Health Psychology
2001, Vol. 20, No. 4, 267–275

Copyright 2001 by the American Psychological Association, Inc.
0278-6133/01/$5.00 DOI: 10.1037//0278-6133.20.4.267

Exercise Duration and Mood State: How Much Is Enough to Feel Better?

Cheryl J. Hansen, Larry C. Stevens, and J. Richard Coast
Northern Arizona University

The effects of exercise duration on mood state were examined. In a repeated-measures design, the Profile of Mood States inventory (D. M. McNair, M. Lorr, & L. F. Droppleman, 1971) was administered before and after 1 quiet resting trial and 3 exercise trials of 10, 20, and 30 min on a bicycle ergometer. Heart rate levels were controlled at 60% of the participant's estimated VO_{2max} level. An overall analysis of variance found improved levels of vigor with reduced levels of confusion, fatigue, and total negative mood. Planned analyses revealed that the improvements in vigor, fatigue, and total mood occurred after 10 min of exercise, with progressive improvements in confusion over 20 min and with no additional improvement over longer periods. These results complement current recommendations, which suggest that to experience positive fitness and health benefits, healthy adults should participate in a total of 30 min of moderate physical exercise daily, accumulated in short bouts throughout the day.

Key words: exercise duration, exercise and mood change, acute aerobic exercise, mood, psychological states

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

The decline of physical fitness in America coupled with the increase in lifestyle-related illnesses has spawned an upsurge of research seeking to document the benefits of exercise as a deterrent to illness. Most research conducted to date has suggested that the benefits of regular physical activity can include improved cardiorespiratory function, reduction in risk for coronary artery disease, and significantly lower risk of chronic disease in general (American College of Sports Medicine, 1995).

Over the past 30 years, this increasing interest in the positive physical benefits of exercise has resulted in a fitness movement, the accompanying growth of a ubiquitous health and fitness industry, and increasing curiosity over the potential for psychological well-being as an added benefit of exercise. Common sense dictates that improved mental health is a natural outcome of exercise (Glenister, 1996), and recent research has attempted to identify potential psychological benefits that may be related to regular exercise. Although a number of design problems have arisen in this attempt to evaluate the effects of exercise on psychological mood (Hinkle, 1992; Kirkcaldy & Shephard, 1990; Yeung, 1996), recently published reviews of the research literature have concluded that regular physical activity is beneficial to psychological health. Specifically, exercise appears to be useful in the management of anxiety, depression, anger, tension, reaction to stress, self-efficacy, and self-esteem (Biddle, 1996; Glenister, 1996; Hinkle, 1992; Kirkcaldy & Shephard, 1990; Yeung, 1996).

Although there is little doubt that exercise benefits mental health, the mechanism by which this is accomplished remains unclear and may ultimately defy parsimonious explanation. For example, Kirkcaldy and Shephard (1990) noted that exercise may contribute to increased levels of the mood-altering neurotransmitters enkephalin and beta-endorphins. These neurotransmitters may to some extent decrease pain sensation and autonomic reaction to stress as well as increase a sense of self-efficacy. However, attempts to correlate a relationship between plasma endorphin levels and mood improvement have been unsuccessful (Kirkcaldy & Shephard, 1990; Yeung, 1996). Methodological problems may account for the failure to demonstrate a connection between exercise, endorphin levels, and mood improvement. It is also possible that plasma neurotransmitter levels do not correspond to neurotransmitter levels in the central nervous system.

A variety of other views may complement the neurotransmitter approach. For example, Estivill (1995) hypothesized that exercise enthusiasts achieve temporary relief from daily stress and that any sense of depression they may feel is replaced by a pleasant and calm state of awareness similar to that found in spiritual practices. She also noted that aerobic exercise may provide a sense of virtuousness similar to the work ethic demanded by traditional religion. In another hypothesis, the extent to which one experiences improved positive affect during exercise may be related to the cohesiveness of the group in which one participates (Courneya, 1995). Yet another explanation is the possibility of a strong placebo or expectancy effect that enhances the perceived improvement in one's sense of well-being (Desharnais, Jobin, Côtè, Lèvesque, & Godin, 1993). This array of hypotheses suggests that the effects of exercise on mental health may be more complex than conceptualized in the individual studies cited above and may involve multiple pathways.

Cheryl J. Hansen and Larry C. Stevens, Department of Psychology, Northern Arizona University; J. Richard Coast, Department of Health, Physical Education, Exercise Science, and Nutrition, Northern Arizona University.

We thank the advanced exercise physiology students at Northern Arizona University who provided their assistance in the prescreening and fitness evaluation of potential participants.

This research was conducted by Cheryl J. Hansen as the thesis requirement for a master of arts degree under the direction of Larry C. Stevens.

Correspondence concerning this article should be addressed to Cheryl J. Hansen or Larry C. Stevens, Department of Psychology, Northern Arizona University, P.O. Box 15106, Flagstaff, Arizona 86011. Electronic mail may be sent to cherylh@execpc.com or larry.stevens@nau.edu.

