12-2007

Exercise Makes You Feel Good, But Does Feeling Good Make You Exercise?: An Examination of Obese Dieters

Robert A. Carels
Bowling Green State University, rcarels@bgsu.edu

Carissa Coit

Kathleen Young

Bonnie Berger

Journal of Sport & Exercise Psychology, 2007, 29, 706-722

Exercise Makes You Feel Good, But Does Feeling Good Make You Exercise?: An Examination of Obese Dieters

Robert A. Carels, Carissa Coit, Kathleen Young, and Bonnie Berger
Bowling Green State University

Whereas exercise-induced mood enhancement has been well documented, the relationship between mood and exercise participation is less well understood. Mood states influence evaluative judgments that could plausibly influence a decision to exercise. Further, most exercise-mood research is limited to normal weight adults in response to a single exercise session. The current investigation examines the influence of (a) morning mood on exercise, (b) exercise intensity/duration on mood enhancement, and (c) daily change in mood on exercise days compared with nonexercise days in obese behavioral weight loss program (BWLP) participants. Participants ($N = 36$) recorded morning, evening, and pre- and postexercise mood, as well as the type, duration, and intensity of exercise. Within-person analyses indicated that (a) morning mood was associated with an increased likelihood of exercising, (b) mood ratings were higher following exercise of greater intensity and duration, and (c) daily mood enhancement was associated with greater exercise initiation and greater exercise intensity. Measuring mood before and after exercise may yield important clinical information that can be used to promote physical activity in obese adults.

Key Words: physical activity, behavioral weight loss program, mood, obesity

Obesity and physical inactivity contribute to such adverse health conditions as heart disease, diabetes, and high blood pressure, which cost more than $170 billion annually in estimated U.S. health care dollars (Finkelstein, Fiebelkorn, & Wang, 2003; Pratt, Macera, & Wang, 2000). Despite the potential health benefits of physical activity, many people have difficulty initiating and maintaining regular physical activity (Marcus et al., 2000). Additionally, exercise is an important factor in successful weight loss and maintenance. Thus, a sedentary lifestyle contributes significantly to the obesity epidemic (Tremblay & Imbeault, 1999). Therefore, considerable attention has focused on understanding the factors that contribute to

Carels, Coit, and Young are with the School of Human Movement, Sports, and Leisure Studies, and Berger is with the Department of Psychology, Bowling Green State University, Bowling Green, OH.

physical activity initiation and maintenance (Cohen-Mansfield, Marx, & Guralnik, 2003; Litwin, 2003).

Not only is mood enhanced by regularly engaging in physical activity, but it may also contribute to the initiation and maintenance of physical activity (e.g., Carels, Berger, & Darby, 2006; U.S. Department of Health and Human Services, 1996). Mood refers to a transient affective state at a particular moment in time (McNair & Heuchart, 2005; McNair, Lorr, & Droppleman, 1992). Research indicates that the effects of mood are motivational—influencing evaluative judgments, such as goal attractiveness and optimism about goal attainment—and have the potential to influence numerous steps in a course of action (Schwarz & Bohner, 1996; Schwarz & Clore, 1996). For example, following negative mood inducement, acutely ill participants reported less confidence that they could carry out illness-alleviating behaviors (Salovey & Birnhaum, 1989). Therefore, when individuals experience a negative mood, they may feel less confident in their ability to perform an action (i.e., diminished efficacy expectations; Salovey & Birhhaum, 1989), be less likely to engage in an action, and may find the outcome less attractive (Schwarz & Bohner, 1996). Therefore, mood is likely to be an important determinant of social cognitions (Bandura, 1997), such as efficacy expectations, which are known to influence participation in exercise. Mood is quite worthy of investigation in an exercise context.

Beyond mood's influence on factors that are likely to have an impact on the initiation of exercise, the mood-enhancing properties of exercise have been well-documented (U.S. Department of Health and Human Services, 1996). Comparisons across studies and participants generally find a differential association between mood enhancement and exercise that differs in intensity, duration, and frequency (e.g., Arent, Landers, & Etnier, 2000; Berger & Motl, 2000; Berger & Tobar, 2007). However, the within-person examination of mood enhancement across numerous bouts of exercise has been limited and is a focus of this investigation. Examination of single bouts of exercise limits conclusions about the consistency of the exercise–mood relationship across multiple bouts of exercise. In addition, reviews note that the preponderance of research has been performed on healthy, normal weight adults in response to a single bout of exercise (Arent et al., 2000; Berger & Motl, 2000). These healthy, normal weight samples limit the generalizability of the findings to populations such as the obese, who are at higher risk for health-related conditions (e.g., diabetes). Finally, research suggests that beyond the acute enhancement of mood, exercise may contribute to enhancement of overall daily mood (e.g., Gauvin, Rejeski, & Norris, 1996). Prolonged or long-term mood enhancement could contribute to the adoption of regular exercise by increasing the goal attractiveness of the exercise (Berger & Tobar, 2007).

