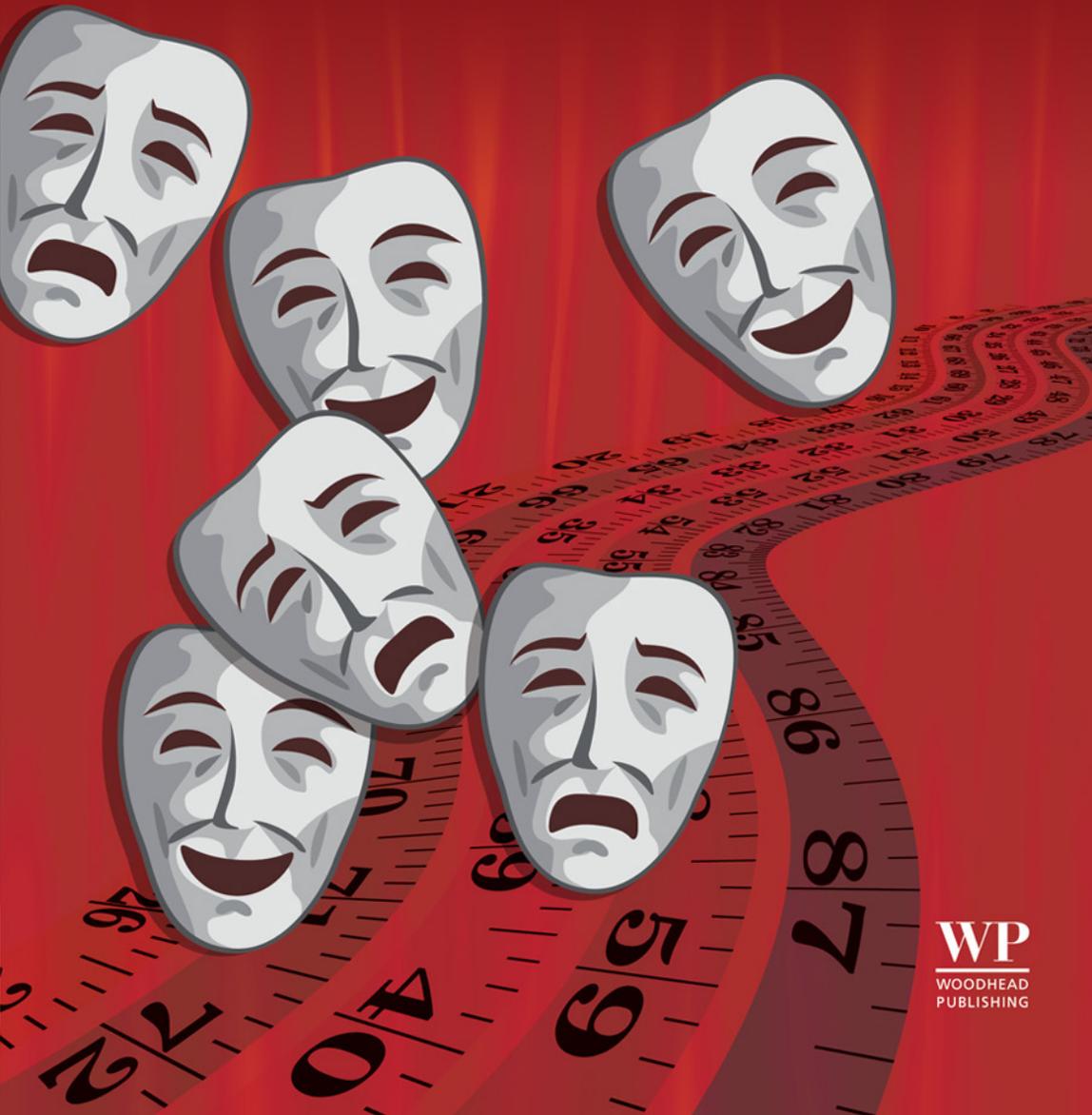




# Emotion Measurement

Edited by Herbert L. Meiselman



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*Edited by*

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# Measurement of Affective Responses to Exercise: From “Affectless Arousal” to “The Most Well-Characterized” Relationship Between the Body and Affect

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Why is there a chapter on exercise included in a book about the measurement of emotion? Exercise, physical activity, and the movement of the human body more broadly, are not topics that readers are used to seeing in books about psychological constructs. Within affective psychology, in particular, these topics are essentially absent. Thus, most scholars would probably be surprised to learn that this was not always the case. In this chapter, we present the study of affective responses to exercise as an example of a research field that was reinvigorated and reoriented along a path to societal relevance by critically reevaluating the way in which its primary outcome of interest, namely affect, was conceptualized and measured. We describe this experience as a possible roadmap for other fields of applied psychological research facing similar measurement-related challenges. We begin with a historical review, to illustrate the epistemological processes through which this line of research was initially led astray, before we outline the corrective actions that were taken and the fruits these actions have borne.

## 1 History from the perspective of psychology

In the late 19th century, it was not uncommon to find extensive discussions on the feelings and emotions associated with exercise and physical exertion in the pages of the books that later came to be regarded as the foundational works of modern psychology. [Bain \(1855\)](#) devoted extensive parts of his *Senses and the Intellect* to the pleasures and displeasures associated with exercise, writing that tasks involving muscular contractions, such as “hard exercise or bodily toil” result in “a feeling of vigour, strength, or intense vitality,” which “counts for a considerable portion of the sum of human pleasure” (p. 92). In the second edition of *The Principles of Psychology*, [Spencer \(1870\)](#) used the pleasure and displeasure associated with exercise as examples to illustrate the crucial function of feelings for

adaptation: “pains are the correlatives of actions injurious to the organism, while pleasures are the correlatives of actions conducive to its welfare” (p. 279). He wrote:

*To a person in health duly rested, the feeling that accompanies absolute inaction of the muscles is unbearable; and this inaction is injurious. On the other hand, extreme exertion of the muscles in general is alike distressing and productive of prostration, while exertion of a particular muscle pushed to a painful excess, leaves a temporary paralysis, and occasionally, by rupturing some of the muscular fibres, entails prolonged uselessness. (pp. 278–279)*

Darwin (1872), in *The Expression of the Emotions in Man and Animals*, noted that “the mere exertion of the muscles after long rest or confinement is in itself a pleasure, as we ourselves feel, and as we see in the play of young animals” (p. 77). In North America, Baldwin (1891) also addressed the pleasure and displeasure associated with exercise. In his *Feeling and Will*, which was the second volume of his *Handbook of Psychology*, he wrote that “muscular sensations are pleasurable within the range of easy effort” and even argued that “these pleasures of activity, such as pleasures of the chase, of sports, of general vigor, are more positive apparently than any other sensuous pleasures” (p. 120).