In an effort to identify the components that contribute to improved mood, many researchers have examined the effects of a single bout of exercise. These studies have suffered from methodological flaws and design differences and have consequently produced some contradictory results. Yeung (1996) presented a review of the literature on single-session studies published between 1976 and 1995; of the 23 studies reviewed and classified as having an experimental design (which required a control group composed of randomly assigned participants), 18 showed mood improvement of the experimental group as compared with the control group on at least one measure, and 5 studies reported no change in mood state. Yeung also reviewed 18 quasi-experimental studies and reported results showing improvement on at least one measure of mood state in 17 of the studies. The remaining study (Berger & Owen, 1992) reported no change other than an increase in fatigue, perhaps due to an artifact of testing immediately after a high-intensity swim session and prior to the recommended heart rate cool-down period. The studies reviewed by Yeung compared numerous forms of aerobic activity with a variety of nonaerobic pursuits. Mood changes reported in the majority of these studies included reduction of anxiety on the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970); reduction of the negative moods of tension–anxiety, depression–dejection, anger–hostility, fatigue–inertia, and confusion–bewilderment; and increase in the positive state of vigor–activity on the Profile of Mood States Inventory (POMS; McNair, Lorr, & Droppleman, 1992).

Other recent studies not included in Yeung's (1996) review also found significant changes in mood state after one bout of aerobic exercise. For example, running and bicycling produced decreases in anxiety and negative mood disturbances as well as an increase in mental vigor (McGowan, Pierce, & Jordan, 1991; Roth, 1989; Steptoe, Kearsley, & Walters, 1993; Tooman, 1982, as cited in Harris, 1987), and participants in step and dance aerobics enjoyed increases in positive mood and decreases in negative mood (Barabasz, 1991; Choi, Van Horn, Picker, & Roberts, 1993; Kennedy & Newton, 1997; Maroulakis & Zervas, 1993).

Confounds that influence postexercise mood state have also been examined in contemporary research. A participant's history of exercise frequency has not appeared to be a relevant factor in significant mood improvement (Choi et al., 1993; Roth, 1989; Steptoe et al., 1993). However, those with higher pretest levels of anxiety may have experienced a greater reduction in that measure (O'Connor, Petruzzello, Kubitz, & Robinson, 1995). The time of day in which a participant exercises also has not appeared to be significant (Maroulakis & Zervas, 1993). With regard to differences between men and women, however, results have been contradictory. Some research reported no difference (Roth, 1989), whereas other studies found a stronger association between exercise and mood state in women than in men (Hansen, Moses, & Gardner, 1997; Morris & Salmon, 1988, and Stephens, 1988, as cited in Choi et al., 1993).

An additional interesting finding has been that, in general, mood states appear to be most positive 10–15 min after completion of exercise (Dyer & Crouch, 1988). However, positive residual effects have been found after 30 min (Steptoe et al., 1993) and even after 24 hr (Maroulakis & Zervas, 1993).

In summary, the results of a majority of studies evaluating the effects of exercise on mood state suggest a positive impact on one's feeling of well-being. Individuals participating in exercise at an aerobic level between 50 and 85% of their VO_{2max} (maximum oxygen consumption in 1 min, calculated as heart rate [HR] reserve = 220 − age − resting HR; 50 to 85% × HR reserve + resting HR = target VO_{2max}; American College of Sports Medicine, 1995) may experience reduction in one or more negative moods, identified as anxiety, depression, anger, fatigue, or confusion. In addition, they may feel an energizing effect from an increase in vigor. It appears that an exerciser feels this positive impact beginning 10–15 min after cessation of exercise and regardless of previous exercise history or workout time of day.

None of the studies referenced above addressed the issue of minimal duration of acute exercise required to achieve significant positive psychological effects, a question that appears to have been largely ignored, particularly for aerobic exercise. Yeung's (1996) extensive review found only four studies that referenced minimal duration. Hobson and Rejeski (1993, cited in Yeung, 1996) found no differential mood effects at 10, 25, or 40 min of exercise. However, three other studies that used less restrictive controls found that brisk walks of only 5–10 min were sufficient to increase energy and reduce tension (Thayer, 1987a, 1987b; Thayer, Peters, Takahashi, & Birkhead-Flight, 1993).

In assessing the changes in mood state before and after exercise, one must consider many confounds. Factors that may influence the effects of exercise on mood include gender, age, individual biomechanical differences, fitness status prior to participation, mood level prior to participation, attitude, expectancy, time of year, time of day, day of the week, temperature, humidity, weather (if research is conducted outside), participation as a group compared with participation alone, duration of each session, number of exercise sessions per week, potential accumulative physical and psychological effects over time, and the inventory used for measurement.

Purpose of the Study

As noted above, scant research has been conducted attempting to determine what length of time in one session of physical activity may be sufficient to show a positive mood improvement. Recently, the Centers for Disease Control and Prevention and the American College of Sports Medicine have shifted their emphasis away from high levels of aerobic exercise and now recommend that to obtain beneficial health and fitness effects adults should accumulate 30 min or more of moderate-intensity physical activity daily (approximately 200 calories per day) and that this accumulation may be accomplished in short bouts of activity throughout the day (Pate et al., 1995). Moderate-intensity exercise has been defined by the American College of Sports Medicine (1995) as 60–75% of HR_{max} or 50–74% of VO_{2max}. Research that could establish a minimal duration that may be required to also experience psychological benefits from a single bout of exercise would also be helpful to the public. The health psychologist, knowing a minimal length of time needed to experience positive mood changes, along with the latest exercise recommendations referenced above, could then use this information as the basis for exercise prescriptions that maximize both physical and psychological effects.

