest 2	1.97 \pm 1.71	1.84 \pm 1.54	2.14 \pm 0.98	2.32 \pm 0.95
Min 7	2.21 \pm 1.23	1.95 \pm 1.43	3.02 \pm 0.89	2.21 \pm 0.85
Min 12	2.10 \pm 1.32	1.89 \pm 1.37	3.22 \pm 0.92	2.16 \pm 0.83
Min 17	2.05 \pm 1.58	1.89 \pm 1.37	3.52 \pm 1.11	2.05 \pm 0.85
Min 22	2.10 \pm 1.78	1.89 \pm 1.24	3.75 \pm 1.12	1.89 \pm 0.74
Min 27	2.02 \pm 1.88	1.95 \pm 1.27	3.94 \pm 1.16	1.79 \pm 0.79
Posttest 0	3.02 \pm 1.24	1.95 \pm 1.35	3.67 \pm 1.05	1.95 \pm 0.78
Posttest 10	2.98 \pm 1.24	1.89 \pm 1.29	3.08 \pm 1.10	1.89 \pm 0.74
Posttest 20	3.00 \pm 1.18	2.16 \pm 1.46	2.79 \pm 1.15	2.00 \pm 0.88

$d = 0.19$. The parallel increases in EA and TA constitute a pattern that is in line with Thayer's (1989) postulate that the two dimensions will exhibit changes in the same direction at low and moderate levels of energy expenditure. The changes in TA were accounted for by a small increase in Tension from Pretest 2 to Posttest 0, $p < .01$, $d = 0.37$, that had dissipated by Posttest 10 and a larger decrease in Calmness from Pretest 2 to Posttest 0, $p < .01$, $d = -0.12$, which remained until Posttest 10, $p < .01$, $d = -0.58$, and finally dissipated at Posttest 20, $p > .05$, $d = -0.12$. In contrast, the only significant change in TA in the control group was a decrease from Pretest 1 to Pretest 2, $p < .01$, $d = -0.76$.

In-Task Changes in Valence and Activation. The descriptive statistics for FS and FAS responses are shown in Table 2. The MANOVA for FS and FAS indicated a significant Group \times Time interaction, Wilks's $\Lambda = .479$, $F(18,63) = 3.814$, $p < .001$. The interaction was significant for both FS, $F(9,72) = 2.17$, $p < .05$, and FAS, $F(9,72) = 7.11$, $p < .001$. In the exercise group, there was no significant change in valence, as indexed by the FS, from Pretest 2 to any time point during exercise. As soon as the exercise stimulus was terminated (i.e., Posttest 0), however, there was a sharp improvement in FS ratings compared with Pretest 2, $p < .01$, $d = 0.70$, that persisted virtually unchanged throughout the 20-min recovery period (at Posttest 20: $p < .01$, $d = 0.70$). There were no significant changes in FS in the control group.

With respect to activation, as indexed by the FAS, the exercise group experienced a significant increase from Pretest 2 to the 5th min of exercise, $p < .01$, $d = 0.94$, and this trend continued until it peaked at the 25th min of exercise, $p < .01$, $d = 1.68$. After exercise, activation decreased steadily but was still above baseline at Posttest 20, $p < .01$, $d = 0.61$. In contrast, there were no significant changes in FAS in the control group.

Individual Responses

Change scores were computed for EA and TA from Pretest 2 to Posttest 0 and for FS and FAS from the 7th (i.e., first during-exercise assessment) to the 27th min of exercise (i.e., last during-exercise assessment). Based on these scores, the exercise group was divided into three subgroups for each variable: individuals who showed increases, no change, and decreases. The frequency counts that resulted from this categorization and the magnitude of affective responses within each category appear in Table 3.

These data indicate that individual change trends were essentially homogeneous with respect to EA, less so for TA and FAS, and not at all homogeneous (in fact, polarized) for FS. Specifically, almost all the exercisers (93.7%) showed increases in EA, although they differed substantially in the magnitude of the change, ranging from 2 to 27 points on a 30-point scale. In TA, most exercisers (77.8%) exhibited increases, as was also indicated by the previous analysis of aggregate scores. A substantial number of participants (17.5%), however, exhibited decreases. In FAS, most exercisers (68.3%) reported increases during exercise, but a substantial