At the time, as the nascent field of psychology was attempting to establish itself as a legitimate science, discussing the interaction between bodily states and human subjective experiences made sense. These pioneers knew that the path to scientific respectability required demonstrating that psychology dealt with real, rather than metaphysical, abstract, or undefinable, phenomena. Exercise was seen as an apt and powerful example that served this purpose well. This is because everyone likely had first-hand experience with the drowsiness of extended bed rest, the invigorating feeling of a brisk walk, and the exhaustion of a hard run or a long day of physical labor. These shared experiences, all clearly emanating from and linked to the function of the physical body, illustrated in vivid fashion the indisputable physicality (ie, reality) of these subjective feelings.

For the first 70 years of the 20th century, however, under the influence of behaviorism and later cognitivism, the affective responses to exercise were effectively eliminated from psychological research and theorizing (see Ekkekakis, 2013a, for a more detailed review). Under behaviorism, the apparently self-rewarding nature of spontaneous running in rodents was a bewildering mystery to researchers. Since internal, subjective feelings of pleasure or displeasure had been banished from the scope of scientific psychology, it was inexplicable why an animal would run, protractedly and persistently, in the absence of an electric shock or the pursuit of food. Cognitivism was open to subjective states but subdued the body to a subservient role, as a physical accessory to an omnipotent, disembodied, cognitive apparatus. Cognitivist theorists readily adopted Walter Cannon’s earlier critique of the James–Lange theory of emotion, viewing bodily stimuli as too diffuse and undifferentiated to be meaningful determinants of the extremely intricate and varied repertoire of human emotions. In the highly influential cognitive theory of emotion by Richard Lazarus, for example, feelings originating in the body were either discarded as mere sensorimotor reflexes

of no psychological interest or pliable raw sensory material that can be transformed into diametrically opposite experiences by merely altering the manner in which they are appraised. According to Lazarus (1984), exercise produces nothing more than “arousal.”

Perhaps the most significant contributor to the neglect of the affective responses to exercise within the psychological literature was the line of research on “excitation transfer” that was initiated by Dolf Zillmann in the 1970s. Echoing the prevalent view of the time that exercise produces only undifferentiated “arousal” devoid of any affective content, Zillmann, Katcher, and Milavsky (1972) used exercise (cycling) to create in their participants a state of “excitation,” which, they claimed, was subsequently “transferred” to a retaliatory aggressive behavior following a provocation. So convinced were psychologists that exercise could only produce a state of high arousal completely devoid of affect, that for decades researchers simply assumed that this was so, without testing this assumption empirically.

Among numerous such examples, in a classic study cited over 1000 times, Isen, Daubman, and Nowicki (1987) used exercise to induce what they termed “affectless arousal” (p. 1122) or “arousal devoid of any particular affective tone” (p. 1128). Believing that exercise would not influence affect, they administered a scale measuring “affective tone” (feel “positive” vs “negative”) only after exercise, making it impossible to ascertain whether a change from baseline took place. Upon reflection, the authors deemed that the use of such a measure was “inappropriate ... for treatments such as the exercise condition, in which ... there is no apparent reason for the question and it is therefore too reactive” (p. 1125).

In another example highlighting the importance of proper measurement, Anderson, Deuser, and DeNeve (1995) used exercise to test the validity of a self-report measure of arousal. Finding that the scores on the scale increased from before to after exercise, and subsequently decreased during recovery, the authors concluded that the measure was “sensitive to changes in perceived arousal created by brief exercise” (p. 441). While this might have seemed a reasonable conclusion, closer inspection of the items of this measure reveal a nearly perfect confound of arousal and pleasure. Almost all items believed to indicate high arousal also denoted pleasure (eg, energetic, lively, vigorous, excited, sharp, alert, powerful). Conversely, almost all items believed to assess low arousal also denoted displeasure (eg, depressed, weak, drowsy, exhausted, sluggish, weary, dull, tired, worn-out, fatigued, sleepy). Therefore, the conclusion that exercise induced a state of pleasant high arousal arguably would have been more accurate.

## 2 History from the perspective of exercise science

Although statements extolling the benefits of exercise for mental health can be found in many ancient texts, as well as in the writings of passionate advocates for exercise and fitness from the fields of medicine, education, and physical education in the 19th and 20th centuries, formal research on this topic only began in the 1970s.

The impetus was an article published in the prestigious *New England Journal of Medicine* in December 1967 by psychiatrists Pitts and McClure (Pitts & McClure, 1967). Prompted by observations that symptoms characteristic of anxiety had been reported in response to exercise among patients with anxiety, Pitts and McClure claimed to have demonstrated that an infusion of lactate (a byproduct of glucose metabolism, which is elevated in blood in response to vigorous exercise) in patients with anxiety “reliably produces an anxiety attack” (p. 1334). In follow-up publications, Pitts (1971) more clearly implicated the elevated levels of lactate in response to exercise in causing anxiety attacks: “exercise produces both markedly enhanced anxiety symptoms and markedly increased blood lactate (as compared to normals) in anxiety neurotics” (p. 86). These statements were seized by the press and portrayed as suggesting that the avoidance of physical exertion was essential for the prevention of anxiety attacks in individuals with anxiety.

The Pitts–McClure hypothesis was unanimously refuted in subsequent studies, with commentators criticizing both the conceptual reasoning behind it and the experimental data that were used to support it. Nevertheless, the extensive publicity made many medical professionals reluctant to recommend exercise to their patients and many patients hesitant to follow recommendations to exercise. Exercise scientists, who typically also tend to be exercise advocates, quickly realized the potential ramifications of this trend and felt the need to respond.

Morgan, Roberts, and Feinerman (1971) wrote that, while the Pitts–McClure conclusions “imply that physical activity may evoke undesirable psychologic changes,” this contrasts with numerous anecdotal observations, in which “‘normal’ individuals invariably report that they feel better following physical activity” (p. 423). Noting that “unfortunately, this ‘feeling better’ sensation has not been corroborated by objective psychologic data” (p. 423), Morgan et al. (1971) conducted the first experimental studies on this topic. In their first study, 120 male university professors were randomly assigned to either a bout of exercise on a treadmill ( $N = 60$ ) or a cycle ergometer ( $N = 60$ ), with each group further randomly subdivided into groups ( $n = 15$  each) that raised their heart rate during exercise to 150, 160, 170, or 180 beats/minute. After a recovery electrocardiogram that took 5 minutes, the participants completed the Depression Adjective Check List (Lubin, 1965), which was administered with a “How you feel today” response set. In a second study, 36 university students (men and women) were randomly assigned to one of three conditions, each lasting 17 minutes: (1) treadmill walk at 3.5 miles/hour and 0% grade, (2) treadmill walk at 3.5 miles/hour and 5% grade, or (3) supine rest. Immediately after these treatments, the participants responded to the Depression Adjective Check List (Lubin, 1965) and the Institute for Personality and Ability Testing Anxiety Battery (Cattell & Rickels, 1964). No significant group differences were found in either study. Nevertheless, the authors noted that “even though significant psychologic changes were not observed, the majority of the subjects tested in these studies reported that the exercise bouts were exhilarating and they ‘felt better’ following the exercise” (Morgan et al., 1971, p. 425). The authors identified the “psychometric instruments” as the central culprit responsible for the inconsistency between the anecdotal reports from participants and their questionnaire data: “It is possible that the psychometric instruments were not

sensitive enough to measure psychologic changes in normal subjects” (p. 425). In response, they announced that they were “constructing a feeling better scale (FBS) in the hope of quantifying the feeling better sensation” (p. 425).

