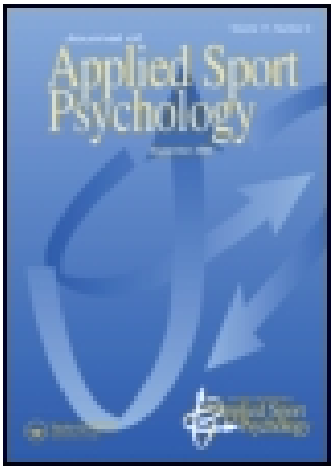

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Exercise and mood: A selective review and synthesis of research employing the profile of mood states

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Exercise and Mood: A Selective Review and Synthesis of Research Employing the Profile of Mood States

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This paper highlights the use of the Profile of Mood States (POMS) in physical activity research by reviewing and synthesizing literature generated in exercise settings. The results of many studies using the POMS have supported the relationships between exercise and acute mood changes in normal populations and between exercise and chronic mood changes in clinical populations. Based on the multitude of studies utilizing the POMS, Berger and colleagues developed a preliminary taxonomy containing enjoyment, mode, and practice guidelines to help maximize the mood benefits associated with exercise. The POMS also has been employed to identify underlying mechanisms that may promote mood alteration. Unfortunately, there is no conclusive evidence that identifies a single mechanism or group of mechanisms as consistently influencing the exercise-mood relationship. Although knowledge of the relationship between exercise and mood alteration is substantial, much remains to be studied. Promising avenues for future investigation of exercise include mood changes in specific populations, environmental influences on mood alteration, and personal characteristics impacting mood alteration.

Mood refers to a host of transient, fluctuating affective states (McNair, Lorr, & Droppleman, 1971, 1981, 1992) that reflect how an individual feels in general or globally at a particular moment in time. Moods range on a continuum from pleasurable to unpleasurable feeling states. In ad-

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dition, individuals differ in the intensity of their mood fluctuations and in their personal predisposition to be primarily positive or negative (Morris, 1989). Moods have postural and behavioral indicators such as slumped shoulders, facial expressions, ways of walking, and whistling. Although the terms *mood* and *emotion* reflect affective states, moods persist for longer periods of time, tend to be less intense, and do not appear to have distinct or specific causes (Morris, 1989; Thayer, 1989, 1996).

The Pervasiveness of Mood

Mood is an integral component of daily life. It serves as a barometer of our general state of psychological well-being, can alter general behavior patterns, and influences physical health (Cohen & Rodriguez, 1995; Parkinson, Totterdell, Briner, & Reynolds, 1996). Mood is related to psychological well-being as evidenced by one's general level of enjoyment, self-concept, and subjective well-being (e.g., Thayer, 1996). Mood also influences our lives by affecting a diverse array of behaviors such as helping others (Morris, 1989; Parkinson et al., 1996) and recalling memorable events (Mayer, McCormick, & Strong, 1995).

Mood and physical health are bi-directionally related in ways that are just beginning to be understood (Cohen & Rodriguez, 1995). Distinct connections between mood and health include influences on health habits, the immune system, and the onset and time-course of specific diseases (Melamed, 1995). Mood has been related to the functioning of the immune system by affecting both the number and activity of B and T lymphocytes, macrophages, leukocytes, antibodies, and reactivity to antigens and pathogens (Maier, Watkins, & Fleshner, 1994). The onset of specific diseases and their response to treatment also may be associated with mood as postulated in models of bi-directional pathways (Cohen & Rodriguez, 1995; Thayer, 1989). Health habits and behaviors likely to be related to mood include dietary intake and eating patterns that have direct affects on obesity and eating disorders (Thayer, 1989). Other health habits related to mood states include the use of tobacco, alcohol, and illicit drugs as well as exercise adoption and adherence (Cohen & Rodriguez, 1995; Thayer, 1989, 1996).

The pervasiveness of mood illustrates that its self-regulation may be an essential factor for establishing healthy habits and lifestyle behaviors as well as for personal happiness. With or without conscious awareness, we try to maintain good moods and to mitigate negative moods (Parkinson et al., 1996; Thayer, 1996; Thayer, Newman, & McClain, 1994). Self-regulation of mood is particularly important when a person is in a negative mood and wants to avoid the automatic effects of mood which produce mood-congruent thoughts and behaviors as well as vicious cycling (Morris, 1989). Diverse techniques to regulate mood include listening to music (McKinney, Antoni, Kumar, Tims, & McCabe, 1997) as well as employing phototherapy techniques and exercising (e.g., Thayer, 1996).

Mood and Exercise

There is a strong consensus that mood enhancement is a primary benefit of physical activity (e.g., Berger, 1996; Berger & McInman, 1993; International Society of Sport Psychology, 1991; Morgan, 1997c). In a position statement describing the psychological benefits of physical activity, the International Society of Sport Psychology (1991) concluded that exercise has been related to desirable changes in mood. Based on a systematic analysis of self-regulation techniques, Thayer and colleagues (1994) reported that exercise was the most effective of 10 general behavioral techniques used to self-regulate moods in normal populations. More specifically, exercise "was self-rated as the most successful at changing a bad mood, fourth most successful at raising energy, and third or fourth most successful at tension reduction" (p. 921). In addition, psychotherapists rated active mood management, which included exercise, as the most effective technique for changing a bad mood (Thayer et al., 1994). The recent report by the United States Department of Health and Human Services (1996) also indicates that physical activity is associated with improvements in mood states such as anxiety and depression.

To examine the mood changes associated with physical activity, researchers have employed a variety of self-report inventories. Basically, measures of mood can be partitioned into general and exercise-specific inventories. General measures of mood include the Activation-Deactivation Adjective Check List (Thayer, 1986), Beck Depression Inventory (Beck, Ward, Mendelsohn, Mock, & Erbaugh, 1961), Multiple Adjective Check List (Nowlis, 1965), Positive Affect Negative Affect Scale (Watson, Clark, & Tellegen, 1988), State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970), and the Profile of Mood States (POMS; McNair et al., 1971, 1981, 1992). The POMS is the focus of this review. Recently, the validity and reliability of using many of the general questionnaires in exercise settings have been questioned (cf. Crocker, 1997). To measure the affective states associated with physical activity itself, researchers have begun to develop exercise-specific measures of mood such as the Exercise-Induced Feeling Inventory (Gauvin & Rejeski, 1993) and the Subjective Exercise Experience Scale (McAuley & Courneya, 1994). The Exercise-Induced Feeling Inventory has 12-items and four subscales: revitalization, tranquillity, positive engagement, and physical exhaustion. The 12-item Subjective Exercise Experience Scale measures positive well-being, psychological distress, and fatigue. These exercise-specific measures, however, may not capture the influence of exercise on the mood states associated with activities/events of daily living such as tension, depression, anger, and confusion. Additionally, there is little normative data for these relatively new inventories, and thus they are not yet conducive to cross-study comparisons.

Use of the POMS in Exercise Settings

The POMS has been a widely used measure of mood in physical activity research. For example, between 1975 and 1990, there were over 74

studies using the POMS in exercise and sport settings (Snow & LeUnes, 1994). Between 1991 and 1996, there were more than 80 studies (Bourgeois, 1996). The original version of the POMS was developed in 1971 and consisted of 65 items; an abbreviated 30-item version of the POMS has been developed more recently (McNair et al., 1971, 1981, 1992). On both versions, respondents rate each item on a 5-point Likert scale with anchors ranging between "Not at all" to "Extremely." Items are combined to form six separate subscales: tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. The subscale scores can be combined to form an overall measure of affect that is labeled total mood disturbance (TMD). The separate subscales are useful when researchers are interested in examining changes in specific moods; TMD is useful in studies containing a small number of participants or when researchers are interested in a single, global estimate of affective states. This paper highlights the use of the Profile of Mood States in physical activity research by reviewing and synthesizing literature generated in exercise settings.