Consequently, the intention of this study is to examine the effects of single bouts of moderate exercise (i.e., 60% of estimated VO_{2max}) of increasing duration on various mood states in a college population. In addition, this study corrects for some potential

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

deficits of earlier research, including controls for level of exertion, time of day, and day of week. Additionally, because of suggested gender differences (Hansen et al., 1997; Morris & Salmon, 1988, Stephens, 1988, as cited in Choi et al., 1993), only female participants were examined in this study. We hypothesized that in all exercise trials, the participants would show a significant decrease in negative mood states compared with the resting control trial. In addition, we hypothesized that as the length of exercise time increases, the degree of mood improvement also increases.

Method

Participants

Twenty-one college students 20–26 years of age volunteered to participate and went through the initial phase of evaluation. To control for gender effects, we included in the final analysis only the 14 female students who completed the trials.[1] As an incentive to participate, a physical fitness assessment was conducted for each person prior to testing, and each participant who completed the study was given a $10 gift certificate. All participants were enrolled in undergraduate course work and received course credit for participating in the experiment. Participants were screened with a health risk questionnaire to assure that participation in exercise posed no potential physical risk.

Materials

The Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992) was used to screen participants for any history of physical problems that would contraindicate aerobic exercise. The PAR-Q, developed by the British Columbia Ministry of Health, is a simple checklist of symptoms commonly used by fitness centers to screen enrollees in exercise classes or by other organizations that conduct exercise fitness testing. The PAR-Q is also useful for screening research participants (Thomas et al., 1992), and has been effective in detecting the gross contraindications to exercise that would be revealed by a brief medical examination (Shephard, Cox, & Simper, 1981).

As an additional screening measure, participants also were asked to complete a health and exercise history questionnaire (Appendix A), developed by Cheryl J. Hansen, prior to testing. It included a request for recent life events that may have had an emotional impact on the participant.

A standardized physical fitness evaluation using the protocol recommended by the Young Men's Christian Association (YMCA) (Golding, Myers, & Sinning, 1989) was conducted on the Friday prior to the start of testing, and the results were provided to the participant after completion of all testing sessions. Cheryl J. Hansen conducted evaluations with assistance from advanced exercise physiology students and their professor. The evaluation included a resting blood pressure and pulse reading and a measurement of height and weight. It also included an estimate of body fat composition using the skinfold caliper method measuring three sites (abdomen, ilium, and triceps), the total of which was used to calculate percent fat estimates as indicated in tables prepared by the YMCA (Golding et al., 1989). Target weight at 23% body fat for women and 16% for men was also calculated using YMCA tables (Golding et al., 1989). In addition, a flexibility test was conducted using the modified sit-and-reach method, and a cardiovascular endurance test was implemented using the YMCA Bike Test (Golding et al., 1989) protocol, which established the participant's estimated VO_{2max} level. This fitness evaluation was used only as an additional incentive to participate; outcomes were not variables in the present study.

Mood state was measured before and after each test session with the self-report POMS inventory developed by McNair, Lorr, and Droppleman (1971), historically the most frequently used measure in exercise and mood state studies (Yeung, 1996). This test contains 65 adjectives rated on a 5-point scale designed to measure tension–anxiety (T), depression–dejection (D), anger–hostility (A), vigor–activity (V), fatigue–inertia (F), and confusion–bewilderment (C). Scale V is negatively related to the other scales. Internal consistency of the POMS inventory ranges from .84 to .95, and test–retest reliability coefficients range from .65 to .74. Validity studies report that high tension scores correlate well with measures of anxiety (r = .80). Other factors also correlate well with like constructs (Lorr, Klett, McNair, & Lasky, 1963, and Lorr & McNair, 1963, as cited in McGowan et al., 1991; McNair et al., 1971).

Prior to the start of research testing, an exercise survey (Appendix B) designed by Cheryl J. Hansen was administered in introductory psychology and exercise physiology courses from which participants were recruited for the study. The questionnaire included statements designed to evaluate an individual's expectancy of physical and emotional change relating to participation in exercise. A reliability test of this instrument indicated an internal consistency coefficient of .84.

To control for socially desirable responses on the POMS, a 20-item version of the Marlowe–Crowne Social Desirability Scale was administered after the last testing session. The reliability of this scale as well as its internal consistency have been found to closely parallel the original inventory (Fischer & Fick, 1993; Strahan & Gerbasi, 1972). Internal consistency reliability of the original 33-item Marlowe–Crowne Social Desirability Scale is reported to be .88 (Crowne & Marlowe, 1960).

Apparatus

The YMCA Bike Test and experimental testing were conducted using Monark (Monark Ergomedic 818E, Stockholm, Sweden) bicycle ergometers, which provide a selection of workload adjustments in kilograms. Target heart rate monitors consisted of a transmitter with an elastic strap worn around the chest of the participant and a wrist receiver that displayed current heart rate. A standard metronome was used to assist participants in maintaining a rate of pedaling at 50 r/min during the YMCA Bike Test protocol.