In actuality, the “Feeling Better Scale” was never developed or at least never published. The reason was the publication of the State-Trait Anxiety Inventory (STAI; [Spielberger, Gorsuch, & Lushene, 1970](#)) and the Profile of Mood States (POMS; [McNair, Lorr, & Droppleman, 1971](#)), which, as it turned out, provided the needed evidence of psychological benefits resulting from exercise. [Morgan \(1973\)](#) reported a series of small studies in which vigorous exercise (ie, at an intensity that should have resulted in substantial elevations of blood lactate concentrations) resulted in reductions in state anxiety and mood disturbance. [Morgan \(1973\)](#) concluded that these findings “seriously challenge the Pitts–McClure hypothesis” since they demonstrate that “muscular exertion reduces, not increases, state anxiety” (p. 114). These initial findings formed the basis of a line of research which, over the next four decades, produced hundreds of studies and dozens of reviews, overwhelmingly claiming to demonstrate that “exercise makes you feel good” ([Fox, 1999](#), p. 413). This mantra still represents the orthodox viewpoint within exercise science. As such, it is echoed in university textbooks and the popular press alike.

There is one problem, however. If “exercise makes you feel good” were true, it would be reasonable to surmise that most people would choose to exercise and be physically active. In other words, there would not be an epidemic of physical inactivity. However, a nationwide study in the United States showed that, when physical activity was measured by objective means (by devices called accelerometers), 97% of adults failed to accumulate 30 minutes of daily moderate-intensity activity on at least 5 days/week ([Tudor-Locke, Brashear, Johnson, & Katzmarzyk, 2010](#)), which is the currently recommended minimum amount of physical activity for health promotion. This suggests that either the particular behavior of physical activity represents the starkest violation of the basic hedonistic principle that has ever been identified or there is something fundamentally wrong with the research ([Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007](#)).

### **3 The dependence of the research process on measurement**

The history summarized in the previous sections illustrates certain noteworthy pitfalls in the research process. In psychology, researchers relied for decades on the untested assumption that exercise produces nothing more than “affectless arousal.” Even when they ventured to empirically test this assumption, weaknesses in the measurement were overlooked, leading researchers to conclude that the previous assumption was correct. Similarly, in exercise science, measurement was seen as a tool whose function was to generate empirical substantiation for a conclusion that fit a virtuous agenda, namely the promotion of salubrious exercise and physical activity.

A valuable lesson that can be learned from this past experience is that, once a certain research practice (eg, acceptance of an untested assumption, selection of a

particular measure) enters the literature, it is likely to be emulated, without critical reappraisal, perhaps even for decades. One of the factors that may motivate this tendency is the fear that, if a crucial methodological element (such as measurement) is deemed erroneous, years of previous research would be called into question. Thus, research often continues down the wrong path because the alternative (ie, taking corrective action but, in the process, possibly invalidating a portion of past findings) is considered too costly. This scenario occurs with sufficient regularity that it warranted a specific warning in the report of the Task Force on Statistical Inference of the American Psychological Association: “Innovators, in the excitement of their discovery, sometimes give insufficient attention to the quality of their instruments. Once a defective measure enters the literature, subsequent researchers are reluctant to change it” (Wilkinson, 1999, p. 596).

In psychology, dozens of published articles reproduced the notion that exercise elicits “arousal” that is devoid of any positive or negative affective content. The studies that were based on this untested assumption are still cited as valid today. In exercise science, the STAI and the POMS, the two measures selected by Morgan in the early 1970s as the only available options that quickly enabled him to respond to the Pitts–McClure hypothesis, remain the most widely used measures in investigations examining the effects of exercise (Ensari, Greenlee, Motl, & Petruzzello, 2015). In fact, extensive prior usage within this research context is explicitly cited as the main reason for their selection, an argument that is evidently found adequate and convincing by peer reviewers and journal editors alike. For example, in one study, the STAI was selected because it “is the most cited anxiety instrument in the context of exercise” (Smith, 2013, p. 373). In another, the POMS was used because it “has been used in many exercise studies” (Sibold & Berg, 2010, p. 335). In a third study, both questionnaires were used; the former “to allow for comparisons” with previous studies and the latter because it is “one of the most frequently used mood measures in sport and exercise psychology” (Johansson, Hassmén, & Jouper, 2011, p. 61).

Under normal circumstances, researchers must first decide which construct to study and, only once they have achieved clarity on this fundamental question, proceed to the equally demanding and complicated step of selecting the best instrument for assessing this construct. It is evident, however, that given the peculiar origins of research on the effects of exercise on the affective domain (ie, haste to document the “feel-good” phenomenon with whatever psychometric instrument was available), this natural progression was violated. In essence, the availability of measures at a particular historical juncture dictated the focal constructs.

It is interesting to note that this point was later conceded by William Morgan. After noting that “much, perhaps most, of the literature dealing with the psychologic effects of exercise has relied on the use of objective self-report inventories designed to measure constructs such as anxiety and depression,” Morgan (1984) acknowledged that this has happened despite the fact that “the extent to which these inventories can tap the psychometric domain of significance to the exerciser has not been evaluated” (p. 134). Among the possible consequences of violating the natural progression from identifying a construct of interest to selecting an appropriate measure, Morgan wrote that “an investigator may employ an objective, reliable, valid test of anxiety or depression to

quantify the psychological effects of exercise, only to find that no ‘effects’ have taken place when, in fact, there may have been numerous effects” (p. 134).

## 4 The importance of knowing your measure

The research on the effects of exercise on state anxiety and mood states, despite the methodological shortcomings that characterize all emerging lines of research, has been instrumental in launching the fascinating and prolific field of exercise psychology. A major focus of this field is on the effects of exercise and physical activity on numerous facets of mental health. Based on research produced over the past half century, clinical guidelines in several countries today recommend exercise as an evidence-based, cost-effective option for the treatment of adult depression. In addition, for many people, exercise and physical activity are their preferred options for regulating mood. While the achievements of this line of research are undeniable, some methodological limitations remain, with measurement being perhaps one of the most consequential. In the following sections, we critically review the three most commonly used psychometric instruments and highlight certain limitations and their implications. Identifying limitations, and appreciating their possible implications, is an important first step in initiating corrective actions and stimulating progress.