Advantages and Disadvantages of the POMS

Before reviewing the POMS literature, it is important to acknowledge the advantages and disadvantages of utilizing this measure in exercise settings. One primary advantage of the POMS is that it appears to be useful in detecting mood fluctuations associated with exercise. As noted in the manual, "The POMS also has proved to be a sensitive measure of the effects of various experimental manipulations upon normal subjects and other nonpsychiatric populations" (McNair et al., 1971, 1981, 1992, p. 1). This sensitivity has enabled researchers to examine a broad base of factors within exercise and sport settings. Some of these factors include exercise duration and intensity (e.g., Berger, Grove, Prapavessis, & Butki, 1997; Morgan, Costill, Flynn, Raglin, & O'Connor, 1988; Motl, Berger, & Wilson, 1996), specific participant populations (e.g., Nelson & Morgan, 1994; Steptoe, Kearsley, & Walters, 1993), and exercise modes conducive to mood alteration (e.g., Berger & Owen, 1988, 1992a). Another advantage of the POMS is that the six subscales seem to be measuring mood subcomponents which are differentially responsive to diverse characteristics of exercise settings. Furthermore, normative data for specific groups, including adults and frequently-studied college students, is helpful for statistical and practical interpretation of POMS scores (Lane & Terry, 1998; McNair et al., 1971, 1981, 1992). The large body of normative data and the available exercise literature employing the POMS also facilitates cross-study comparisons.

The POMS also has disadvantages which need to acknowledged when interpreting the meaning of POMS results. One disadvantage is that the POMS initially was developed for use with clinical populations. However, the normative data available for normal and physically active populations expands its usefulness. Another disadvantage of the POMS is that five of

the six subscales measure the negative mood characteristics of tension, depression, anger, fatigue, and confusion. It is difficult to conceptualize whether a decrease in a negative mood state actually indicates mood benefits. However, a decrease in tension, depression, and anger seems to translate into an experience of "feeling better" as initially described by Morgan (1985). Another disadvantage of the POMS is that the reputed 3 to 5 minutes for completing the inventory can require additional time in older populations and those experiencing chronic pain. Repeated administrations of the full length POMS also can be intrusive. Consequently, there are shortened versions of the POMS that contain between 6 and 32 items (Grove & Prapavessis, 1992; McNair et al., 1971, 1981, 1992; Shacham, 1983; Terry, Keohane, & Lane, 1996; Whelan & Meyers, 1998).

Methodological and Design Concerns

In addition to the advantages and disadvantages associated with using the Profile of Mood States, there are general methodology and design issues that require careful consideration when examining the relationship between physical activity and mental health. Key methodological concerns include randomization, suitable control conditions, and appropriate sample size and power. Design concerns also are important to consider and include controlling for expectancy as well as other third-variable influences, and employing state-of-the-art statistical analyses (e.g., Morgan, 1997b; Schutz & Gessaroli, 1993). Some of the methodological and design concerns reflect a lack of knowledge and oversight. Others reflect the difficulty of conducting research in the area of exercise and mood alteration. For example, exercise participants should be randomly assigned to treatment. However, personal considerations such as exercise preferences, time schedules, and hypothesis testing may preclude random assignment of participants.

Because design flaws permeate many studies, results of research in the area of exercise and mood should be interpreted cautiously to avoid making overly enthusiastic, sometimes unsubstantiated claims. Currently, no definitive statements can be made regarding a causal relationship between physical activity and mood enhancement. The underlying mechanisms of observed mood changes also remain unclear. To enhance our understanding of the exercise-mood relationship, future studies need to be based on theoretical models, employ appropriate and powerful research designs, and focus specifically on acute and/or chronic exercise programs with carefully defined training protocols (Morgan, 1997b; Schutz & Gessaroli, 1993). As emphasized in the next section, psychological characteristics of the participant such as mental-health status even may have implications for the complex relationship between physical activity and mood.

Mood Responses to Exercise in Normal Populations as Indicated by the POMS

Short-term or acute mood benefits for members of "normal" populations have been associated with participation in a wide range of physical

Table 1
Acute mood changes in a variety of exercise types for members of normal populations

Activities and authors	Sex	Age (years)	Duration	Intensity	POMS subscale changes[1]
Aerobic Dance					
Dyer & Crouch (1988)	M/F	17 to 26	45 min	N/A	T, D, V, C
Maroulakis & Zervas (1993)	F	19 to 55; *M* = 28.8	30 min.	60–80% $HR_{reserve}$	T, D, A, V, C
McInman & Berger (1993)	F	15 to 43; *M* = 23.1	45 min.	N/A	T, D, A, V, C
Cycling					
Farrell et al. (1986)	M	*M* = 24.2	30 min.	70% VO_{2max}	T
Steptoe & Cox (1988)	F	18 to 23; *M* = 20.0	8 min.	25 watts	V
				100 watts	T, V, F
Steptoe et al. (1993)	M	20 to 35 Active *M* = 26.4 Inactive *M* = 27.3	20 min.	50 & 70% VO_{2max}	T, V
Hatha Yoga					
Berger & Owen (1988)	M/F	*M*s = 22.8 & 27.2	40 & 80 min.	N/A	T, D, A, F, C
Berger & Owen (1992a)	M/F	*M* = 28.4	60 min.	N/A	T, D, A, F, C
Jogging					
Berger et al. (1988)	M/F	*M* = 20.0	20 min.	65–80% HR_{max}	T, D, A
Berger & Owen (1998)	M/F	*M*s = 20.7 to 25.1	20 min.	55, 75, & 79% HR_{max}	T, D, A, V, F, C
Berger et al. (1998)					
Study 1	M/F	18 to 51; *M* = 21.39	15 min.	50, 65, & 80% HR_{max}	T, D, A, V, C (females only)
Study 2	M/F	18 to 45; *M* = 22.22	15 min.	50, 65, & 85% HR_{max}	T, D, A, V, C
Boutcher & Landers (1988)	M	N/A	20 min.	80 to 85% HR_{max}	No changes
Dyer & Crouch (1988)	M/F	17 to 26	30 min.	N/A	T, D, A, V, F, C
Farrell et al. (1987)	M	*M* = 27.4	80 min.	40% VO_{2max}	No change
			80 min.	60% VO_{2max}	T
			40 min.	80% VO_{2max}	T

Table 1
Continued

Activities and authors	Sex	Age (years)	Duration	Intensity	POMS subscale changes[1]
Kraemer et al. (1990)	M/F	*M*s = 28.8 to 31.5	30 min.	80% HR_{max}	T, D, A, C, TMD
Rock-climbing					
Motl et al. (in press)	M	18 to 38; *M* = 25.5	10 to 50 min.	N/A	T, D, V, C
Swimming					
Berger et al. (1997)	M/F	12 to 20; *M* = 14.6	3,500–5,000 meters	N/A	T, D, C
			6,000–7,000 meters	N/A	V, F, TMD
Berger et al. (1993)	F	*M* = 22.4 CZ	60 min.	N/A	T, D, A, V, C
		M = 20.5 US	30	N/A	T, D, A, V, C
Berger & Owen (1988)	M/F	N/A	40 min.	N/A	T, C
Berger & Owen (1992a)	M/F	*M*s = 20.3 & 21.1	25 to 30 min.	N/A	T, D, A, V, C
Tai Chi					
Jin (1992)	M/F	Females: *M* = 37.8 Males: *M* = 34.6	60 min.	N/A	V, TMD
Walking					
Berger & Owen (1998)	M/F	*M* = 22.3	20 min.	55, 75, & 79% HR_{max}	T, D, A, V, F, C
Jin (1992)	M/F	Females: *M* = 34.6 Males: *M* = 37.8	60 min.	6 km/hr.	TMD
Weight Training					
Dyer & Crouch (1988)	M/F	17 to 26	40 min.	N/A	A, V, C