Procedure

The PAR-Q, Health and Exercise History Questionnaire, and physical fitness assessment were administered on the Friday prior to testing as part of the prescreening process. A repeated measures design was implemented wherein each participant performed in each of the four test conditions. Immediately before each test, the participant was asked to complete the POMS inventory, responding to each question exactly as he or she felt at that moment. Participants exercised either alone or isolated in separate parts of the exercise facility where they could not see or talk to one another. Each participant was tested at the same time and on the same day of each week for 4 consecutive weeks. The four treatment conditions consisted of the following: Test 1—sitting quietly for 30 min facing a third-floor window; Test 2—a warmup on the bicycle to bring HR to 60% of estimated

[1] Fifty-five lower division undergraduate Introduction to Psychology and Exercise Physiology students were solicited within their respective classes and were offered incentives to participate during one summer term. Of these 55 potential participants, 26 initially volunteered; 5 of these failed to appear for the scheduled fitness evaluation; 2 dropped out during the exercise trials; 2 of the remaining 19 participants were screened out for medical reasons; 1 of the remaining participants failed to complete the POMS; and 2 of the remaining participants were male and were excluded because of recent studies showing gender effects on the relationship between exercise and mood state (Hansen et al., 1997; Morris & Salmon, 1988, and Stephens, 1988, as cited in Choi et al., 1993). Only the participants who completed all phases of the study were included in the final analysis.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Table 1
Mean Pre–Post POMS Differences (SDs) and F Ratios

	Duration of aerobic exercise (min)				
Mood	0	10	20	30	$F(3, 39)$
Tension	−2.86 (4.19)	−3.21 (3.85)	−4.57 (3.99)	−4.29 (4.60)	0.86
Depression	−1.21 (1.67)	−0.29 (0.99)	−1.93 (2.40)	−1.86 (2.19)	2.60
Anger	−0.07 (1.00)	−0.93 (2.70)	−1.29 (2.16)	−1.21 (1.63)	1.27
Vigor	−4.64 (4.22)	1.21 (6.47)	1.86 (4.44)	0.57 (8.13)	3.99*
Fatigue	0.50 (2.44)	−3.85 (4.57)	−3.79 (3.95)	−2.79 (3.36)	4.05
Confusion	−0.07 (2.20)	−1.07 (1.33)	−2.86 (2.68)	−2.07 (2.64)	5.05**
Total mood	1.36 (7.62)	−12.00 (12.63)	−15.79 (13.80)	−11.50 (16.41)	5.62**

Note. Negative mood scores reflect a decrease in the respective mood from pre- to posttreatment. POMS = Profile of Mood States.
* $p < .05$. ** $p < .005$.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

VO_{2max} and maintaining that level while pedaling the bicycle ergometer for 10 min; Test 3—a warmup to bring HR to 60% of estimated VO_{2max} and maintaining that level while pedaling the bicycle ergometer for 20 min; and Test 4—a warmup to bring HR to 60% of estimated VO_{2max} and maintaining that level while pedaling the bicycle ergometer for 30 min. During each warmup, the work load was gradually increased to a level that allowed the participant to comfortably maintain HR at 60% of maximum during the testing period. To allow for HR reduction, to avoid the possibility of a state of tension and fatigue that may initially follow cessation of exercise and thus negatively impact mood state, and to be consistent with the recommended cooldown period following a workout (Dyer & Crouch, 1988), we followed each bicycle testing period with a 10-min cooldown on the bicycle using a lower workload. During each testing period, the participant wore an HR monitor and was instructed to maintain estimated 60% target HR within five beats by adjusting the speed of pedaling. Current HR was recorded at the end of the 10-min cooldown. After the cooldown, participants were again given the POMS inventory with a request to answer each question exactly as they felt at that moment. After the POMS had been completed during the last testing session, each participant was asked to complete the Marlowe–Crowne inventory. To control for possible order effects, we randomly assigned participants to a test order. After completion of all testing sessions, each participant was given an interpretation of the results of his or her physical fitness assessment together with a $10 gift certificate. Questions about the nature of this study were addressed at that time.

Results

Planned, separate, within-subject factorial analyses of variance (ANOVAs) were used to analyze the scale differences in pre- to posttesting for each of the seven mood categories. An alpha level of .05 was used for all statistical tests.[2] Results are reported in Table 1 and Figures 1–7.

No significant improvement in mood state across levels of testing was found for tension, depression, or anger. With regard to the remaining variables, however, a significant decrease in fatigue was observed, $F(3, 39) = 4.05$, $p = .013$; a significant improvement in vigor was found across levels of testing, $F(3, 39) = 3.99$, $p = .014$; and a decrease in confusion was also significant, $F(3, 39) = 5.05$, $p = .005$.

The sum of the scores of five of the scales from the POMS inventory (tension, depression, anger, fatigue, and confusion) minus vigor also yields a total mood score. ANOVA results of the total mood score were found to be significant, $F(3, 39) = 5.62$, $p = .003$ (see Table 1).

To evaluate the possibility that the participants' desire to respond in a socially appropriate manner affected postexercise scores, we computed a Pearson product-moment correlation between Marlowe-Crowne scores and all pre-post inventory difference scores and found no significant correlations.

To test our hypothesis that with each increasing duration of exercise, negative mood states would decrease significantly, we conducted planned comparisons using paired t tests to evaluate the scale differences from one time level to the next. An increase in vigor, $t(13) = -3.04$, $p = .01$, a decrease in fatigue, $t(13) = 2.88$, $p = .013$, and a decrease in total negative mood, $t(13) = 3.19$, $p = .007$, were significant when comparing testing between 0 and 10 min. A trend toward a decrease in confusion from 0 to 10 min, $t(13) = 1.90$, $p = .08$, reached significance from 10 to 20 min, $t(13) = 2.83$, $p = .014$. A comparison of 10 min with 20 min or 20 min with 30 min indicated no additional significant improvements in mood state.

By comparison, Figures 1, 2, and 3 present the nonsignificant mood changes for tension, depression, and anger, respectively. Figure 4 demonstrates the rather dramatic and significant increase in vigor in a comparison of 0 min with 10 min. Figure 5 presents a similarly strong and significant decrease in fatigue in a comparison of 0 min with 10 min. Figure 6 shows the consistent decrease in confusion from 0 min to 20 min. Finally, total mood score comparisons between 0 and 10 min, as indicated in Figure 7, also showed a significant decrease in total negative mood.