### 4.1 *Understanding the State-Trait Anxiety Inventory (STAI)*

Not surprisingly, some of the problems plaguing the measurement of emotion-related constructs in other areas of psychology have also been prevalent in the line of research investigating the effects of exercise. For example, the state-anxiety scale of the STAI (Spielberger et al., 1970) is commonly used as a general measure of “how people feel” when they exercise. However, this scale was developed to measure a very specifically defined and narrowly demarcated emotional response (ie, state anxiety), in accordance with Spielberger’s highly influential cognitive theory of anxiety. Thus, in the context of this theory, a state-anxiety response is theorized to occur following an appraisal of (mainly ego-related rather than physical) threat. The state-anxiety scale of the STAI was developed to assess a constellation of cognitive, experiential, behavioral, and perceived autonomic symptoms, presumed to manifest in unison, and jointly constitute a “syndromal” response to the appraisal of threat. According to Spielberger, Lushene, and McAdoo (1977), state anxiety is an “emotional reaction or response that is evoked when a person perceives a particular situation as personally dangerous or frightening for him” (p. 242, sexist language in the original). Thus, for the STAI items to be considered valid indicators of the construct of state anxiety, it is assumed that, prior to responding to the questionnaire, the research participant was presented with a potentially threatening stimulus and that this stimulus was cognitively appraised as threatening: “If an individual appraises a specific situation as threatening, it is assumed that he will respond to it with an elevation in [state anxiety]; ie, he will experience an immediate increase in the intensity of an unpleasant emotional state characterized by consciously experienced feelings of tension, apprehension, and

heightened autonomic system activity” (p. 242). In other words, the theory upon which the STAI was based sets forth a very specific scenario in which the measure should be used and the scores should be interpreted.

Research within the context of acute exercise has uncovered an additional pitfall that had not been identified in other contexts. Specifically, in most other research situations, experimental manipulations specifically target the appraisal of threat, either trying to induce it (eg, exposing participants to a phobic object) or alleviate it (eg, through sessions of cognitive-behavioral psychotherapy). In these scenarios, the items of the state-anxiety scale respond in a more-or-less unified fashion (ie, there may be differences in the degree of change but typically not in the direction of change). This pattern of results is in line with Spielberger’s theory and has, therefore, appropriately been considered evidence supporting the validity of the state-anxiety scale. However, in exercise studies, experimental manipulations are designed to change the level of autonomic activation (increase it during exercise, decrease it during recovery), not the appraisal of threat. This is a unique experimental scenario that seems inconsistent with Spielberger’s theory of anxiety. Consequently, the item pool exhibits a “fission” phenomenon, with items that tap somatic activation responding in an opposite direction from others. For example, in response to a bout of exercise, participants report being less “at ease,” less “calm,” less “relaxed,” less “steady” (all scored as indicating a higher level of state anxiety) but also, at the same time, less “nervous” and less “worrying” (Ekkekakis, Hall, & Petruzzello, 1999). Not only does this phenomenon cause a disintegration of the internal consistency of the scale but it also clearly renders the total score invalid as a measure of state anxiety as conceptualized by Spielberger.

Despite these issues, the STAI remains one of the most popular measures in studies investigating the effects of exercise on “how people feel.” This is in spite of the fact that the participants are, in nearly all cases, neither trait-anxious nor state-anxious, and the experimental protocols do not involve a manipulation of the appraisal of threat (Ensari et al., 2015). Even more disconcertingly, it has become common to administer the state-anxiety scale of the STAI and then interpret the results as referring to the vast and conceptually distinct domain of “mood.” For example, after a comparative evaluation of different measures that could be used to evaluate how patients with fibromyalgia feel in response to exercise bouts, the authors concluded: “we recommend ... the STAI to measure exercise-induced changes in mood” (Gowans, DeHueck, & Abbey, 2002, p. 608).

## **4.2 Understanding the Profile of Mood States (POMS)**

Like the STAI, the POMS remains a very popular measure in studies investigating the effects of exercise on how people feel, nearly half a century after it was first used for this purpose. When authors offer a specific argument to justify the selection of this particular measure, they almost invariably invoke its extensive prior use.

The most common mistake in using the POMS is the inappropriate extrapolation from the six specific states assessed by this questionnaire (ie, tension, depression, anger, vigor, fatigue, and confusion) to the content domain of “mood” in general. For example, after finding that a bout of exercise increased the score of the Vigor scale

and decreased the scores of the Tension and Depression scales, authors commonly conclude that exercise improved “mood.” In other cases, researchers may find that different types or amounts of exercise did not produce significant differences in any of the POMS scales and conclude that the experimental conditions had no effect on “mood.” In making this type of extrapolation, researchers are essentially putting forth the bold theoretical thesis that the global domain of “mood” can be satisfactorily reduced to the six distinct states tapped by the POMS. However, there is neither any empirical evidence that this is true nor even a claim by the developers of the POMS that this was the intent when the scale was developed (McNair et al., 1971).

In actuality, the POMS, originally named the Psychiatric Outpatients Mood Scale, was developed to capture those states that, based on clinical experience, psychiatrists considered relevant in assessing the effects of various psychotropic drugs, particularly among war veterans with anxiety or what would now be characterized as posttraumatic stress. Anxiety and depression were the primary targets. Because the inability to control outbursts of anger or hostility and to maintain adequately high levels of vigor (energy) and low levels of fatigue were commonly reported side effects of medications, these states were also included. Finally, some authors have expressed puzzlement over the inclusion of “confusion” in a questionnaire that purportedly assesses mood, although by most accounts confusion is not a “mood.” This decision can be explained by the desire of the developers of this questionnaire to include a scale that assessed any disruptive effects of psychotropic drugs on judgment and mental clarity. Therefore, despite its unquestionable popularity over many years, it should be clear that using the POMS in exercise studies does not allow researchers to extrapolate findings about the effects of exercise on the global domain of mood.

### **4.3 Understanding the Positive and Negative Affect Schedule (PANAS)**

While not as popular in exercise research as the STAI and the POMS, the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) has also been used in several studies investigating the effects of exercise on how people feel. Unlike the STAI and the POMS, both of which were developed to measure distinct states, the PANAS was developed with the express purpose of capturing two dimensions, namely Positive Affect (PA) and Negative Affect (NA), which can jointly provide an encompassing representation of a global domain of content. Therefore, in theory, by using the PANAS, researchers would be justified in extrapolating from assessing PA and NA to drawing conclusions about a broader, superordinate construct.

While this could be considered an important strength of the PANAS, the potential benefit to researchers is limited by the fact that the exact nature of the superordinate domain of content represented by the item pool is ambiguous. Some items refer to emotions (eg, proud, guilty, ashamed), others refer to mood states (eg, irritable, upset), and others refer to core affect (eg, nervous, jittery). There are even several items that seem to refer to cognitions and self-appraisals (eg, interested, strong, inspired, determined, attentive).

Secondly, the labels given to the two constituent dimensions of the PANAS, namely “PA” and “NA,” have been widely misinterpreted as referring to all varieties

of pleasure and displeasure, respectively. For example, it is common to see PA used as a synonym of “happiness” and NA as a synonym of “sadness.” Moreover, many researchers are convinced that, for example, PA encapsulates the full range of pleasant states, including those that involve high levels of activation (eg, excitement), medium levels of activation (eg, happiness), and low levels of activation (eg, calmness): “Positive affect comprises a range of pleasant states including happiness, excitement, and calmness. Negative affect comprises a range of unpleasant states including anger, sadness, and anxiety” (Jones, Lane, Bray, Uphill, & Catlin, 2005, p. 408). These beliefs are inaccurate, however. Although numerous authors, including the developers of the PANAS themselves, have tried to correct these misunderstandings over the years, their efforts have been largely unsuccessful.