[1] POMS Subscale Changes were in both desirable and undesirable directions.
Note: M = Male and F = Female; N/A = Information not available; T = Tension, D = Depression, A = Anger, V = Vigor, F = Fatigue, C = Confusion, and TMD = Total Mood Disturbance.

activities. As illustrated in Table 1, the acute mood benefits have included decreases in tension, depression, anger, and confusion. There have been changes on vigor and fatigue as measured by the POMS, but these have been in both desirable and undesirable directions. Some of the physical activities associated with mood enhancement include aerobic dance, circuit training, cycling, Hatha yoga, jogging, rock climbing, swimming, Tai chi, and weight-training. Mood benefits have been reported by women and men of various ages participating primarily in moderate-intensity exercise for 20 to 75 minutes. (See columns 2, 3, 4, and 5 of Table 1 for participant and exercise characteristics in the various studies of the exercise and mood relationship.) Other studies finding little or no evidence of acute mood improvements on the POMS attribute lack of change to unpleasant environmental conditions such as excessive heat and high-intensity exercise (e.g., Berger & Owen, 1986, 1992b; Boutcher & Landers, 1988). Given the preponderance of positive research findings, it is safe to conclude that a single exercise session has been associated with mood benefits as indicated by changes on various POMS subscales.

Chronic mood changes as measured by the POMS also have been related to exercise for members of normal populations. However, these results have been more equivocal than the short-term changes. Some researchers have found that exercise programs ranging from several weeks to several months were conducive to chronic improvements in mood (e.g., Brown et al., 1995; Steptoe, Edwards, Moses, & Mathews, 1989). Other researchers have failed to produce evidence that long-term exercise programs were associated with improved mood states (e.g., Berger, Friedman, & Eaton, 1988; King, Taylor, Haskell, & DeBusk, 1989). Mood by definition is transient and fluctuating (McNair et al., 1971, 1981, 1992), and thus it is difficult to interpret the actual meaning of chronic mood changes in exercise settings for individuals who are not anxious or depressed. Chronic mood changes may reflect altered dispositional mood state, psychological health, the time of year, life experiences (e.g., marriage, job promotion), expectancy of benefits, improved fitness, or simply being happy that the study is finished. As Martinsen and Morgan (1997) noted, it is unlikely that exercise will induce chronic changes in mood for individuals who score within normal ranges on the POMS subscales.

Mood Responses to Exercise in Clinical Populations as Indicated by the POMS

Initially, the POMS was developed for use with psychiatric outpatients to assess their mood responses to therapeutic treatments (McNair et al., 1971, 1981, 1992). Although the POMS should be an ideal measure of the mood changes associated with exercise for members of clinical populations with affective disorders, few researchers have employed the POMS to examine acute mood responses to exercise for individuals in this context. In one study, women who were depressed (n = 6) reported decreases in depression and total mood disturbance on the POMS when

tested immediately before and after exercising at 40%, 60%, and 80% of estimated VO_2 max (Nelson & Morgan, 1994). No mood changes were noted for the non-depressed females (n = 5) who completed the same bouts of exercise. This study provided preliminary support for acute mood benefits with exercise in depressed populations, but it requires replication given the small sample size. To our knowledge, there is no research in exercise settings that investigates acute mood changes as measured by the POMS in individuals with anxiety disorders.

When researchers have observed long-term changes on the POMS subscales, the chronic mood benefits have been primarily for individuals encountering clinical levels of depression or anxiety (Martinsen, 1993; Martinsen & Morgan, 1997). Some studies indicated that for individuals with mild to moderate depression, as determined by the Beck Depression Inventory (Beck et al., 1961), exercise was as effective as cognitive therapy and cognitive therapy-plus-exercise for chronic improvements on tension, depression, anger, vigor, fatigue, and confusion (Fremont & Craighead, 1987; Harris, 1987). For individuals labeled as anxious, moderate-intensity exercise was more effective than an attention-control placebo condition for long-term mood improvements on the POMS (Steptoe, Edwards, Moses, & Mathews, 1989). These studies support the contention that chronic mood changes on the POMS are associated with exercise in individuals who display initial mood disturbances.

Preliminary Taxonomy to Maximize Mood Benefits: As Measured by the POMS

Contrary to the impressions fostered by the popular press and the Nike advertisement of "Pure pleasure no matter how damn hard it may be," the mood benefits of physical activity are not automatic. In addition, the mechanisms underlying both acute and chronic mood change such as elevation of body temperature, endorphin level, time out, and enhanced self-concept remain speculative (e.g., Morgan, 1997b).

Desirable changes in mood seem to be dependent upon complex interactions among the participant, exercise mode, and exercise practice conditions (Boutcher & Landers, 1988; Morgan, 1997c). Recognizing these complex interactions, Berger and colleagues (e.g., Berger 1996; Berger & Owen 1988, 1998; Berger et al., 1997; Motl, Berger, & Leuschen, in press) have developed a preliminary taxonomy to identify factors that may help to maximize the mood benefits associated with physical activity. (See Figure 1.) The taxonomy is presented here as a framework for investigating some of the factors influencing the relationship between mood alteration and physical activity. The relationship between the taxonomy factors and mood change appears to be interactive. Some of the factors are based on research utilizing the POMS. Other factors are more speculative and will require revision as new, related research becomes available. Although the taxonomy requires further validation, it is helpful in highlighting studies of the relationship between mood and exercise uti-

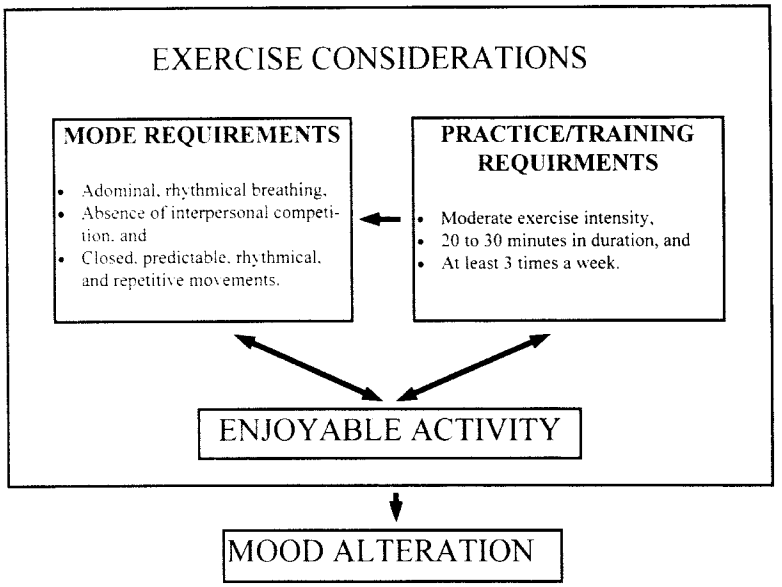

Figure 1. Tentative Taxonomy for Enhancing the Psychological Benefits of Exercise (Berger, 1996; Berger & Owen, 1988, 1992a).

lizing the POMS, as well as the exercise parameters related to mood changes, and needed areas for further research.

Enjoyable or Pleasing

Although defining enjoyment is difficult (e.g., Kimiecik & Harris, 1996; Wankel, 1997), participating in an enjoyable activity seems to be important for mood enhancement (Berger, 1996; Berger & Owen, 1988). Enjoyment is an overriding requirement in the exercise taxonomy that adjusts for individual preferences in physical activity. Intuitively, an enjoyable bout of exercise would be associated with greater mood benefits than exercise that was perceived as less enjoyable or even unpleasant. In one study that directly investigated the importance of enjoyment for mood enhancement, Motl and colleagues (in press) examined whether exercise enjoyment was associated with the short-term mood changes reported by rock-climbers and students in a health education lecture class who listened to a lecture and watched a video on rock-climbing. Results indicated that enjoyment of rock-climbing and the health education class activities were related to acute changes on tension, depression, vigor, and total mood disturbance as measured by the POMS. Supporting the importance of enjoyment within the exercise experience, unpleasant environmental conditions such as high temperatures seemed to negate the consistent mood benefits on the POMS subscales which have been associated with swimming (e.g., Berger & Owen, 1986). In summary, personal enjoyment

seems to be an important criterion for encouraging the short-term improvements in mood associated with exercise.