To determine whether the significant results obtained above were related to participants' expectations of exercise, we computed correlations between expectations (Questions 1–4 on the exercise survey), how exercise makes an individual feel (the fifth question),

[2] The alpha level for significance was not adjusted for potentially excessive familywise error rate because of the presence of planned orthogonal analyses and the relatively small number of tests conducted (Hays, 1988; Rosenthal & Rosnow, 1984). Nonetheless, the familywise error rate obtained from these analyses was an acceptable .035, suggesting a low likelihood of capitalizing on chance outcomes in these analyses.

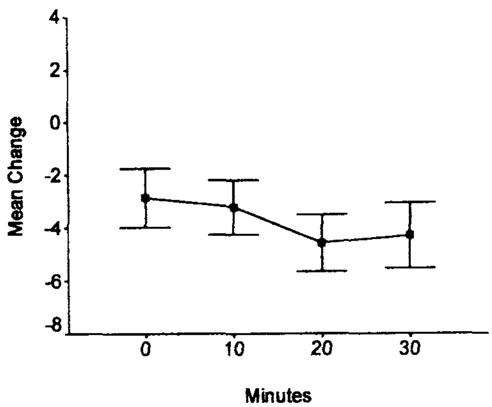

Figure 1. Pre- to postexercise changes in tension by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±1 *SE.*

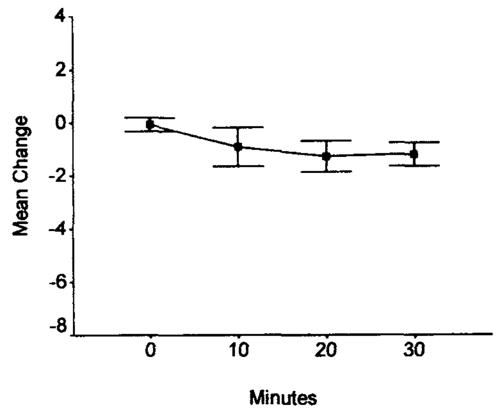

Figure 3. Pre- to postexercise changes in anger by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±1 *SE.*

and the difference scores in total mood for 0, 10, 20, and 30 min. We found no significant relationships among these variables.

To rule out the potential effects of participants' fitness levels and heart rate recoveries on mood state, we examined correlations between estimated VO_{2max} levels (which ranged from 24.83 to 61.80 with a mean of 36.55) and HRs after cooldown (which ranged from 84 to 130), with total mood score differences at 0, 10, 20, and 30 min. We found no significant correlations, suggesting that fitness level and heart rate recovery after exercise were not related to the amount of improved mood state.

Average room temperature was correlated with each mood category as well as with total mood score differences at 0, 10, 20, and 30 min. A significant correlation was found between room temperature after 30 min of exercise and tension, fatigue, and total mood score ($r = .68, p < .001$; $r = .74, p < .001$; and $r = .69, p < .001$, respectively). These results suggest that although room temperature may not be a significant factor in the amount of improvement in negative mood state during short periods of exercise, it may become a factor that negatively affects the degree of improvement in tension, fatigue, and total mood during longer periods of exercise.

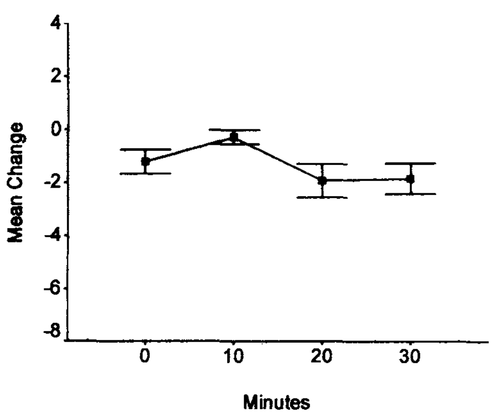

Figure 2. Pre- to postexercise changes in depression by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±1 *SE.*

Additionally, potential effects of the order of presentation of exercise conditions were examined through separate multivariate analyses of variance (MANOVAs) for each of the four exercise conditions across the seven POMS variables. None of these analyses revealed significant order effects.

Discussion

One of the purposes of this study was to attempt to establish a minimal duration of exercise from which positive psychological benefits may accrue. In general, the results suggest that in this population, exercising for 10 min at an aerobic level of 60% is sufficient for increasing vigor, decreasing fatigue, and decreasing total negative mood state. In addition, the results suggest that confusion may improve as well but be slower to diminish, with significant changes occurring only after 20 min. It appears that with this female college sample, estimated level of physical fitness, amount of heart rate recovery during a 10-min cooldown, and expectations of the benefits of exercise can be ruled out as contributory factors in mood improvement. These results, then, complement recommendations by the Centers for Disease Control and Prevention and the American College of Sports Medicine for 30 min or more of daily moderate physical activity carried out in short

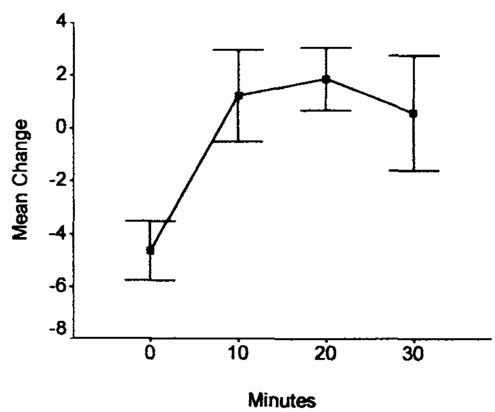

Figure 4. Pre- to postexercise changes in vigor by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±1 *SE.*