Far from being benign, the confusion has severe and far-reaching implications. The most fundamental postulate in the development of the PANAS was that the PA and NA dimensions are orthogonal (ie, statistically unrelated). In accordance with this postulate, the items comprising the PA and NA factors of the PANAS were specifically selected to minimize the correlation between the two factors. One of the implications of this position is that one can experience both high levels of “PA” and “NA” at the same time. This has been widely misinterpreted as meaning that one can experience both pleasure and displeasure, or happiness and sadness, at the same time.

In actuality, the theoretical model that formed the basis of the PANAS clearly considers “happy” and “sad” as located at the two opposite ends of the same bipolar dimension named “pleasantness–unpleasantness” (see Watson & Tellegen, 1985, p. 221). In other words, contrary to numerous assertions in the literature, happiness is not part of PA and sadness is not part of NA. PA does not encompass all varieties of pleasure and NA does not encompass all unpleasant states. Rather, states characteristic of PA are only those that combine pleasure with high activation (eg, elated, enthusiastic, excited). Likewise, states characteristic of NA are only those that combine displeasure with high activation (eg, distressed, jittery, nervous).

Making things even more confusing, although many researchers have assumed that states like calmness and relaxation would be included in the domain of PA and states like sluggishness and drowsiness would be included in the domain of NA, this is not so. In the conceptual model of the PANAS, calmness and relaxation are, in fact, characteristic of low NA (ie, polar opposites of states like distressed and jittery). Likewise, sluggishness and drowsiness are, in fact, characteristic of low PA (ie, polar opposites of states like elated and enthusiastic).

A crucial point that is almost universally overlooked by researchers who select the PANAS for their studies is that another fundamental postulate used in the development of this measure was that all low-activation states were considered nonaffective and, therefore, were deliberately excluded from the scope of the PANAS. According to Watson and Tellegen (1985), the PA and NA dimensions are “descriptively bipolar but affectively unipolar” (p. 212). This somewhat cryptic statement means that, even though factor analyses yield bipolar factors (eg, distressed and jittery at one end and calm and relaxed at the opposite end), it is only the high-activation poles of these bipolar factors that should be considered affective: “only the high end of each dimension represents a state of emotional arousal (or high affect), whereas the low end of

each factor is most clearly and strongly defined by terms reflecting a relative absence of affective involvement (eg, calm and relaxed for Negative Affect, dull and sluggish for Positive Affect)” (p. 212).

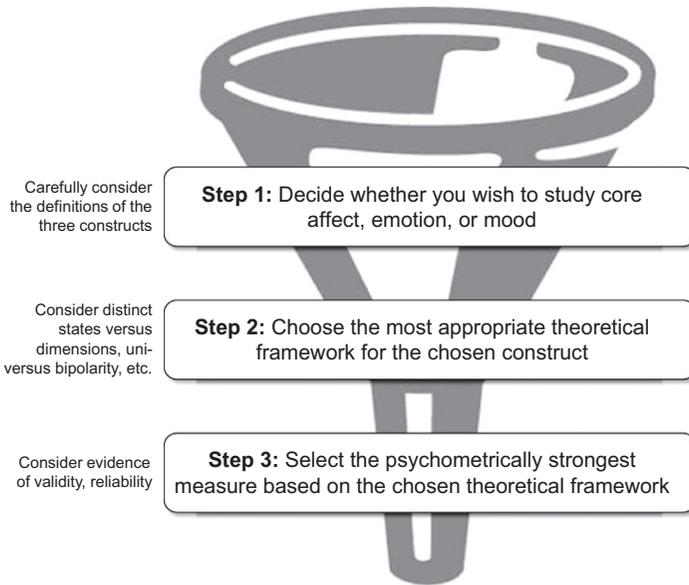
Exercise researchers are probably greatly interested in low-activation pleasant states (eg, calmness, relaxation, serenity) and low-activation unpleasant states (eg, tiredness, fatigue boredom), as these may be relevant to how people feel after a bout of exercise. Thus, most users of the PANAS are surprised when they realize that “the PANAS scales ... contain only the high-end markers and include no items assessing fatigue and serenity” (Watson & Clark, 1997, p. 276). This problem, however, has been raised repeatedly in the affect literature, where experts have issued warnings such as the following: “PANAS-PA and PANAS-NA scales do not measure all pleasant and unpleasant affective states, but rather measure only high-activation states. Researchers using those scales might assume that they are sampling the affective domain broadly, but in fact this is not so” (Feldman Barrett & Russell, 1999, pp. 12–13).

## 5 Three-step approach to measurement

As illustrated in the previous sections, the study of affective responses to exercise, over a period of 40 years, has undergone phases plagued by problems that can be found, in similar form, in several other areas of applied psychological research. These problems include, among others, lack of clarity about the exact nature and the limits of the construct of interest, allowing the availability of measures to dictate what construct is studied, a generally poor understanding of psychometric principles, and deep confusion about the scope and limitations of the most popular measures.

In the last few years, however, substantial progress has been made in the study of affective responses to exercise, as evidenced by several indicators. As one example, in a chapter published in the second edition of the *Handbook of Research Methods in Personality and Social Psychology*, Quigley, Lindquist, and Feldman Barrett (2014) wrote: “Exercise provides perhaps the most well-characterized way to manipulate peripheral physiological arousal producing an affective change” (p. 229). Labeling exercise as “perhaps the most well-characterized way” is significant considering that other methods have been studied not only for much longer periods of time but also by much larger groups of investigators (eg, sympathetic nervous system agonists such as epinephrine, alcohol, nicotine, opioid drugs). Certainly, the dramatic change in the psychological literature, within only the last 30 years, from viewing responses to exercise as “affectless arousal” (Isen et al., 1987) to the description by Quigley et al. (2014) above can be characterized as remarkable.

In the following sections, we outline the specific steps that have led to the transformation of this line of research, in hopes that this recipe can be applied, with similar positive results, to other fields. Specifically, a new approach to the measurement of affect has been the centerpiece of a general overhaul of the methodological platform that is used to study the effects of exercise on the affective domain. This new approach consists of using a three-tiered decision-making process for choosing a measure (Ekkekakis, 2008, 2012, 2013b) (Fig. 12.1).



**Figure 12.1** The three-step system for choosing (and justifying the selection of) a measure of core affect, emotion, or mood.