Mode Requirements

Mode requirements refer to types of physical activity that may be related to mood enhancement. Physical activities differ from one another in a number of ways. However, four aspects of exercise mode seem particularly conducive to mood improvement: (a) abdominal and rhythmical breathing, (b) relative absence of interpersonal competition, (c) closed or predictable activities, and (d) are repetitive and rhythmical movements (Berger, 1996; Berger & Owen, 1988).

Abdominal and rhythmical breathing. This mode requirement suggests that exercise should promote rhythmical and abdominal breathing. Although the research literature implies that aerobic exercise is necessary for mood enhancement (e.g., Berger, 1994; Dyer & Crouch, 1988), participants in other types of exercise also have reported mood benefits as measured by the POMS (e.g., Berger & Owen, 1988, 1992a; Jin, 1992). In addition, the definition of aerobic exercise is somewhat unclear. Presumably, aerobic exercise is performed in a heart rate training zone of approximately 60% to 90% of maximal heart rate (American College of Sports Medicine, 1995).

Investigating the need for aerobic exercise, Berger and Owen (1992a) found that participants in Hatha yoga, an activity with few aerobic training benefits, reported as many mood benefits on the POMS as individuals who participated in swimming. Participants in brisk walking, Tai chi, and meditation also reported similar acute mood benefits on all six POMS subscales (Jin, 1992). Based on recent evidence, Berger (1996) suggested that the aerobic guideline be changed to a requirement for rhythmical, abdominal breathing since swimming, walking, meditation, Tai chi, and yoga as well as most aerobic activities promote such breathing patterns. Further supporting this guideline reconfiguration, rhythmical abdominal breathing is a central component in many stress reduction and meditative techniques. Although the rhythmical, abdominal breathing requirement is logical, it requires considerably more research.

Relative absence of interpersonal competition. If an individual is interested in maximizing the mood benefits associated with exercise, a relative absence of competition is desirable. Competition can be detrimental to mood for many reasons. One is event outcome. Theoretically, 50% of the participants in any competition lose a match or contest. Even if an individual is fortunate enough to be on a winning team, the player may be unhappy with his/her own performance. For many individuals, the focus of competition seems to emphasize the end-product of winning, rather than the process of participating for enjoyment of the activity itself (Duda, 1996).

Interpersonal competition, losing, and self-criticism probably are not conducive to mood enhancement. Supporting this possibility, Berger, But-

ki, and Berwind (1995) found that individuals who participated in aerobic dance reported significant mood benefits when measured immediately after exercising on the POMS subscales of tension, depression, anger, vigor, and confusion. Intramural participants in basketball and volleyball reported overall mood disturbances immediately after exercising. When examining the mood changes of competitive sport more closely, it became apparent that winning and losing (i.e., event outcome) influenced mood change. Individuals on losing teams reported decreases in vigor and increases in anger and TMD. Individuals on winning teams reported mood benefits on the six POMS subscales (Berger et al., 1995). Similar effects of winning and losing on desirable and undesirable mood changes have been reported by Grove and Prapavessis (1992) when the POMS was administered immediately after exercise. Hassmén and Blomstrand (1995) have reported that the detrimental effects of losing on mood were observed when the POMS was administered immediately and even 2 hours after exercise. It is unclear whether losing an event, but being satisfied with one's performance is conducive to desirable mood change. In summary, it seems that losing a competitive event tends to be associated with mood decrements.

Closed, predictable, and repetitive activities. The third mode requirement is the need for a closed or predictable physical activity. As defined by Gentile (1972), closed tasks are characterized by temporal and spatial certainty (i.e., predictability). Participants in closed activities such as jogging, swimming, Hatha yoga, and riding a stationary bicycle encounter few if any unanticipated events. Exercisers in these activities can pre-plan their movements, "tune out" the environment, and engage in free association while they are exercising (Berger, 1994, 1996). Illustrating the importance of predictable forms of exercise, Berger and Owen (1988) found that joggers and participants in Hatha yoga reported greater acute mood benefits than did fencers on the POMS subscales of tension, depression, anger, fatigue, and confusion. Yoga and jogging are closed, predictable, and spatially certain; fencing is a less predictable and more open activity. Although open activities also may be conducive to mood alteration for exercisers who prefer to focus their attention outward, there are no studies of which we are aware on this topic.

Another possible mode requirement, a need for the physical activity to promote repetitive and rhythmical movements, has generated little or no research. However, personal reports (e.g., Paffenbarger & Olsen, 1996) and the consistent mood benefits of physical activities such as bicycling, jogging, and swimming (see Table 1) support inclusion of this factor within the taxonomy. The logic underlying this guideline is that repetitive and rhythmical movements do not require much attention. Thus, the participants are free to follow their own train of thought and to let their minds wonder, often finding solutions to nagging problems while exercising (e.g., Berger & Mackenzie, 1980; Paffenbarger & Olsen, 1996). The automaticity and monotony of repetitive movements seem to have an almost hypnotic effect. Automaticity and monotony also may encour-

age introspection and/or creative thinking during exercise (Berger & Mackenzie, 1980; Berger & McInman, 1993; Paffenbarger & Olsen, 1996) which may facilitate the desirable changes in mood. However, this mode requirement remains speculative until research is available on the possible benefits of repetitive and rhythmical movements.

Practice Requirements

As illustrated in Figure 1, the practice requirements of frequency, intensity, and duration also can influence the relationship between mood and physical activity. It seems that the training guidelines for physical fitness (e.g., American College of Sports Medicine, 1995) and the customary training regimens of athletes may be different from the exercise guidelines for promoting acute mood benefits. Sport-specific training principles may stimulate performance adaptations, but they probably are not conducive to mood enhancement. Thus, different practice guidelines are needed to achieve mood benefits. The three practice requirements, which follow, seem likely to maximize acute mood benefits and to promote the health benefits of exercise.

Frequency: Regularly included in a weekly schedule. The rationale for the frequency requirement is that developing and maintaining cardiovascular and cardiorespiratory fitness enables participants to exercise with a minimum of unpleasant bodily responses (Berger & McInman, 1993) by habituating to the exercise stimulus (Raglin, 1997). By exercising at least three times a week, participants can learn to "listen" to their bodies, to pace themselves, and to relax while exercising (Berger, 1994; Paffenbarger & Olsen, 1996). Supporting a possible relationship between fitness status and acute mood change, Steptoe and colleagues (1993) reported that regular exercisers reported some short-term improvements in mood on the POMS following a bout of intense exercise; the inactive participants reported mood decrements. Similar results were observed for highly fit and moderately fit exercisers who completed the POMS before and after intense exercise (Steptoe & Cox, 1988). In addition, the transient and highly fluctuating nature of mood as well as the observation that mood benefits last between 2 and 4 hours after exercise (Raglin, 1997; Thayer, 1996) both support the need to exercise frequently in order to re-establish the benefits. Thus, individuals may need to be physically active on a regular basis, even daily, to reap the short-term mood benefits.

Moderate exercise intensity. Moderate intensity exercise may not optimize fitness and sports training benefits, but it consistently has been associated with mood benefits (Berger & Owen, 1988, 1998; Motl et al., 1996; Steptoe et al., 1993). In contrast, high-intensity exercise may promote cardiorespiratory and metabolic training benefits, but it has been associated with few desirable changes in mood (e.g., Berger & Owen, 1992b; Motl et al., 1996; O'Conner, 1997).