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

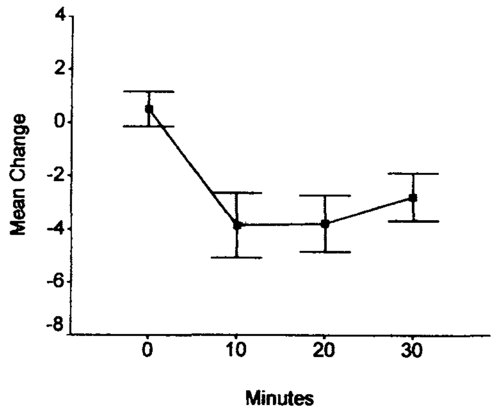

Figure 5. Pre- to postexercise changes in fatigue by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±1 *SE.*

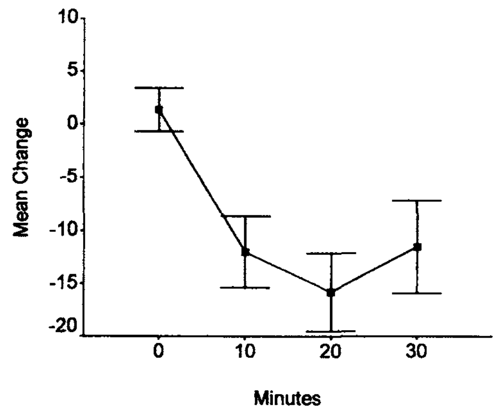

Figure 7. Pre- to postexercise changes in total mood by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±1 *SE.*

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

bouts throughout the day, as a means of obtaining improved physical fitness and positive health benefits (Pate et al., 1995). This study suggests that 10-min bouts may provide some measure of psychological benefit as well, at least to a college-age population, with little improvement from longer workouts, with the exception of diminished confusion. These results offer initial, tentative guidelines for the prescription of aerobic exercise toward the enhancement of psychological health.

As noted above, no significant improvement in mood state across levels of testing was found for tension, depression, or anger. This finding may have resulted from the low scores found at pretest assessment, which averaged 7.06, 2.07, and 1.45, respectively. Norms for female college students and for female adults between the ages of 18 and 65 are reported to be 8.5 and 12.8 for tension, 5.9 and 10.2 for depression, and 5.6 and 9.7 for anger (McNair et al., 1992). Pretest scores found in this research sample are low enough for one to assume that there was little or no room for improvement in these mood dimensions. In future research it would be of interest to explore duration and the effects of exercise on tension, depression, and anger with a sample having higher

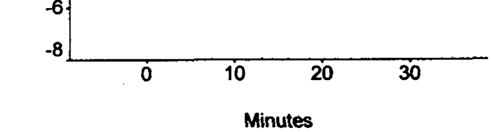

Figure 6. Pre- to postexercise changes in confusion by duration of exercise. Negative scores indicate a decrease. The vertical lines represent ±*1 SE.*

pretest mood scores, assuming, of course, that such positive effects would result from aerobic exercise.

The remaining results of this study contribute to 2 decades of research indicating that the acute effects of exercise include "the alleviation of negative mood states . . . [as well as] the enhancement of positive mood" (Yeung, 1996, p. 124). As in the present study, Tooman (1982, as cited in Harris, 1987) and Maroulakis and Zervas (1993) also found less confusion in participants after a single bout of exercise. In addition, Maroulakis and Zervas found a significant increase in vigor, and both they and Barabasz (1991) found a significant decrease in total negative mood score. When one is evaluating statistical significance in research, it is often useful to consider what importance the results may have when applied outside of the laboratory setting. When we reviewed the total negative mood score at the 10-min testing level in the current study, the pretest mean was 4.67 and the posttest mean was −5.20. McNair et al. (1992) indicated that norms for total mood were 16.3 for college females and 33.4 for adult females between the ages of 18 and 65. It is apparent that this sample of college women was significantly below the norm for negative mood initially. Additionally, the remarkable drop in negative mood to −5.20 implies that for a sample already very low in negative mood, a meaningful benefit may accrue after only 10 min of exercise.

Of course, other variables could affect an individual's mood state after exercise. Some of those considered in this study included the participant's estimated VO_{2max} level, HR after cooldown, and the temperature of the room during the biking session. We found no correlation between estimated VO_{2max} and HR when compared with total mood score across all four testing levels. However, a correlation between room temperature during the 30-min exercise session and tension, fatigue, and total mood was found to be significant. Mean room temperatures at each duration of exercise were 75.6°F at 10 min, 74.1°F at 20 min, and 74.25°F at 30 min. With such a narrow difference in mean temperatures, it is possible that the correlation between room temperature and 30 min of exercise indicates that ambient temperature becomes a more important factor affecting tension, fatigue, and total negative mood during longer periods of exercise.