## 6 Step 1: Decide whether you wish to study core affect, emotion, or mood

As is common practice in most fields of psychological research, studies investigating the effects of exercise on how people feel have generally regarded the affective domain as undifferentiated and all constructs contained therein as essentially interchangeable. In other words, as alluded to in previous sections, it had become common practice, for example, to measure the emotion of state anxiety and then proceed to discuss the findings as referring to the domain of “mood.” This confusion is a direct reflection of the lack of systematic attempts in psychology to draw lines of demarcation between the constructs that fall under the broad umbrella of affective phenomena. Even researchers specializing in the study of affective phenomena freely interchanged the terms “affect,” “mood,” and “emotion” in their writings at least until the 1990s. Since then, however, the hazards of continuing to pretend that this vast and obviously diverse domain is homogeneous became gradually apparent. As a result, leading theorists started proposing tentative sets of defining features that could begin to distinguish important constructs such as core affect, emotions (or prototypical emotional episodes), and mood (Russell & Feldman Barrett, 1999). While the inherent fuzziness of these constructs continues to present considerable challenges and consensus remains a distant and possibly unattainable ideal, a quasiconsensual classification scheme has emerged in practice. As one indication, for example, some textbooks on

emotion for undergraduate students now contain sections that attempt to explain how basic types of affective phenomena differ:

*The term mood refers to a state that typically lasts for hours, days, or weeks, sometimes as a low-intensity background. When it starts or stops may be unclear. Whereas episodes of emotion typically have an object, moods are often objectless and free-floating. We feel emotions about specific people or events. Philosophers call the focus of an emotional experience its “intentional object.” When you are angry, you usually have a very clear sense of what you’re angry about (e.g., your roommate’s arrogance or your dad telling an embarrassing story about your first date). When you’re in an irritable mood, in contrast, it may not be obvious why you feel as you do: the intentional object is less clear.*

*Keltner, Oatley, and Jenkins (2014, p. 28).*

Perhaps, given the complexity of the subject matter, perfect clarity and universal agreement among the members of the research community may never be achieved. Nevertheless, it should be evident that the scientific study of affective phenomena cannot advance without coming to terms with the fact, for example, that the displeasure of pain (an example of core affect), becoming angry at a coworker after a remark perceived as offensive (an emotional episode), and feeling irritable (a mood state) represent substantively distinct phenomena. The need for such distinctions is just as necessary in the context of exercise as it is in any other field of psychological research. This is because, like so many other situations or stimuli in life, exercise can induce responses in all of these classes of phenomena. Running outdoors on a hot and humid day, for example, raises core body temperature and accelerates fluid loss, causing dehydration. The bodily stress caused by these adverse environmental conditions, added to the stress of running itself, induces a strong sense of exhaustion and malaise that neither required an antecedent cognitive appraisal nor can be effectively suppressed by cognitive techniques, such as reframing or reappraisal. Sweating on the elliptical trainer in a crowded gymnasium and becoming aware of the stares of seemingly super-fit and youthful exercisers in revealing attire immediately triggers a cognitive appraisal of failing to live up to societal ideals of the perfectly toned, athletic physique. Leaving the cardiology clinic after a symptomatic treadmill test can put anyone in a negative mood for the rest of the week, causing withdrawal from family and friends, terse reactions during conversations, and an overwhelming sense of pessimism about the future. It is clear that these three scenarios involve varieties of affective responses that are experientially and mechanistically different. Therefore, a sensible approach to researching these scenarios must begin with a clear decision about which type of phenomenon (a core affective reaction, an emotion, or a mood) is involved in each of these situations.

## **6.1 What is core affect?**

Russell and Feldman Barrett (1999) defined core affect as “the most elementary consciously accessible affective feelings... that need not be directed at anything” (p. 806). Unlike emotions (defined next), core affect is not about any particular cause

or object and can be found in “free-floating” form, unaccompanied by a cognitive appraisal, behavioral expressions, or coping attempts. In fact, one always experiences some variety of core affect. Examples of core affects include pleasure, displeasure, tension, and calmness.

Core affect is phylogenetically ancient, with deep evolutionary roots, because it is presumed to serve crucial adaptational functions. Core affect is the most fundamental motivational force, leading individuals to approach useful stimuli and avoid dangerous ones. The ability to elicit free-floating core affective responses in noncognitively mediated fashion has several adaptational advantages, including speed, reliability (due to the absence of any cognitive filtering), and a clear prioritization of behavioral options (Cabanac, 1992).

## 6.2 What is emotion?

In current theorizing, which is heavily influenced by the cognitivist perspective (eg, Lazarus, 1982, 1991a, 1991b), emotions are states that follow from the appraisal of a specific situation as having important implications for the well-being of the individual (eg, facilitating or endangering the achievement of an important goal). For example, if an individual interprets a situation as indicating that she or he has failed to live up to a desired standard, the result is the emotion of shame. Conversely, if the individual appraises the situation as indicating that an important, ego-enhancing objective has been achieved, the result is the emotion of pride. Emotions are generally defined as coordinated responses that involve multiple systems. Besides the cognitive appraisal at the core of the response, there is a characteristic core affective reaction (eg, a characteristic type of displeasure for shame and a characteristic type of pleasure for pride), a physiological “signature” that may be more-or-less specific to the particular emotion, a pattern of behavioral expression (most likely dictated or constrained by cultural norms), and corresponding actions and coping efforts (eg, approach or avoidance).

Emotions are always responses to a particular situational stimulus, so they are always triggered by something and are about something. The object or cause of the emotion, however, can vary. A person, thought, event, animal, or inanimate object may elicit an emotion; the cause may be real or imagined. In the context of an exercise class, an individual may cognitively appraise a social-evaluative threat and this may elicit the emotion of (social) anxiety. A cardiac rehabilitation patient recovering from bypass surgery may appraise exercise as dangerous, resulting in the emotion of fear.

## 6.3 What is mood?

Like emotions, moods are theorized to require an antecedent cognitive appraisal. What distinguishes moods from emotions, however, is that, unlike emotions, the stimuli that lead to the emergence of moods may not always be easily identifiable. For example, waking up in the morning in an irritable mood may be associated with a fight between the spouses the previous night; the memory of the fight itself may have faded but the unpleasant mood may linger on during the following day. Moreover, importantly, what is appraised in the case of moods may be different from what is appraised in the case of emotions. Although in emotions the object is typically specific and well-defined

(eg, a comment, a loud noise), in the case of moods the object may be unspecific and poorly defined (eg, “my life” or “the future of my children”). Thus, the cause of moods is often described as diffuse rather than specific. Moods also tend to have lower intensity and longer duration compared to emotions; moods may last for hours, days, weeks, or even months, whereas emotions typically last for seconds or minutes.

#### **6.4 So, what should I study?**

These short descriptions of core affect, emotion, and mood should help underscore that these phenomena are distinct; closely related and with fuzzy borders but nevertheless distinct. Therefore, continuing to interchange the terms or, worse, measuring one construct (eg, the emotion of state anxiety) but drawing conclusions about another (eg, mood) should be regarded as scientifically unjustified and counterproductive. As is often said, which construct an investigator should target depends on what the purpose of the research is. To return to the previous examples, if the objective is to provide a description of how an exerciser feels while running outdoors on a hot and humid day (ie, describe a response unknown in advance), without experimentally manipulating a particular cognitive appraisal, a reasonable target would be to examine the dynamics of core affect before, during, and after the run. If the goal is to study the state elicited in response to the perception that one’s body shape or level of physical conditioning is being evaluated by critical observers in a crowded gymnasium, one is essentially hypothesizing that a cognitive appraisal of (ego-related) threat would occur, leading to the specific emotion of social anxiety. Finally, in a research scenario in which the investigator hypothesizes that a diagnostic treadmill test at the cardiology clinic may elicit a lasting sense of helplessness and a pessimistic outlook toward the future and life in general, a reasonable approach would be to focus on specific mood states, such as dysphoria and irritability.