Investigating the mood changes associated with different exercise in-

tensities, Motl and colleagues (1996) compared the acute mood changes among highly fit collegiate cyclists who rode their bicycle on a stationary trainer at moderate, high, and maximal exercise intensities. Cyclists reported short-term improvements on anger, vigor, fatigue, and confusion after the moderate-intensity exercise at 69% of maximal heart rate (HR_{max}). High-intensity training (89% HR_{max}) and maximal-intensity exercise to exhaustion were associated with no mood changes and negative mood responses respectively. These differential mood changes were independent of cyclists' goal orientation toward physical activity. Thus, even in trained cyclists, high-intensity exercise was not associated with mood benefits.

Relatively little research is available on the mood changes associated with low-intensity exercise. Based on the work of Thayer (1987, 1989, 1996), it appears that low-intensity exercise such as brisk walking may be conductive to mood alteration as measured on the Activation-Deactivation Adjective Check List. An association between acute mood benefits and low-intensity walking/jogging also has been reported by Jin (1992) and by Berger and Owen (1998). Until more is known about the mood benefits of low-intensity exercise and a possible intensity threshold, exercise intensity probably should be in the moderate range to encourage mood benefits (e.g., Berger, 1996; Berger & McInman, 1993; Berger & Owen, 1988, 1992b). Individual preferences for low-, moderate-, or high-intensity exercise (e.g., Mertesdorf, 1994) also may influence the relationship between exercise and mood alteration. Until there is additional evidence of mood benefits at high- and low-intensities of exercise, moderate-intensity exercise would appear to be a good choice, unless individuals are certain that they prefer to exercise at high or low intensity.

Duration: At least 20 minutes. Many researchers using the POMS have found mood benefits associated with exercise sessions that are a minimum of 20 to 30 minutes in duration (see Table 1). Exercising for as little as 5 to 10 minutes has been associated with desirable mood changes (Thayer, 1987, 1996). This shorter exercise duration (i.e., 1 to 20 minutes), however, requires further research given the small effect size (ES = .04) reported in a meta-analysis by Petruzello, Landers, Hatfield, Kubitz, and Salizar (1991). Exercising for an extended duration which often occurs with overload training has been associated with either no mood changes (e.g., Berger et al., 1997; Hooper, Mackinnon, & Hanrahan, 1997) or with mood disturbances (e.g., O'Connor, Morgan, & Raglin, 1991; Morgan et al., 1988). In a direct examination of the relationship between swimming duration and mood changes, Berger et al. (1997) found that only shortened or taper practices were associated with acute mood benefits for young age-group swimmers. Normal-distance practice sessions were associated with mood decrements on the POMS. The guideline of at least 20 to 30 minutes of exercise for mood alteration seems to be the most tenable at the present time.

Comparative Effectiveness of Exercise and other Mood Alteration Approaches as Indicated by POMS Scores

Many other techniques such as the relaxation response, meditation, reading, and social interaction are effective for mood regulation (e.g., Parkinson et al., 1996; Thayer, 1996). Comparing these techniques to exercise highlights the relative effectiveness of physical activity for mood alteration and helps to maintain a broad perspective of techniques for self-regulation. Illustrating the relative effectiveness of exercise in participants who were randomly assigned to treatment, Berger et al. (1988) found that exercise and the highly established relaxation response were associated with similar short-term reductions on tension, depression, and anger subscales of the POMS. Further illustrating the comparable effects of exercise, Jin (1992) found that following a mental/emotional stressor, brisk walking, reading, meditation, and Tai chi were associated with similar acute mood benefits on each of the six POMS subscales. It is important to note that exercise was not any more effective than other techniques for mood alteration. However, the comparable benefits of the various strategies do not diminish the effectiveness of exercise as a mood enhancement technique. Future studies need to determine whether the mood benefits of exercise in comparison to other techniques are associated with possibly different underlying mechanisms, duration of benefits, and patterns of change on individual POMS subscales.

Possible Causal Mechanisms for the Mood Benefits of Physical Activity: The POMS Research

The exact mechanisms which cause the psychological benefits of physical activity are not known. This important, but still unanswered question continues to capture the interests of researchers. The possible causes of mood alteration can be separated into three categories of potential mechanisms: physiological, psychological, and a combination of both. Despite common perceptions, there is little research evidence to support any individual or group of factors as consistently producing mood benefits as measured by the POMS. The present summary of tenable mechanisms possibly underlying the relationship between mood alteration and physical activity is limited to research using the POMS.

Research focusing on physiological mechanisms include, but are not limited to the endorphin, cortisol, monoamine, and thermogenic hypotheses (see reviews in Morgan, 1997c). Much of the research on physiological mechanisms employing the POMS has been focused on the endorphin hypothesis. Researchers have provided some support for the endorphin hypothesis when administering the opiate receptor antagonist naltrexone and examining the exercise-mood relationship (e.g., Daniel, Martin, & Carter, 1992). Pre-exercise administration of naltrexone inhibited positive mood changes on the POMS as well as a visual analogue scale following aerobic exercise. However, other studies have not supported the endorphin hypothesis. Researchers have found that beta-en-

dorphin levels circulating in the blood stream were not related to mood changes on the POMS (Farrell et al., 1986; Farrell, Gustafson, Morgan, & Pert, 1987). These same studies suggest that peripheral levels of corticotrophin, dopamine, epinephrine, growth hormone, and norepinephrine were unrelated to mood change on the POMS. Beta-endorphin levels even have been negatively related to changes in the POMS subscales of depression and confusion in male exercisers (Kraemer, Dzewaltowski, Blair, Rinehardt, & Castracane, 1990). Kraemer and colleagues also found a similar inverse relationship between corticotrophin and mood; no association was apparent for growth hormone. The equivocal relationship between beta-endorphins and mood change with exercise seems to be related to the blood-brain barrier (i.e., endothelial cell layer surrounding the capillaries) which is relatively impermeable to peptides and other large molecules circulating in the blood stream. Therefore, changes in peripheral levels of beta-endorphins would not be expected to modify central nervous system opiod activity or to be related to mood states. Identification of physiological mechanisms possibly underlying the relationship between exercise and mood is an important area of future research.

Psychological mechanisms also may influence the relationship between exercise and mood alteration. Potential psychological mechanisms include the following: improved self-concept, feelings of self-efficacy, enjoyment, expectancy of psychological benefits, "time out" from one's routine and daily hassles, and an increased sense of control (e.g., Berger, 1996; Berger, Owen, & Man, 1993; Morgan, 1985). To examine a possible relationship between self-concept and acute mood alteration, McInman and Berger (1993) administered Shacham's (1983) abbreviated version of the POMS and Self-Description Questionnaire III (Marsh, 1992) to women immediately before and after participating in aerobic dance and to a control group. Exercisers reported greater mood improvements and enhanced self-concept than the controls. However, there was no evidence that changes in self-concept were related to the mood benefits associated with exercise. Examining another possible mechanism, Motl et al. (in press) found that enjoyment was associated with acute mood changes on the POMS for rock-climbers and health-education students who listened to a lecture and watched a video of rock-climbing. Recently, Berger, Owen, Motl, and Parks (1998) examined whether expectancy of psychological benefits was related to mood changes after jogging. Despite significant acute mood benefits, expectancy of psychological benefits were not conclusively related to the significant changes on the POMS subscales of tension, depression, anger, and confusion. Continued research employing the POMS will help illuminate whether other hypotheses such as "time out" and an increased sense of control are viable mechanisms for mood alteration.