Although a strength of the present study was the reduction of error variance through application of a repeated measures design,

Table 2
Power Analysis

POMS Mood	Observed power	η^2	Estimated effect size
Tension	.220	.062	.253
Depression	.594	.167	.447
Anger	.312	.089	.310
Vigor	.797	.235	.554
Fatigue	.803	.237	.557
Confusion	.889	.280	.624
Total mood	.921	.302	.657

Note. POMS = Profile of Mood States Inventory. η^2 = amount of variability in mood state explained by exercise.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

the relatively small number of participants could have created a corresponding deficit in the reduction of power across the analyses. To test this possibility, we conducted separate power analyses for each initial POMS mood state analysis. Results of this power analysis, including not only the observed power but also the amount of variability in the respective mood state explained by exercise (η^2) and the estimated effect size (*f*), are reported in Table 2 (Cohen, 1988). This post hoc analysis indicates small effect sizes and very low power for the number of participants used in this study across the variables of tension and anger, with only 22% and 31% probabilities, respectively, of rejecting the null hypothesis. Probability increases to nearly 60% for the variable of depression. However, for the POMS variables of vigor, fatigue, confusion, and total mood, probabilities of rejecting the null hypothesis increase to 80%, 80%, 89%, and 92%, respectively, for the available number of participants, with correspondingly large effect sizes. For these latter measures, 24%–30% of the variability in mood state is accounted for by exercise. Although a larger number of participants, as well as higher base rates of tension, depression, and anger, may well have increased power and allowed a demonstration of exercise effects on these variables, the relatively small sample size and repeated measures design enabled an anticipated moderate to large magnitude of effect of exercise to produce significant increases in vigor and decreases in fatigue, in confusion, and in total negative mood. These salubrious effects of aerobic exercise on psychological mood now await replication and extension into other affective as well as temporal dimensions.

References

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

Barabasz, M. (1991). Effects of aerobic exercise on transient mood state. *Perceptual and Motor Skills, 73,* 657–658.

Berger, B. G., & Owen, D. R. (1992). 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.

Biddle, S. (1996). Embracing exercise in "sport" psychology. *Journal of Sport Science, 14,* 109–110.

Choi, P. Y. L., Van Horn, J. D., Picker, D. E., & Roberts, H. I. (1993). Mood changes in women after an aerobics class: A preliminary study. *Health Care for Women International, 14,* 167–177.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Courneya, K. S. (1995). Cohesion correlates with affect in structured exercise classes. *Perceptual and Motor Skills, 81,* 1021–1022.

Crowne, D. P., & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology, 24,* 349–354.

Desharnais, R., Jobin, J., Côté, C., Lèvesque, L., & Godin, G. (1993). Aerobic exercise and the placebo effect: A controlled study. *Psychosomatic Medicine, 55,* 149–154.

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

Estivill, M. (1995). Therapeutic aspects of aerobic dance participation. *Health Care for Women International, 16,* 341–350.

Fischer, D. G., & Fick, C. (1993). Measuring social desirability: Short forms of the Marlowe–Crowne Social Desirability Scale. *Educational and Psychological Measurement, 53,* 417–424.

Glenister, D. (1996). Exercise and mental health: A review. *Journal of the Royal Society of Health, 116,* 7–13.

Golding, L. A., Myers, C. R., & Sinning, W. E. (Eds.). (1989). *Y's way to physical fitness: The complete guide to fitness testing and instruction* (3rd ed.). Champaign, IL: Human Kinetics Publishers.

Hansen, C. J., Moses, K., & Gardner, C. (1997). The effects of time-incremented running on mood state of college athletes. *Psi Chi Journal of Undergraduate Research, 2,* 133–139.

Harris, D. B. (1987). Running therapy and psychotherapy. In W. M. Morgan & S. E. Goldston (Eds.), *Exercise and mental health* (pp. 128–129). Washington, DC: Hemisphere.

Hays, W. L. (1988). *Statistics* (4th ed.). New York: Holt, Rinehart, & Winston.

Hinkle, J. S. (1992). Aerobic running behavior and psychotherapeutics: Implications for sports counseling and psychology. *Journal of Sport Behavior, 15,* 263–277.

Kennedy, M. M., & Newton, M. (1997). Effect of exercise intensity on mood in step aerobics. *Journal of Sports Medicine and Physical Fitness, 37,* 200–204.

Kirkcaldy, B. D., & Shephard, R. J. (1990). Therapeutic implications of exercise. *International Journal of Sport Psychology, 21,* 165–184.

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

McGowan, R. W., Pierce, E. F., & Jordan, D. (1991). Mood alterations with a single bout of physical activity. *Perceptual and Motor Skills, 72,* 1203–1209.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1971). *Manual for the Profile of Mood States.* San Diego, CA: Educational and Industrial Testing Service.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). *Manual for the Profile of Mood States* (Rev. ed.). San Diego, CA: Educational and Industrial Testing Service.

O'Connor, P. J., Petruzzello, S. J., Kubitz, K. A., & Robinson, T. L. (1995). Anxiety responses to maximal exercise testing. *British Journal of Sports Medicine, 29,* 97–102.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G. W., King, A. C., Kriska, A., Leon, A. S., Marcus, B. H., Morris, J., Paffenbarger, R. S., Patrick, K., Pollock, M. L., Rippe, J. M., Sallis, J., & Wilmore, J. H. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association, 273,* 402–407.

Rosenthal, R., & Rosnow, R. L. (1984). *Essentials of behavioral research: Methods and data analysis.* New York: McGraw-Hill.

Roth, D. L. (1989). Acute emotional and psychophysiological effects of aerobic exercise. *Psychophysiology, 26,* 593–602.

Shephard, R. J., Cox, M. H., & Simper, K. (1981). An analysis of "Par-Q" responses in an office population. *Canadian Journal of Public Health, 72,* 37–40.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *STAI manual.* Palo Alto, CA: Consulting Psychologists Press.