### **7 Step 2: Choose the most appropriate theoretical framework for the chosen construct**

Many investigators coming to the study of affective phenomena from other research traditions within contemporary psychology are perhaps used to working with constructs approached from one theoretical perspective (eg, the only one ever developed or one that prevailed over others in time). A characteristic example is self-efficacy, a construct derived from one particular theoretical framework (social-cognitive theory) and typically associated with one dominant definition. The consequence of approaching a construct from only one theoretical perspective is that there is also, typically, only one approach to the measurement of that construct. Thus, in several domains of psychological research, there is no formal decision-making process leading to the selection of a measure.

This is clearly not the case in the study of affective phenomena, however. Consider the aforementioned popular measures that have been used to study how people feel in response to exercise, namely the STAI, the POMS, and the PANAS. In the framework

that served as the theoretical basis of the STAI, state anxiety was conceptualized as a distinct emotional state, consisting of a cohesive cluster of symptoms. In other models of state anxiety that followed that by Spielberger, state anxiety was conceptualized instead as a multifactorial domain, consisting, for example, of cognitive and somatic factors of symptoms.

In the framework of the POMS, mood states were conceptualized as distinct states, each represented by a single unipolar factor. In addition to the commonly used (unipolar) version of the POMS, however, there is also a “bipolar” version. Instead of targeting six distinct unipolar mood states, this bipolar version targets bipolar factors (eg, anxious vs composed, hostile vs agreeable, depressed vs elated).

In the case of the PANAS, the targeted domain of content is the global domain of “mood” rather than distinct states. This global domain is presumed to be captured by the PANAS in its entirety. This is achieved not by measuring every conceivable distinct state that may be subsumed within it but rather by measuring two elemental, constituent dimensions that together define this domain, namely PA and NA. As explained earlier, the theoretical framework further postulates that PA and NA are orthogonal to each other (ie, statistically unrelated). Finally, this theoretical framework includes the controversial postulate that, although these two dimensions may be bipolar, the low-end poles are of no interest because they reflect the absence of affect and, therefore, they must be excluded from the scope of measurement.

In addition to the STAI, the POMS, and the PANAS, the literature on affective phenomena also includes numerous other conceptualizations and associated measures. Readers can appreciate that each of the fundamental postulates that comprise these theoretical frameworks has a direct impact on the measures based on these frameworks and shapes them (their scope, their limits, their internal structure) in a profound way. Altering the measure, in turn, also alters the measurements (the data) and, therefore, the conclusions the measure yields.

As [Russell and Feldman Barrett \(1999\)](#) warned, “some researchers use categories, some dimensions; some use bipolar concepts, some unipolar ones; some presuppose simple structure, some a circumplex, and some a hierarchy” (p. 805). Explaining the full meaning and the implications of these terms is beyond the scope of this chapter. Therefore, interested readers are encouraged to consult other sources, in which these ideas are presented in appropriate detail (eg, [Ekkekakis, 2013b](#)). What is crucial to emphasize here is that, unlike other domains of psychological research characterized by one dominant theory and one dominant approach to measurement, affective phenomena have been approached by a multitude of theoretical perspectives (one might even say an overwhelming diversity of theoretical perspectives). The differences between these theories are not subtle or trivial. The impact of these theoretical differences on measurement can be decisive. Consequently, researchers entering this field should regard the practice of presenting a measure in the Methods section unaccompanied by a supporting rationale as fundamentally inadequate. The selection of a measure of core affect, emotion, or mood must reflect a careful and well-informed decision-making process. Given the impact of measurement on the quality of the data that a study can ultimately produce, this decision-making process must be presented in sufficient detail to enable peer reviewers, editors, and other readers to evaluate it.

## 8 Step 3: Select the psychometrically strongest measure based on the chosen theoretical framework

In most published reports, the measures of core affect, emotion, or mood appear as de facto choices, unaccompanied by a supporting conceptual rationale. In an effort to provide at least some type of evidence to support their choice, authors occasionally add certain psychometric data (eg, an index of internal consistency). While offering some rationale may be better than offering no rationale, certain caveats are important to consider. Presenting psychometric data, such as convergent or discriminant validity coefficients or indices of model fit from confirmatory factor analyses, may be unhelpful, or even misleading, if this step is not preceded by the two previous steps outlined here. It makes little sense, for example, to argue that a certain factor model has been found to fit the data well if readers have been given no explanation for why that particular theoretical model was deemed appropriate for the study in the first place.

## 9 A research exemplar: The three-step approach to measurement in action

The gradual adoption of the three-step approach described here and elsewhere (Ekkekakis, 2008, 2012, 2013b) has arguably been a significant catalyst for progress in the line of research examining how people feel when they exercise. To illustrate the approach in action, we present here excerpts from a published study, in which the stated purpose was “to examine acute affective responses to exercise behavior as a predictor of future physical activity participation” (Williams et al., 2008, p. 232).

*Step 1:* Beginning to present their rationale for the measurement approach they used, the authors stated: “When considering the relationship between affect and physical activity, it is important to first distinguish among affect-related terms” (p. 232). They then proceeded to explain the differences between these constructs. After reviewing the previous literature, the authors arrived at the following summary statement, which establishes their reasons for focusing on core (basic) affect as their target construct:

*All of the studies reviewed measured distinct affective states rather than basic affect. When examining the relationship between affective responses to acute exercise and future physical activity participation there are a large number of reasons to prefer basic affect over distinct affective states at the present stage of knowledge development. For example, distinct affective states such as tranquility, tension, or confusion-bewilderment do not lend themselves to any clear hypotheses concerning the relationship between affect and future behavior.*

*Williams et al. (2008, p. 234).*

*Step 2:* Once they established their rationale for focusing on core affect, the authors proceeded to explain why they opted to adopt a dimensional perspective and, more

specifically, why they chose to focus on the bipolar dimension of affective valence as the most relevant construct for their specific purpose. Consistent with the ideas presented in this chapter, the key argument was that, given the focus of the study on motivation (eg, approach vs avoidance of physical activity), it is the bipolar dimension of valence (pleasure vs displeasure) that seems most relevant as a possible predictor of behavior:

*Consistent with hedonic theory [...], differences in positive–negative valence of basic affective responses to exercise among previously sedentary individuals may serve to reinforce or punish the behavior and in turn make future physical activity participation more or less likely. [...] It is not clear which distinct affective states would have the greatest influence on subsequent physical activity, and since not all distinct affective states can be measured at one time, there would be a risk of failing to measure one or more crucial affective states.*