Table 3 Frequency and Magnitude of Individual Affective Responses

Response	Frequency count	Range	$M \pm SD$
Energetic arousal (from Pretest 2 to Posttest 0)			
Increase	59 (93.7%)	2-27	11.59 \pm 6.54
No change	3 (4.8%)		
Decrease	1 (1.6%)	1-1	1.00
Tense arousal (from Pretest 2 to Posttest 0)			
Increase	49 (77.8%)	1-18	5.75 \pm 3.50
No change	3 (4.8%)		
Decrease	11 (17.5%)	1-10	3.00 \pm 2.90
Feeling Scale (from the 7th to the 27th min of exercise)			
Increase	28 (44.4%)	1-2	1.18 \pm 0.39
No change	9 (14.3%)		
Decrease	26 (41.3%)	1-6	1.73 \pm 1.22
Felt Arousal Scale (from the 7th to the 27th min of exercise)			
Increase	43 (68.3%)	1-3	1.40 \pm 0.62
No change	18 (28.6%)		
Decrease	2 (3.2%)	1-1	1.00 \pm 0.00

part of the sample (28.6%) reported no change. Finally, in the most striking finding, the sample was found to be divided in two almost equal halves with respect to changes in affective valence during exercise, as indexed by the FS: 44.4% reported improvements by 1 to 2 points, whereas another 41.3% reported a deterioration of valence by 1 to 6 points. The remaining 14.3% of participants remained stable during the exercise bout. In other words, in the case of the FS, the conclusion that was derived from the aggregate-based analysis (i.e., that there were no significant changes in FS during exercise) was found in actuality to apply to no more than 14% of the sample. For the remaining approximately 86% of the sample, this conclusion misrepresented the actual pattern of changes.

A 3×5 —group (increase, no change, decrease) by time (7th, 12th, 17th, 22nd, 27th min of exercise)—ANOVA on FS scores revealed a significant interaction, $F(18,104) = 8.34, p < .001$. The positive-changing group showed continually improving FS scores throughout the exercise bout, with little change from during to postexercise. The exercise-associated improvement reached significance 15 min into the exercise bout, $p < .01, d = 0.57$, and peaked immediately after exercise, $p < .01, d = 1.2$. In contrast, the negative-changing group showed continually declining FS scores during exercise. This decline reached significance 15 min into the exercise bout, $p < .01, d = -0.41$, and grew progressively larger until the 25th min of exercise, $p < .01, d = -0.76$. Immediately after exercise, however, this pattern reversed itself and there was an abrupt rebound in FS, $p < .01, d = 1.4$. Although the postexercise FS scores were markedly higher than those during exercise, they were not significantly higher than baseline levels until Posttest 20, $p < .05, d = 0.48$.

By cross-tabulating membership in the groups that were formed on the basis of their change trends in FS and FAS, five of the nine cells were found to include 6 or more individuals (see Table 4): (a) 6 individuals exhibited stable activation coupled with improving valence (Act=Val+), (b) 11 exhibited stable activation coupled with worsening valence (Act=Val-), (c) 8 exhibited increasing activation but remained stable in terms of valence (Act+/Val=), (d) 21 exhibited increasing activation coupled with improving valence (Act+/Val+), and (e) 14 exhibited increasing activation coupled with deteriorating valence (Act+/Val-). These five response patterns accounted for 95% of the sample, and the latter two alone represented 56% of the sample. Figure 2 shows the mean responses of the exercise group on the FS and FAS plotted in circumplex space. This pattern can be contrasted with Figures 3a–e, which depict the response trajectories of the five subgroups just described.

Table 4 Cross-Tabulation of Subgroups Exhibiting Increases, Decreases, or No Changes in Affective Valence (FS) and Activation (FAS)

Valence (FS)	Activation (FAS)		
	Increase	No change	Decrease
Increase	21 (33.3%)	6 (9.5%)	1 (1.6%)
No change	8 (12.7%)	1 (1.6%)	0 (0.0%)
Decrease	14 (22.2%)	11 (17.5%)	1 (1.6%)

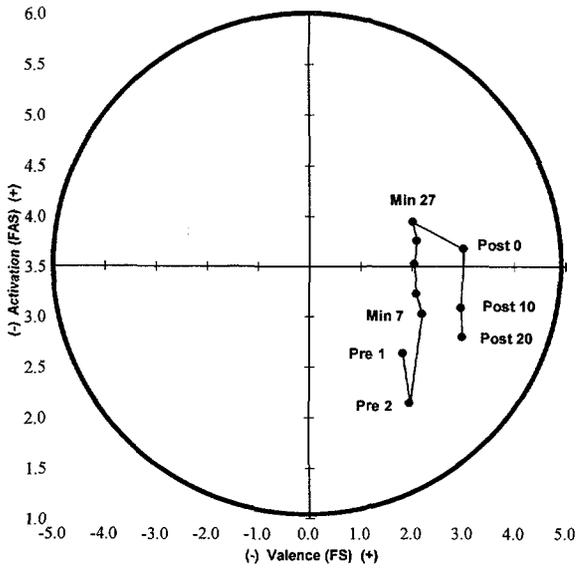


Figure 2 — Changes in affective valence (FS) and activation (FAS) before, during, and after the exercise bout plotted in circumplex space.