Across numerous bouts of exercise, mood and exercise were examined using an ecologically valid methodological approach. Data from the current study were collected as part of a weight loss investigation with obese participants. The reciprocal relationship between mood and exercise initiation, intensity, and duration was examined. During the first 4 weeks and final 4 weeks of a 16-week behavioral weight loss program (BWLP), daily mood was evaluated in the morning and evening, as well as before and after bouts of exercise. Exercise type (e.g., walking), intensity, and duration were also recorded. The following hypotheses were examined in this preliminary, prospective investigation of mood and exercise measured on numerous occasions in obese participants.

As previously indicated, research suggests that mood may influence the initiation of exercise through various factors (e.g., goal attractiveness, efficacy expectations, anticipation of feeling good, and increased energy; Salovey & Birnhaum, 1989; Schwarz & Bohner, 1996). Therefore, a primary hypothesis was that on days a participant reported a lower (i.e., more negative) morning mood, he or she would be less likely to exercise during the day compared with days that a participant reported a higher morning mood.

Another hypothesis focused on exercise intensity and duration and subsequent mood. Research indicates that physical activity sessions and programs emphasizing moderate intensity (rather than low intensity) and longer duration exercise sessions (greater than 20 min) typically report greater mood enhancement (Arent et al., 2000; Berger & Tobar, 2007; Osei-Tutu & Campagna, 2005). However, heterogeneity in sample and/or exercise program characteristics makes comparisons difficult. Also, inconsistent and sometimes even undesirable changes in mood have been observed among participants exercising at high or maximal intensity, such as greater than 80% of maximum heart rate (Berger & Owen, 1992; Tobar, 2005). However, it was not anticipated that participants in the BWLP would achieve sustained levels of high-intensity exercise. In this investigation, obese participants were encouraged to progress toward walking (i.e., low- to moderate-intensity exercise) for 30 min to an hour every day. Employing a within-person design across numerous bouts of exercise, it was hypothesized that greater exercise intensity (i.e., moderate intensity) and duration would be associated with greater postexercise mood enhancement (change from pre- to postexercise mood) than lower intensity and shorter bouts of exercise (Berger & Owen, 1998; Hansen, Stevens, & Coast, 2001).

A final hypothesis focused on daily mood enhancement and exercise. Using experience-sampling methods, research performed with healthy, physically active females indicates that postexercise mood is enhanced throughout the day compared with preexercise mood and mood on nonexercise days (Gauvin et al., 1996). Because research suggests that the mood benefits of exercise may last 2 to 4 hours after exercising (Morgan, 1987; Raglin & Morgan, 1987), it was hypothesized that daily mood enhancement (change in mood from morning to evening) would be greater on exercise compared with nonexercise days in this investigation's obese sample.

Methods

Participants

Fifty-one obese adults began a 16-week BWLP and 43 (84.4%) completed the program. All participants were asked to complete an exercise and mood diary during the first 4 and final 4 weeks of the weight loss program. Thirty-six participants completed mood and exercise diary data. Twenty-four participants completed a diary during both the first and final 4 weeks of the program. However, data was analyzed on all participants who completed both or either the first or final 4-week mood and exercise diary ($N = 36$).

Participants were recruited through local advertisements and fliers, and were included in this investigation if they were obese (body mass index [BMI] ≥ 30 kg/m^2) nonsmokers, and excluded if they had cardiovascular disease, musculoskeletal

problems preventing moderate physical activity, or insulin-dependent diabetes. All participants received their physician's medical clearance.

In this investigation, the mean age was 49.3 (*SD* = 11.2). Approximately 65% of the participants had an annual income that exceeded $30,000 per year. More than 73% had at least a baccalaureate degree, and 67% worked full time. Eighty-nine percent of the participants were Caucasian and, as commonly observed in BWLPs, most of the participants were women (89%). Mean baseline BMI (kg/m^2) was 41.5 (*SD* = 7.3; range = 31–65) and mean weight was 236.6 lbs. (*SD* = 51.1; range 157–415) at the beginning of the weight loss program.

Procedure

The weekly 16-session weight loss intervention based on the LEARN program (Brownell, 2004) was administered in small groups (i.e., 7–12 participants). The LEARN program emphasizes gradually losing weight, progressively increasing physical activity, and decreasing energy and fat intake through permanent lifestyle changes. Additional program topics include (a) self-monitoring of eating behavior, (b) controlling stimuli associated with eating, (c) physical activity, (d) nutrition education, (e) modifying self-defeating thoughts and negative emotions associated with dieting and body image, (f) setting realistic goals, (g) relationships, and (h) relapse prevention and weight maintenance. Although the LEARN program encourages increasing all forms of exercise and daily lifestyle physical activity, it recommends walking 30 to 60 min every day as a final goal. The program, which was psychoeducational in nature, offered no structured exercise sessions to participants. During the first 4 weeks and the final 4 weeks of the 16-week intervention, participants completed an exercise and mood diary.