New Directions: Exercise and Mood Alteration Research

As illustrated by the need to search for mechanisms underlying the relationship between exercise and mood alteration, there still are many

unexplored areas of research which may benefit from using the POMS. Possible research directions include examining the mood changes associated with exercise for individuals suffering from specific diseases such as acquired immunodeficiency syndrome (AIDS) or affective disorders. Other interesting areas of needed research concerning the exercise-mood relationship include the role of environmental factors such as music, television, exercise class size, and crowdedness. Finally, the relationship between mood change and individual characteristics of the exerciser such as self-presentational concerns, social-physique anxiety, and preferred level of exertion also need investigation. In the following sections, the limited research using the POMS to investigate these areas is discussed.

Specific Populations

Initial diagnosis of HIV-1 infection is a frightening event and probably has a host of psychological consequences such as fear, anxiety, depression, and anger. These negative affective states may have important consequences for HIV-1 progression, especially since affective states may influence cell-mediated immunity (Kiecolt-Glasser & Glasser, 1996; Maier et al., 1994). Exercise interventions that do not deplete energy stores may decrease emotional distress and thereby enhance the immune system. This possible buffering effect would appear to be important during both initial infection and the later stages of HIV-1 progression. Illustrating the positive role of exercise on indices of mood and immune function during initial diagnosis of HIV-1 infection, LaPerriere and associates (1990) indicated that non-exercisers reported greater mood decrements on the POMS subscales of tension and depression than did exercisers following initial notification of positive serologic HIV-1 status. Exercisers diagnosed with HIV-1A also demonstrated more positive immune functioning as measured by CD56 (natural killer cells) and CD4 (T-helper/inducer) than non-exercisers with positive HIV-1A status (LaPerriere et al., 1990). In light of the positive effect of exercise on both mood and immune function during initial HIV-1 diagnosis, further research is needed to assess the interactive role of immune status, chronic exercise, and mood states during different stages of disease progression.

Psychologists, psychiatrists, and exercise specialists have suggested that physical activity can be a treatment modality for individuals with anxiety and depressive mood disorders (e.g., Martinsen, 1993; Martinsen & Morgan, 1997; Raglin, 1997). Additional research on the efficacy of exercise for treating clinical anxiety and depression is necessary, especially research utilizing the POMS which was developed initially for psychiatric outpatient populations. As noted in the earlier section on mood changes in clinical populations, this group of individuals has reported chronic mood benefits associated with therapeutic exercise programs (Fremont & Craighead, 1987; Steptoe et al., 1989). Exercise may be an effective, low cost alternative to traditional approaches for treating affective disorders as measured by the POMS (Berger, 1996; Martinsen, 1993;

Martinsen & Morgan, 1997; Nelson & Morgan, 1994). However, exercise does not seem to be a commonly accepted treatment modality for clinical populations. Additional research with this specific population might assist in bringing exercise interventions into main stream treatment programs.

Environmental Influences

Directors of many gymnasiums, health clubs, and other workout sites are providing music and television for many reasons: to attract exercisers, to encourage pulsating workouts, and to distract people from the physical sensation of effortful exercise. Unfortunately, the effects of music and television on mood are not clear. Some individuals may find that listening to music or viewing television during exercise is enjoyable and mood enhancing; others may not. Steptoe and Cox (1988) examined whether lively, stimulating music moderated mood changes as measured by the POMS after participation in high- and low-intensity bicycle ergometry. There was no evidence that music was differentially associated with mood changes at either exercise intensity. We are not aware of any research examining the influence of exercising while either watching television or reading on the relationship between exercise and mood alteration. The potential influences of these distracting activities during exercise are needed areas of investigation.

Crowded environments, the size of exercise groups, and leadership may influence exercise enjoyment and mood alteration. Crowded exercise environments such as those encountered in some weight rooms may detract from mood benefits after exercise. Waiting in line for an exercise machine may be stressful and annoying for some individuals and thus may be counterproductive to mood improvement. In addition to crowded environments, class or group size may be inversely related to enjoyment of exercise (Widmeyer, Brawley, & Carron, 1990). Large exercise groups may be less enjoyable than smaller ones, and this would seem to have implications for mood alteration. Conversely, smaller exercise groups may be more conducive to desirable mood changes than larger groups. Exercise leaders also may inadvertently and unknowingly affect mood alteration. In conclusion, the relationship between mood alteration and the factors of facility crowdedness, group or class size, and leadership quality are promising areas for future research.

Personal Characteristics

Self-presentational concerns and social-physique anxiety also may impact mood alteration. Self-presentation involves the processes by which an individual attempts to monitor and control the impressions that other people form of them (Leary, 1992). Social physique anxiety includes feelings of nervousness or discomfort associated with public evaluation of one's physical appearance (Hart, Leary, & Rejeski, 1989). Exercise environments are particularly salient settings for self-presentation concerns and social-physique anxiety. Both of these constructs may be related

to the mood alteration and exercise relationship. Individuals who are motivated to self-present while exercising may focus on incorrect exercise cues and may exercise too intensely (Leary, 1992) to experience enjoyment or mood benefits. People who are high in physique-related anxiety are more likely to experience nervousness, discomfort, and less exercise enjoyment in body-conscious settings while exercising. (Hart et al., 1989; Leary, 1992). Thus, social-physique anxiety may be detrimental to acute mood benefits. The possible influences of social-physique anxiety and self-presentational concerns on the mood changes associated with physical activity need direct investigation.

Another individual characteristic that may affect mood alteration is preferred level of exertion. Although many individuals follow the fitness guidelines of the American College of Sports Medicine (1995) or the workout suggestions of personal trainers, these "training" guidelines may not be conducive to mood improvements. To maximize the psychological benefits of exercise, an individual may need to exercise at an intensity that is personally enjoyable. There is a need to examine the differential effects of preferred level of exertion in comparison to other experimenter-selected intensities on mood alteration.

Conclusions

The past 25 years of research using the POMS in exercise settings has just begun to uncover the complex inter-relationships. The POMS has been a potent, reliable, and valid measure of mood in physical activity settings. The growing body of research demonstrating the benefits of exercise for acute improvements on the tension, depression, anger, and confusion subscales and sometimes on the vigor and fatigue subscales has supported the potency of the POMS. Based on the large body of research using the POMS, Berger and colleagues (Berger, 1996; Berger et al., 1988, 1997; Berger & Owen, 1988, 1992a, 1992b, 1998; Motl et al., in press) have developed a taxonomy containing enjoyment, mode, and training guidelines to facilitate the mood benefits of physical activity and to serve as a guide for future research. Supporting the need for continued investigation of the taxonomy factors, Morgan (1997a) concluded that there is a ". . .need to address the related issues of *exercise mode* (e.g., running, walking); *intensity* (e.g., low, moderate, high); *duration* (e.g., 15, 30, 45 min); *frequency* (e.g., 1, 3, 5 days per week); preferred versus prescribed exertion levels;. . ." (p. 231). The POMS also has been employed to identify possible mechanisms that may influence the relationship between exercise and mood alteration. Unfortunately, there is little evidence to identify a single or group of mechanisms that consistently influence the mood benefits associated with physical activity.

Much remains to be studied regarding the exercise-mood relationship. Examining mood changes in specific populations, the environmental influences of mood alteration, and individual factors affecting mood in exercise are promising avenues for future investigation. Given the usefulness

of the POMS in exercise settings, we await future studies of the exercise-mood relationship using this widely employed measure of mood. We suspect that future research will provide additional insights into the use of exercise as a technique to regulate mood in both normal and clinical populations.

REFERENCES

American College of Sports Medicine (1995). *ACSM's guidelines for exercise testing and prescription* (5th ed.). Baltimore, MD: Williams & Wilkins.

Beck, A. T., Ward, C. H., Mendelsohn, M., Mock, J., & Erbaugh, H. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4,* 561–571.

Berger, B. G. (1994). Coping with stress: The effectiveness of exercise and other techniques. *Quest, 46,* 100–119.

Berger, B. G. (1996). Psychological benefits of an active lifestyle: What we know and what we need to know. *Quest, 48,* 330–353.