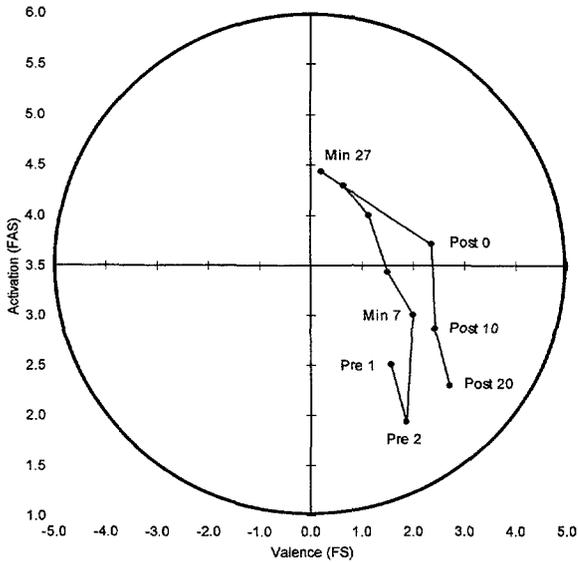


Figure 3a — Affective response pattern for subgroup Act+/Val- (n = 14).

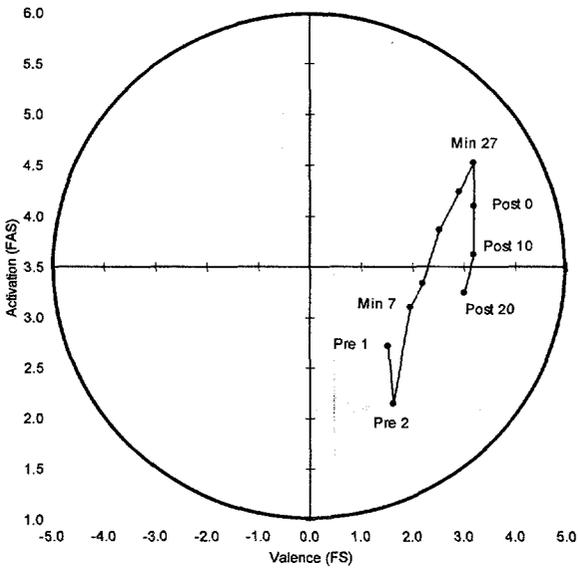


Figure 3b — Affective response pattern for subgroup Act+/Val+ (n = 21).

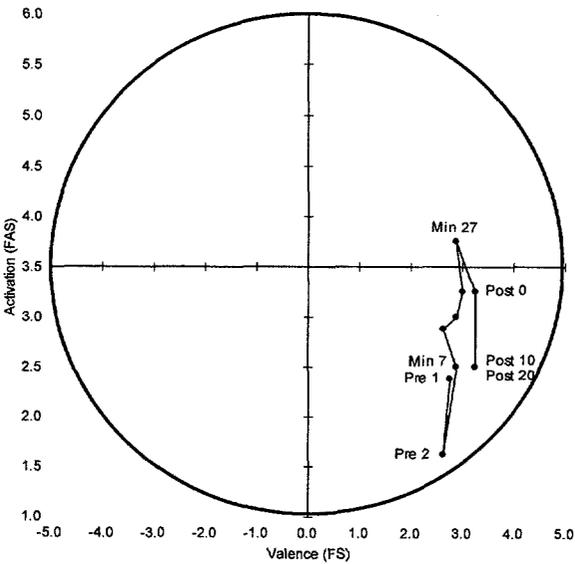


Figure 3c — Affective response pattern for subgroup Act+/Val= (n = 8).