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

Strahan, R., & Gerbasi, K. C. (1972). Short, homogeneous versions of the Marlowe–Crowne Social Desirability Scale. *Journal of Clinical Psychology, 28,* 191–193.

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

Thayer, R. E. (1987b). Problem perception, optimism, and related states as a function of time of day (diurnal rhythm) and moderate exercise: Two arousal systems in interaction. *Motivation and Emotion, 11,* 19–36.

Thayer, R. E., Peters, D. P., III, Takahashi, P. J., & Birkhead-Flight, A. M. (1993). Mood and behavior (smoking and sugar snacking) following moderate exercise: A partial test of self-regulation theory. *Personality and Individual Differences, 14,* 97–104.

Thomas, S., Reading, J., & Shephard, R. J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Canadian Journal of Sport Science, 17,* 338–345.

Yeung, R. R. (1996). The acute effects of exercise on mood state. *Journal of Psychosomatic Research, 40,* 123–141.

Appendix A

Health and Exercise History Questionnaire

Name ____________________ Birth Date __________ Date __________
Telephone No. __________ Sex ______ Occupation ____________________
Ethnicity ____________________ Height __________ Weight __________
Are you a student? ________ Full time ________ or Part time ________ Grade level ________
Are you on any medications? ______ If yes, please identify type and how long ____________________
Do you smoke? __________ If yes, how many cigarettes/cigars per day ______________
Have you smoked in the past? ______ How long has it been since you quit? ______
How often do you drink alcoholic beverages? __________ Number of drinks __________
Have you ever had
high blood pressure _____ heart trouble _____ epilepsy _____
injuries to back, neck, knee _____ diabetes _____ asthma _____
In the past year have you experienced
chest pain ________ back/neck pain ________ swollen, stiff or painful joints ________
surgery ________ if yes, what type? ____________________
Have any of your blood relatives had heart disease, heart surgery, or angina? _____
Have you engaged in some form of exercise regularly during the past year? _____
In the past six months? _____ If so, what type? ____________________
Duration each session? ________ Times per week? ______
Do you have any discomfort, shortness of breath, or pain with moderate exercise? ________
In the past six months have you experienced any traumatic events which may have caused severe sadness, anxiety, or depression? ______
If yes, please briefly describe ____________________

In the past six months have you experienced any extremely exciting or exhilarating events? ______
If yes, please briefly describe ____________________

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Appendix B

Exercise Survey

Your Initials ________________ Your Birth Date ________________

Please respond to the following questions by rating each in the blank space as follows:

1—none; 2—a little; 3—a moderate amount; 4—quite a lot; 5—an extreme amount

1) To what extent do you expect aerobic exercise to improve your physical fitness? ________

2) To what extent do you expect aerobic exercise to improve your overall health status? ________

3) To what extent do you expect aerobic exercise to reduce your level of stress? ________

4) To what extent do you expect aerobic exercise to increase your sense of well-being? ________

Please provide brief answers to the following:

On a scale of one to five, how does exercise make you feel (circle a number)?

1 (terrible) 2 3 4 5 (exhilarated)

Do you exercise regularly? ________ On average, how many days per week? ____________

Does exercise help you to feel better? ____________________________

Does exercise make you feel worse? ____________________________

If exercise helps you feel better, how long do you have to exercise each time you work out to feel better? ______________

If exercise makes you feel better, why do you think it has this effect on you? ____________________________

If exercise makes you feel worse, why do you think it has this effect on you? ____________________________

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Call for Papers: Health and Cognition

Health Psychology is inviting competitive submissions for a special section devoted to research on physical health (or disease) and cognition. Numerous health-related factors have been shown to influence cognitive performance, thereby potentially affecting quality of life and daily functioning. Examples include lifestyle (e.g., smoking, physical activity), endocrine (e.g., cortisol, thyroid), and genetic (e.g., apolipoprotein E [APOE] factors; systemic diseases (e.g., cardiovascular, pulmonary, renal, hepatic); neurotoxic exposures (e.g., solvent, lead); and medical, surgical, and lifestyle interventions (e.g., medication use, coronary artery bypass surgery, exercise).

Papers that include direct assessment (rather than self-report) of relevant health-related variables are strongly preferred. Research with the following objectives would be appropriate: (a) understanding what domains of cognition are most affected by various dimensions of health and disease; (b) determining relevant moderator variables (e.g., age, education, race/ethnicity, genetic polymorphisms) to identify whether certain subgroups of individuals are vulnerable; (c) characterizing the biological and psychological mechanisms underlying health-cognition relations; (d) determining whether medical, surgical, or lifestyle treatments improve (or further compromise) cognitive performance; and (e) identifying whether changes in cognition associated with health status affect individuals' quality of life, daily functioning, or medical adherence.

Other topics may be relevant. Authors with questions regarding the appropriateness of particular research may contact either of the editors of this special section, Shari R. Waldstein (waldstei@umbc.edu) or Merrill F. Elias (mfelias@aol.com). Papers should be submitted with a cover letter identifying the submission as a response to the call for papers on health and cognition. Submit two manuscript copies and one electronic version, conforming to usual *Health Psychology* submission requirements (consult Instructions to Authors in *Health Psychology*) by September 1, 2001, to Arthur A. Stone, Ph.D., State University of New York at Stony Brook, Department of Psychiatry, South Campus, Putnam Hall, Stony Brook, New York 11794-8790.