Berger, B. G., Butki, B. D., & Berwind, J. S. (1995). Acute mood changes associated with competitive and non-competitive physical activities. [Abstract]. *Journal of Applied Sport Psychology, 7,* S41.

Berger, B. G., Friedman, E., & Eaton, M. (1988). Comparison of jogging, the relaxation response, and group interaction for stress reduction. *Journal of Sport & Exercise Psychology, 10,* 431–447.

Berger, B. G., Grove, J. R., Prapavessis, H., & Butki, B. D. (1997). Relationship of swimming distance, expectancy, and performance to mood states of competitive athletes. *Perceptual and Motor Skills, 84,* 1199–1210.

Berger, B. G., & Mackenzie, M. M. (1980). A case study of a woman jogger: A psychodynamic analysis. *Journal of Sport Behavior, 3,* 3–16.

Berger, B. G., & McInman, A. (1993). Exercise and the quality of life. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of research on sport psychology* (pp. 729–760). New York: Macmillan Publishing.

Berger, B. G., & Owen, D. R. (1986). Mood alteration with swimming: A reexamination. In L. Vander Velden, & J. H. Humprey (Eds.), *Psychology and sociology of sport: Current selected research 1* (pp. 97–113). New York: AMS Press.

Berger, B. G., & Owen, D. R. (1988). Stress reduction and mood enhancement in four exercise modes: Swimming, body conditioning, Hatha yoga, and fencing. *Research Quarterly for Exercise and Sport, 59,* 148–159.

Berger, B. G., & Owen, D. R. (1992a). Mood alteration with yoga and swimming: Aerobic exercise may not be necessary. *Perceptual and Motor Skills, 75,* 1331–1343.

Berger, B. G., & Owen, D. R. (1992b). Preliminary analysis of a causal relationship between swimming and stress reduction: Intense exercise may negate the effects. *International Journal of Sport Psychology, 23,* 70–85.

Berger, B. G., & Owen, D. R. (1998). Relation of low and moderate intensity exercise with acute mood change in college joggers. *Perceptual and Motor Skills, 87,* 611–621.

Berger, B. G., Owen, D. R., & Man, F. (1993). A brief review of literature and examination of acute mood benefits of exercise in Czechoslovakian and United States swimmers. *International Journal of Sports Psychology, 24,* 130–150.

Berger, B. G., Owen, D. R., Motl, R. W., & Parks, L. (1998). Relationship between expectancy of psychological benefits and mood alteration in joggers. *International Journal of Sport Psychology, 29,* 1–16.

Bourgeois, T. (1996). Recent developments in the use of the Profile of Mood States in sport and exercise since 1991. [Abstract]. *Journal of Applied Sport Psychology, 8,* S102.

Boutcher, S. H., & Landers, D. M. (1988). The effects of vigorous exercise on anxiety, heart rate, and alpha activity of runners and nonrunners. *Psychophysiology, 25,* 696–702.

Brown, D. R., Wang, Y., Ward, A., Ebbeling, C. B., Fortlage, L., Puleo, E., Benson, H., & Rippe, J. M. (1995). Chronic psychological effects of exercise and exercise plus cognitive strategies. *Medicine and Science in Sports and Exercise, 27,* 765–775.

Cohen, S., & Rodriguez, M. S. (1995). Pathways linking affective disturbances and physical disorders. *Health Psychology, 14,* 374–380.

Crocker, P. R. E. (1997). A confirmatory factor analysis of the Positive Affect Negative Affect Schedule (PANAS) with a youth sport sample. *Journal of Sport & Exercise Psychology, 19,* 91–97.

Daniel, M., Martin, A. D., & Carter, J. (1992). Opiate receptor blockade by naltrexone and mood state after acute physical activity. *British Journal of Sports Medicine, 26,* 111–115.

Duda, J. L. (1996). Maximizing motivation in sport and physical education among children and adolescents: The case for greater task involvement. *Quest, 48,* 290–302.

Dyer, J. B., III, & Crouch, J. G. (1988). Effects of running and other activities on moods. *Perceptual and Motor Skills, 67,* 43–50.

Farrell, P. A., Gustafson, A. B., Garthwaite, T. L., Kalkhoff, R. K., Cowley, A. W. Jr., & Morgan, W. P. (1986). Influence of endogenous opiods on the response of selected hormones to exercise in humans. *Journal of Applied Physiology, 61,* 1051–1057.

Farrell P. A., Gustafson, A. B., Morgan, W. P., & Pert, C. B. (1987). Enkephalins, catecholamines, and psychological mood alterations: Effects of prolonged exercise. *Medicine and Science in Sports and Exercise, 19,* 347–353.

Fremont, J., & Craighead, L. W. (1987). Aerobic exercise and cognitive therapy in the treatment of dysphoric moods. *Cognitive Therapy and Research, 11,* 241–251.

Gauvin, L., & Rejeski, W. J. (1993). The exercise-induced feeling inventory: Development and initial validation. *Journal of Sport & Exercise Psychology, 15,* 403–423.

Gentile, A. M. (1972). A working model of skill acquisition with application to teaching. *Quest, 17,* 3–23.

Grove, J. R., & Prapavessis, H. (1992). Preliminary evidence for the reliability and validity of an Abbreviated Profile of Mood States. *International Journal of Sport Psychology, 23,* 93–109.

Harris, D. V. (1987). Comparative effectiveness of running therapy to psychotherapy. In W. P. Morgan, & S. E. Goldston (Eds.), *Exercise and mental health* (pp. 123–130). Washington, DC: Hemisphere.

Hart, E. A., Leary, M. R., & Rejeski, W. J. (1989). The measurement of social-physique anxiety. *Journal of Sport & Exercise Psychology, 11,* 94–104.

Hassmén, P., & Blomstrand, E. (1995). Mood state relationships and soccer team performance. *The Sport Psychologist, 9,* 297–308.

Hooper, S. L., Mackinnon, L. T., & Hanrahan, S. (1997). Mood states as an indication of staleness and recovery. *International Journal of Sport Psychology, 28,* 1–12.

International Society of Sport Psychology (1991, Fall). Physical activity and psychological benefits: An ISSP position statement. *News Letter, 2* (2), 1–3.

Jin, P. (1992). Efficacy of Tai Chi, brisk walking, meditation, and reading in reducing mental and emotional stress. *Journal of Psychosomatic Research, 36,* 361–370.

Kiecolt-Glasser, J. K., & Glasser, R. (1996). Mind and immunity. In D. Goleman, & J. Gurin (Eds.), *Mind/body medicine: How to use your mind for better health* (pp. 39–61). Yonkers, NY: Consumer Reports Books.

Kimiecik, J. C., & Harris, A. T. (1996). What is enjoyment? A conceptual/definitional analysis with implications for sport and exercise psychology. *Journal of Sport & Exercise Psychology, 18,* 247–263.

King, A. C., Taylor, C. B., Haskell, W. L., & DeBusk, R. F. (1989). Influence of regular aerobic exercise on psychological health: A randomized, controlled trial of healthy middle-aged adults. *Health Psychology, 8,* 305–324.

Kraemer, R. R., Dzewaltowski, D. A., Blair, M. S., Rinehardt, K. F., & Castracane, V. D. (1990). Mood alteration from treadmill running and its relationship to beta-endorphin, corticotropin, and growth hormone. *Journal of Sports Medicine and Physical Fitness, 30* (3), 241–246.

Lane, A., & Terry, P. (1998). Development of normative data for Profile of Mood States-C among adult and young athletes. *Journal of Sports Sciences, 16,* 89–90.

LaPerriere, A. R., Antoni, M. H., Schneiderman, N., Ironson, G., Klimas, N., Caralis, P., & Fletcher, M. A. (1990). Exercise intervention attenuates emotional distress and natural killer cell decrements following notification of positive serologic status for HIV-1. *Biofeedback and Self-regulation, 15,* 229–242.