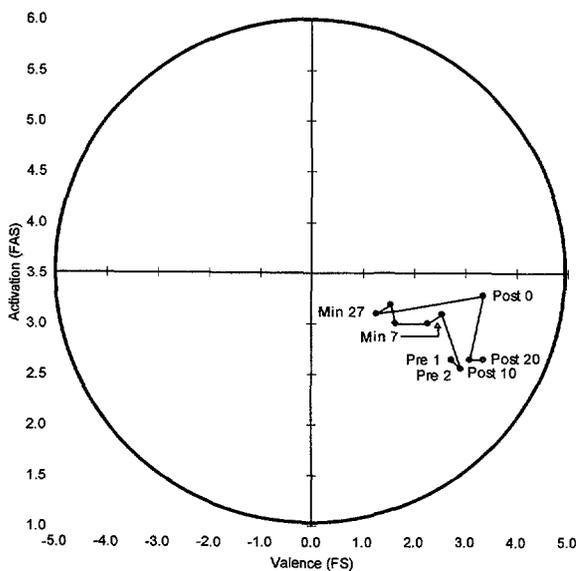


Figure 3d — Affective response pattern for subgroup Act=/Val- ($n = 11$).

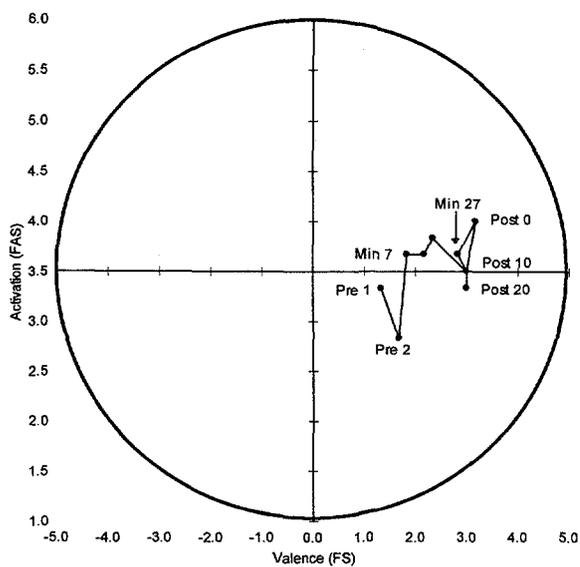


Figure 3e — Affective response pattern for subgroup Act=/Val+ ($n = 6$).

Discussion

The American College of Sports Medicine (1995) characterizes exercise prescription as an “art” (p. 155). This is because,

given the diverse nature and health needs of the population, . . . guidelines cannot be applied in an overly rigid or precise fashion, that is by simply applying mathematical calculations based on test data. The techniques presented should be used with flexibility and with careful attention paid to the goals of the individual. Exercise prescriptions will require modifications in accordance with observed individual responses and adaptations. (p. 155)

The emphasis on *individual* preferences and responses is quite common in writings that highlight “enjoyability” as a critical determinant of exercise adherence (King & Martin, 1993). Yet researchers often find that the intuitive need to acknowledge individual variability is hard to reconcile with the deep-rooted preoccupation with the pursuit of the “perfect” nomothetic model. To resolve this conceptual quandary, many researchers have adopted the assumption that moderate-intensity exercise (i.e., not “too much,” not “too little”) is a safe and effective prescription that can lead to positive affective changes “in all individuals” (Morgan, 1997, p. 11). The rationale is that, although some individuals might *prefer* to exercise at lower or higher intensities, moderate-intensity exercise will still make them feel good or, at worst, will not make them feel bad.

In the present study, we examined the extent to which this proposition actually applies to individuals, as opposed to averages derived from entire groups. As described in the introduction, although we took several steps to control factors external to the exercise stimulus itself that are known to introduce variability in affective responses to exercise, we also sought to assess affective responses in a comprehensive and unbiased fashion. This entailed (a) monitoring affective states before, during, and after exercise, as opposed to limiting the investigation to affective changes from pre- to postexercise, and (b) examining affective responses from a global-dimensional, as opposed to a restricted-categorical, framework. The description of responses in terms of the basic dimensions of affective space ensured that salient affective changes, regardless of their magnitude or direction, would be properly identified.