*Williams et al. (2008, p. 234).*

*Step 3:* With their target construct clearly identified, and their arguments for a dimensional approach (with a particular focus on the dimension of affective valence) explained, the authors then proceeded to present their measure of choice. While reference is made to the previous use of the measure in the context of exercise research, the decision to choose this particular measure is justified primarily on the basis of the conceptual arguments presented in the preceding two steps. Here, additional information is provided about the construct validity of the measure by referencing correlations with other measures of affective valence, as well as measures of physical activity participation:

*The Feeling Scale (FS) is a single-item, dimensional measure of the valence dimension of affect ... Participants were asked to rate their present feelings on an 11-point good/bad bipolar scale with verbal anchors at +5 = very good, +3 = good, +1 = fairly good, 0 = neutral, -1 = fairly bad, -3 = bad, -5 = very bad. The FS has been used as a measure of affective valence in a number of physical activity studies [...] and has been shown to be related to other measures of affective valence [...], as well as present and past physical activity participation.*

*Williams et al. (2008, p. 235).*

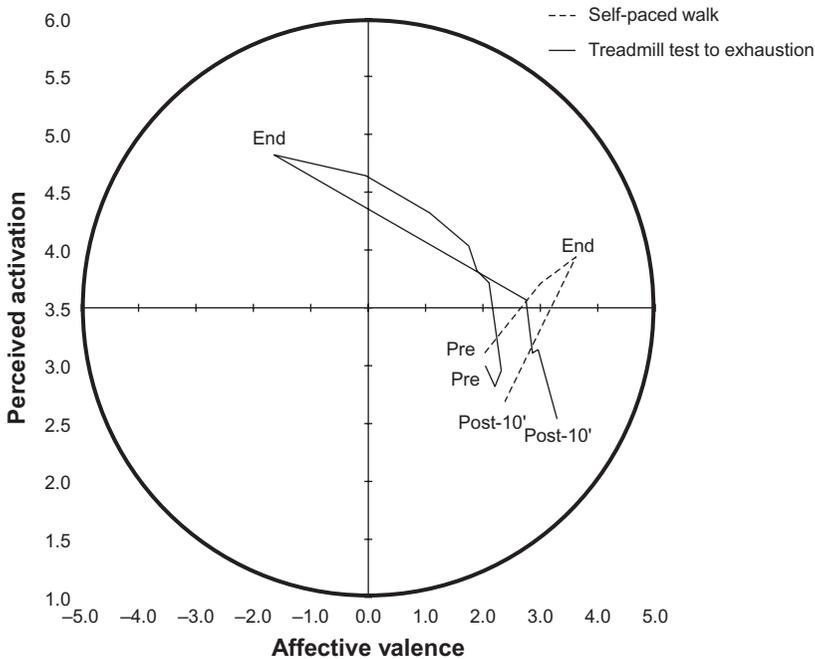
Following the three-step approach, as illustrated in this example, can reduce arbitrary decisions, can make misunderstandings and erroneous assumptions about the underlying theories easier to spot, can provide readers with the necessary information to meaningfully evaluate the reasoning behind the choice of measure, and may ultimately encourage researchers to think more systematically and critically about this crucial methodological decision. While the application of this three-step approach is slowly gaining ground, there is still much room for improvement. It is worth contemplating, for example, how much more rapid progress could be if journals required authors to fully document their choice of measures along the lines of the example shown here.

## 10 Conclusion and synopsis of current evidence

As illustrated in this chapter, psychologists have been speculating and introspecting about how exercise and physical activity make people feel since the dawn of psychology in the 19th century. The modern revival of this line of research in the 1960s was plagued by a variety of methodological limitations, with a haphazard approach to measurement being perhaps the most crucial and most consequential. The problems we identified in the preceding sections are not unique to this line of research, however. They are merely a reflection of the serious, widespread, and persistent problems that have long characterized the measurement of affective constructs in psychological research in general. Among the most disconcerting problems we highlighted here is the use of measures without providing an adequate rationale and without an accurate understanding of their scope and underlying theoretical bases. The specific misconceptions we identified in the use of the STAI, POMS, and PANAS are indicative of the severity of these problems and illustrate the need to reform current research and reporting practices.

The three-step approach to justifying the selection of measures of core affect, emotion, and mood in research reports was presented here as a possible remedy. The gradual adoption of this approach in studies investigating the effects of exercise and physical activity on affect over the past few years can be credited with the recent characterization of exercise as “perhaps the most well-characterized way to manipulate peripheral physiological arousal producing an affective change” (Quigley et al., 2014, p. 229). This description represents a remarkable departure from both the erroneous view within psychology that exercise produces merely “affectless arousal” (Isen et al., 1987, p. 1122) and the equally erroneous view within exercise science that the only effect that exercise has is that it “makes you feel good” (Fox, 1999, p. 413).

What contemporary research is showing instead is that the effects of exercise and physical activity on affect exhibit a dose–response pattern (Ekkekakis, 2013a; Ekkekakis, Parfitt, & Petruzzello 2011). As shown in Fig. 12.2, a short self-paced walk, for example, leads to a shift from a low-activation pleasant state (which is the baseline state for most healthy adults at rest) to a high-activation and even more pleasant state (Ekkekakis, Backhouse, Gray, & Lind, 2008; Ekkekakis, Hall, Van Landuyt, & Petruzzello, 2000). This “boost” of perceived energy is a highly sought-after effect, which many individuals pursue through various, occasionally unhealthy, means (ie, from caffeine and energy drinks to illicit substances). In contrast, strenuous exercise that causes a substantial disruption of homeostasis and prevents the maintenance of a physiological steady-state has been shown to cause a shift toward a high-activation unpleasant state associated with tension and distress (Ekkekakis, Hall, & Petruzzello, 2008; Hall, Ekkekakis, & Petruzzello, 2002). Dispelling any notions that the relationship between exercise and affect may lend itself to simplistic generalizations (eg, “exercise makes *people* feel...”), the evidence indicates considerable interindividual variability, which is maximized when the exercise poses an appreciable, though not overwhelming, challenge (Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). As the aforementioned study by Williams et al. (2008) showed, consistent with the basic postulate of



**Figure 12.2** An example of affective responses to exercise, represented in “circumplex” affective space, defined by the dimensions of affective valence (pleasure–displeasure, along the horizontal axis) and perceived activation (low–high, along the vertical axis). The two experimental conditions shown are: (1) a 15-minute walk on the treadmill at a self-chosen pace and (2) a treadmill test (lasting on average for 11.3 minutes). *Pre* indicates the beginning of each activity, *End* indicates its end, and *Post-10'* indicates a time point 10 minutes after the end. Based on data reported in Ekkekakis et al. (2000) and Hall et al. (2002).

psychological hedonism, this variability in affective responses to exercise is a significant predictor of how physically active individuals choose to be in their daily lives.

In conclusion, the overhaul of the measurement approach used in the study of affective responses to exercise has proven both practical and fruitful. The adoption of the basic guidelines we outlined in this chapter has resulted in the revitalization of this intriguing line of research. We present this experience here in hopes that this approach can also be implemented in other areas of psychological research with similarly positive results.

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