Leary, M. R. (1992). Self-presentational processes in exercise and sport. *Journal of Sport & Exercise Psychology, 14,* 339–351.

Maier, S. F., Watkins, L. R., & Fleshner, M. (1994). Psychoneuroimmunology: The interface between behavior, brain, and immunity. *American Psychologist, 49,* 1004–1017.

Maroulakis, E., & Zervas, Y. (1993). Effects of aerobic exercise on mood of adult women. *Perceptual and Motor Skills, 76,* 795–801.

Marsh, H. W. (1992). *The Self-Description Questionnaire (SDQ) III: A theoretical and empirical basis for the measurement of multiple dimensions of late adolescent self-concept. An interim test manual and a research monograph.* San Antonio, TX: The Psychological Corporation.

Martinsen, E. W. (1993). Therapeutic implications of exercise for clinically anxious and depressed patients. *International Journal of Sport Psychology, 24,* 185–199.

Martinsen, E. W., & Morgan, W. P. (1997). Antidepressant effects of physical activity. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 93–106). Washington, DC: Taylor and Francis.

Mayer, J. D., McCormick, L. J., & Strong, S. E. (1995). Mood-congruent memory and natural mood: New evidence. *Personality and Social Psychology Bulletin, 21,* 736–746.

McAuley, E., & Courneya, K. S. (1994). The Subjective Exercise Experiences Scale (SEES): Development and preliminary validation. *Journal of Sport & Exercise Psychology, 16,* 163–177.

McInman, A. D., & Berger, B. G. (1993). Self-concept and mood changes associated with aerobic dance. *Australian Journal of Psychology, 45,* 134–140.

McKinney, C. H., Antoni, M. H., Kumar, M., Tims, F. C., & McCabe, P. M. (1997). Effects of guided imagery and music (GIM) therapy on mood and cortisol in healthy adults. *Health Psychology, 16,* 390–400.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971, 1981, 1992). *Profile of Mood States manual.* San Diego: Education and Industrial Testing Service.

Melamed, B. G. (1995). Introduction to the special section: The neglected psychological-physical interface. *Health Psychology, 14,* 371–373.

Mertesdorf, F. L. (1994). Cycle exercising in time with music. *Perceptual and Motor Skills, 78,* 1123–1141.

Morgan, W. P. (1985). Affective beneficence of vigorous physical activity. *Medicine and Science in Sports and Exercise, 17,* 94–100.

Morgan, W. P. (1997a). Conclusion: State of the field and future research. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 227–232). Washington, DC: Taylor and Francis.

Morgan, W. P. (1997b). Methodological considerations. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 3–32). Washington, DC: Taylor and Francis.

Morgan, W. P. (Ed.) (1997c). *Physical activity and mental health.* Washington, DC: Taylor and Francis.

Morgan, W. P., Costill, D. L., Flynn, M. G., Raglin, J. S., & O'Connor, P. J. (1988). Mood disturbance following increased training in swimmers. *Medicine and Science in Sports and Exercise, 20,* 408–414.

Morris, W. N. (1989). *Mood: The frame of mind.* New York: Springer-Verlag New York.

Motl, R. W., Berger, B. G., & Leuschen, P. S. (in press). The role of enjoyment in the exercise-mood relationship. *International Journal of Sport Psychology.*

Motl, R. W., Berger, B. G., & Wilson, T. E. (1996). Exercise intensity and the acute mood states of cyclists. [Abstract]. *Journal of Sport & Exercise Psychology, 18,* S59.

Nelson, T. F., & Morgan, W. P. (1994). Acute effects of exercise on mood in depressed female students. *Medicine and Science in Sports and Exercise, 26,* S156.

Nowlis, V. (1965). Research with the Mood Adjective Check List. In S. S. Tomkins, & C. E. Izard (Eds.), *Affect, cognition and personality* (pp. 352–389). New York: Springer.

O'Connor, P. J. (1997). Overtraining and staleness. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 145–160). Washington, DC: Taylor and Francis.

O'Connor, P. J., Morgan, W. P., & Raglin, J. S. (1991). Psychobiologic effects of 3 days of increased training in female and male swimmers. *Medicine and Science in Sports and Exercise, 23,* 1055–1061.

Paffenbarger, R. S. Jr., & Olsen, E. (1996). *Lifefit: An effective exercise program for optimal health and a longer life.* Champaign, IL: Human Kinetics.

Parkinson, B., Totterdell, P., Briner, R. B., & Reynolds, S. (1996). *Changing moods: The psychology of mood and mood regulation.* New York: Longman.

Petruzzello, S. J., Landers, D. M., Hatfield, B. D., Kubitz, K. A., & Salizar, W. (1991). A meta-analysis on the anxiety-reducing effects of acute and chronic exercise: Outcomes and mechanisms. *Sports Medicine, 11,* 143–182.

Raglin, J. S. (1997). Anxiolytic effects of physical activity. In W. P. Morgan (Ed.), *Physical activity and mental health* (pp. 107–126). Washington, DC: Taylor and Francis.

Schutz, R. W., & Gessaroli, M. E. (1993). Use, misuse, and disuse of psychometrics in sport psychology research. In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of Research on Sport Psychology* (pp. 901–917). New York: McMillan Publishers.

Shacham, S. (1983). A shortened version of the Profile of Mood States. *Journal of Personality Assessment, 47,* 305–306.

Snow, A., & LeUnes, A. (1994). Characteristics of sports research using the Profile of Mood States. *Journal of Sport Behavior, 17,* 207–211.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. (1970). *State-trait anxiety inventory manual.* Palo Alto, CA: Consulting Psychologists Press.

Steptoe, A., & Cox, S. (1988). Acute effects of aerobic exercise on mood. *Health Psychology, 7,* 329–340.

Steptoe, A., Edwards, S., Moses, J., & Mathews, A. (1989). The effects of training on mood and perceived coping ability in anxious adults from the general population. *Journal of Psychosomatic Research, 32,* 537–547.

Steptoe, A., Kearsley, N., & Walters, N. (1993). Acute mood response to maximal and submaximal exercise in active and inactive men. *Psychology and Health, 8,* 89–99.

Terry, P. C., Keohane, L., & Lane, H. (1996). Development and validation of a shortened version of the Profile of Mood States suitable for use with young athletes. *Journal of Sports Sciences, 14,* 49.

Thayer, R. E. (1986). Activation-Deactivation Adjective Check List: Current overview and structural analysis. *Psychological Reports, 58,* 607–614.

Thayer, R. E. (1987). Energy, tiredness, and tension effects of a sugar snack versus moderate exercise. *Journal of Personality and Social Psychology, 52,* 119–125.

Thayer, R. E. (1989). *The biopsychology of mood and arousal.* New York: Oxford University Press.

Thayer, R. E. (1996). *The origin of everyday moods: Managing energy, tension, and stress.* New York: Oxford University Press.

Thayer, R. E., Newman, J. R., & McClain, T. M. (1994). Self-regulation of mood: Strategies for changing a bad mood, raising energy, and reducing tension. *Journal of Personality and Social Psychology, 67,* 910–925.

US Department of Health and Human Services (1996). *Physical activity and health: A report of the Surgeon General.* Atlanta, GA: US Department of Health & Human Services, Centers for Disease Control & Prevention, National Center for Chronic Disease Prevention and Health Promotion.

Wankel, L. M. (1997). "Strawpersons," selective reporting, and inconsistent logic: A response to Kimiecik and Harris's analysis of enjoyment. *Journal of Sport & Exercise Psychology, 19,* 98–109.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063–1070.

Whelan, J. P., & Meyers, A. W. (1998). *An efficient measure of immediate mood state: The brief assessment of mood.* Manuscript submitted for publication.

Widmeyer, W. N., Brawley, L. R., & Carron, A. V. (1990). The effects of group size in sport. *Journal of Sport & Exercise Psychology, 12,* 177–190.

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