According to the unitary and nomothetic views of the exercise–affect relationship that we discussed in the introduction, interindividual variation in affective responses to moderate-intensity exercise is traditionally assumed to manifest itself as differences in the *magnitude* of the response, not the *direction*. The results of the present study, however, indicate that individuals responded in largely the same direction, albeit to notably different degrees, on only two of the self-report affective measures employed: the EA scale of the AD ACL, with all but 1 participant showing improvements (93.7%) or no change (4.6%) from pre- to immediately postexercise (including cool-down), and the FAS, with all but 2 participants showing increases (68.3%) or no change (28.6%) from the first to the last during-exercise assessments. On the contrary, although the aggregate-based statistical analyses indicated that exercisers responded with significant postexercise increases in TA and no significant changes in FS during exercise, an examination of individual cases demonstrated important deviations from this pattern in substantial

portions of the sample. Specifically, it was found that, although most individuals (77.8%) did in fact experience postexercise increases in TA by up to 18 points, 17.5% of the sample responded in the opposite direction, reducing their TA scores by up to 10 points. In terms of the changes in affective valence experienced during exercise (as indexed by the FS), the situation was more dramatic. The aggregate-based finding that the exercise stimulus did not elicit any affective changes was found to represent no more than 14.3% of the sample. In actuality, the rest of the sample was divided in two almost equal halves, with one half reporting progressive improvement in valence and the other half reporting progressive deterioration from the 7th to the 27th min of the exercise bout.

In light of previous findings that individual response patterns might be influenced by the "law of initial values" (i.e., higher initial values associated with decreases, lower initial values associated with increases; see Gauvin et al., 1996, 1997; Raglin & Wilson, 1996; Rejeski et al., 1995), we did investigate this possibility by examining differences in initial scores between "increasers" and "decreasers" in TA and FS. In TA, the 11 decreasers did in fact have a significantly higher mean score at Pretest 2 compared with that of the 49 increasers (20.6 versus 14.6, respectively; $p < .001$). This was not the case with FS, however; the 26 decreasers and the 28 increasers differed negligibly at the first during-exercise assessment (2.27 vs. 1.96; $p > .05$) and the two preexercise assessments (at both times, $p > .05$). Therefore, although individual response patterning in TA might be attributable in part to a tendency to regress toward the mean, initial values did not appear to have influenced the patterning of responses in FS.

The expression of divergent and almost mirror-image change patterns in FS during exercise in different subgroups of individuals caused the mean scores of the group to appear stable throughout the exercise session. This finding should alert researchers to the potential interpretational pitfalls associated with aggregate-based analyses. In a previous study, for example, Boutcher, McAuley, and Courneya (1997) reported that FS scores remained unchanged as groups of trained and untrained participants ran consecutively at light, medium, and hard self-rated intensities. As was the case in the present study, this finding might have been the result of divergent response patterns within the groups.

In two previous studies, examinations of individual patterns of affective change revealed remarkable diversity that was masked by aggregate-based analyses. Ekkekakis et al. (1997) examined the affective responses of 8 trained cyclists to a bout of cycle ergometry performed in the heat, under conditions of dehydration, until exhaustion. The average response was a shift toward a deactivated unpleasant state, compelling one to interpret it as evidence that this type of exercise has a fatiguing effect. However, in actuality, this pattern only reflected the changes experienced by 2 of the 8 individuals. Similar findings were reported in a dose-response study involving three levels of imposed exercise intensity (30–35%, 50–55%, and 65–70% of age-predicted maximal heart rate reserve) and a self-selected intensity (Zervas, Psychountaki, & Ekkekakis, 1999). When individual changes were examined, all four conditions were found to be associated with increases, decreases, and no changes in affective ratings, with no discernible systematic differences among conditions.

Our results indicate that the divergent negative and positive shifts observed during exercise among individuals were unified in a positive upswing immediately after exercise. Other authors who have noted a similar pattern have argued

that exercisers should try to “focus” on how they felt after, as opposed to during, exercise (e.g., Parfitt & Eston, 1995). Generally, views that deemphasize the motivational consequences of any negative affective changes that occur during exercise are not uncommon. From this perspective, negative changes are dismissed as being short lived, and, instead, emphasis is placed on the fact that they are typically succeeded by more robust and longer lasting positive changes (e.g., Morgan & Ellickson, 1989). It is important to remember, however, that whether the negative changes during or the positive rebound after exercise have a more salient motivational impact is entirely unknown at this point. It is also unknown whether individuals can selectively attune (or be trained to attune) to the positive parts of their experience and dismiss the negative ones. Although we emphasize that our views on this topic are just as speculative as those of others, we caution that such suggestions seem to disregard the important role that unconscious processes might play in the formation of avoidance tendencies (Reber, 1993). Therefore, it is premature to dismiss the possible motivational implications of the negative affective changes experienced by some individuals during exercise. The impact of these negative shifts on exercise adherence remains to be investigated.

The present study was designed to examine the prevalence of individual patterning in affective responses to moderate-intensity exercise, but it was not designed to explore the substrates of these individual differences. In post hoc analyses, we failed to find an association between increasing or decreasing tendencies in FS and estimated $\text{VO}_{2\text{max}}$; perceived exertion; gender; self-reported intensity, duration, or frequency of habitual physical activity; or the scales of the Behavioral Inhibition System–Behavioral Activation System questionnaire (Carver & White, 1994).

Ekkekakis and Petruzzello (1999) surveyed several individual difference constructs that have been theorized to mediate the relationship between degree of stimulation and affect (e.g., extraversion, sensation seeking, telic/paratelic dominance). However, in pilot work using the standard, non-exercise-specific self-report measures of these constructs, we have failed to establish a reliable association between any of these traits and affective responses to exercise. Nevertheless, we believe that future research on the role of these traits is warranted, particularly in the direction of devising self-report measures with exercise-specific references and assessing theoretically relevant psychophysiological indices of approach versus avoidance dispositions in the exercise context (Hall, Ekkekakis, Van Landuyt, & Petruzzello, 2000; Petruzzello, Hall, & Ekkekakis, in press; Petruzzello & Landers, 1994; Petruzzello & Tate, 1997).

Other researchers have reported that people’s preference for an active as opposed to sedentary lifestyle and maintaining moderate as opposed to more vigorous physical activities might have a genetic substrate (Lauderdale et al., 1997). This could be related to the tendency to seek out new and exciting stimuli (McGue & Bouchard, 1998) or the sensitivity to or tolerance of nociception (Mogil, 1999), which also appear to have genetic bases. These possibilities warrant research attention in the future.

The five idiosyncratic response patterns identified by plotting individual responses in circumplex space (see Figures 3a–e) seem to support Feldman-Barrett’s (Feldman, 1995a, 1995b; Feldman-Barrett, 1998) contention that people differ in terms of their “valence focus” and “arousal focus.” These terms describe the degree to which individuals attend to and discriminate between gradations of the

valence or the activation dimension of their affective experiences, respectively. In the present study, 8 exercisers (12.7%) exhibited changes along the activation but not the valence dimension during exercise, whereas 17 exercisers (27%) exhibited changes along the valence but not the activation dimension. This issue has some additional theoretical implications. Most mainstream psychology researchers who have used exercise interventions have assumed that exercise produces activation that is devoid of valence. This activation serves only as an affective substrate, which is "colored" by assigning to it a "positive" or a "negative" evaluation and label through a process of cognitive appraisal (e.g., see Anderson, Deuser, & DeNeve, 1995; Isen, Daubman, & Nowicki, 1987; Sinclair, Hoffman, Mark, Martin, & Pickering, 1994). Our findings and Feldman-Barrett's suggestions indicate that there might be complex individual differences in the manner in which affective responses to exercise are generated. Although some individuals might indeed experience exercise as an affectively vacuous, merely activation-inducing stimulus, those with a valence focus might tend to attune closely to the positive or negative stimulus properties of exercise.

Provided that the results reported herein are replicated, we believe that they have far-reaching practical implications for public health physical activity recommendations. The progress reports of the Healthy People 2000 program show that most Americans avoid regular physical activity. The portion of the population that engages in light to moderate physical activity 5–7 times per week remains virtually unchanged since 1985, substantially short of the target figures (United States Department of Health and Human Services, 1999). This creates an urgent need to reevaluate the assumptions underlying prescription guidelines for health-oriented physical activity. The affective changes experienced by individuals in response to an exercise bout might partly determine whether they will adhere to the exercise program over the long haul. In exercise (Wankel, 1993), as in other domains (Emmons & Diener, 1986), people are likely to do what makes them feel good and avoid what makes them feel bad. In this context, it is important to realize that unitary and nomothetic conceptions of the exercise–affect relationship, regardless of their intuitive appeal, provide poor accounts of the diversity encountered in real-life affective responses. As such, they can misguide recommendations to the public, misinform practitioners, and do a disservice to individuals who make the critical decision to begin an exercise program. Abandoning the traditional unitary and nomothetic views will surely bring more complexity to conceptual models. But, to use Galton's words from over a century ago, the appreciation for the "charm of variety" also has the potential to improve the scientific quality of these models and, ultimately, the effectiveness of public health physical activity recommendations. As Allport (1940) put it, "psychology will become *more* scientific, i.e., better able to make predictions, when it has learned to evaluate single trends in all their intrinsic complexity" (p. 17).

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