Feeling Scale and Exercise Diary

Because mood valence may reflect positive or negative evaluations of a situation, with intensity indicating the importance of the situation to the person (Frijda, Ortony, Sonnemans, & Clore, 1992; Schwarz & Clore, 1996), mood was rated on a single-item, unidimensional 10-point feeling scale (Hardy & Rejeski, 1989; *very negative mood* = −5, *neutral* = 0, *very positive mood* = 5). A single-item, unidimensional feeling scale was utilized to enhance compliance with completing multiple measures of mood across numerous days and bouts of exercise. More specifically, participants completed a mood rating every morning upon waking, every evening before going to bed, and immediately before and after bouts of exercise. Research suggests that single-item measures of subjective well-being and mood show acceptable reliability and correspondence with longer measures (McKenzie & Marks, 1999; Pavot & Diener, 1993).

For the purposes of this investigation, planned exercise was defined as any exercise performed for the purpose of obtaining physical activity, and does not include physical activity associated with daily living (e.g., occupational exertion or taking the stairs). Although participants were strongly encouraged to increase physical activity within daily activities, physical activity within daily activities was not recorded in the participant's exercise diaries. For each bout of exercise, participants indicated type, intensity, and duration. Intensity was rated on a 10-point scale

(*no effort* = 0, *moderate effort* = 5, *extreme effort* = 10). Duration was reported in minutes. Research indicates that self-report physical activity logs are a valid and reliable indicator of participation in physical activity (King et al., 2000).

Data Analysis

Hierarchical (multilevel) regression was used to examine the hypothesized relationships between mood and exercise. Hierarchical regression allows for within-person and between-person analyses to be conducted simultaneously while adjusting for the autocorrelation of the observations, and thus reducing the possibility of inflated results (Hox, 2002). The hierarchical regression equations were specified using HLM 6.02 (Science Software International, Lincolnwood, IL), using restricted maximum likelihood computations. All within-person variables were person centered (i.e., each individual's raw scores subtracted from his or her individual mean), allowing for the detection of deviations from each individual's mean, and all variables included in between-person analyses were grand mean centered (i.e., individual's mean score subtracted from the group's mean score) to allow for the interpretation of individuals relative to the participants as a group.

Results

Descriptive Statistics

Data from the first and final 4 weeks of the 16-week program were included for exercise and mood enhancement analyses. Because mood and exercise diaries were collected 12 weeks apart, assessment period was controlled for in all analyses (i.e., first 4 weeks = 0; final 4 weeks = 1). Examination of the data indicated minimal skewness and kurtosis. Therefore, no data transformations were performed. Estimation of the pseudo-R^2 statistics for within- and between-persons analyses was performed. (For more on this, please see the endnote.) The associations between baseline BMI, weight loss, and mood- and exercise-related variables were examined to identify potential covariates for the between-persons analyses. Higher baseline BMI was negatively associated with preexercise mood ($r = -.39$, $p < .02$). Thus, baseline BMI was controlled for in all between-persons analyses of the hypothesized relationships between mood and exercise. Weight loss was not associated with preexercise mood. Neither weight loss during the program nor baseline BMI were associated with exercise intensity, duration, morning mood, evening mood, or postexercise mood.

Participants attended, on average, 13.2 group sessions ($SD = 2.3$; range 2–16) over 16 weeks (82.5%). For the participants in this investigation, weight loss over the 16-session program was, on average, 15.1 pounds, ($SD = 12.0$; range +0.6 to −55), or 6.2% of total body weight ($SD = 4.8$). Program attendance was positively associated with frequency of exercise ($r = .35$, $p < .05$) and weight loss ($r = .59$, $p < .01$). Even though there were no significant differences between program completers and dropouts who completed physical activity diaries ($N = 4$) on morning and evening mood, pre- and postexercise mood, and exercise duration and intensity,

and given that only four dropouts completed physical activity diaries, there are too few participants to draw any conclusions.

A total of 36 participants completed 1,480 days of diary entries ($M = 37.9$; $SD = 17.9$ per person; range 14–56). Thirty-four participants completed 835 entries during the first 4 weeks and 26 participants completed 645 entries during the final 4 weeks. Two participants completed the diary during the final 4 weeks but not during the first 4 weeks. The resulting overall resulting sample size was 36 (both time periods: $N = 24$; first 4 weeks only: $N = 10$; final 4 weeks only: $N = 2$). Overall, participants recorded a total of 1,137 morning mood assessments ($M = 31.6$, $SD = 15.5$) with an average morning mood of 1.1 ($SD = 1.9$), and 1,058 evening mood assessments ($M = 29.4$, $SD = 14.6$) with an average evening mood of 2.5 ($SD = 1.7$). Both morning and evening mood assessments indicated that, on average, participants reported slightly positive moods.

Participants reported 710 sessions of exercise, an average of 19.2 sessions per person ($SD = 12.5$; first 4 weeks: $M = 8.5$, $SD = 8.2$; final 4 weeks: $M = 10.7$, $SD = 7.3$), although the duration and intensity of exercise were not always recorded for each instance. Regarding exercise, participants reported 449 reports of low/moderate-intensity physical activity (such as walking, 63.2%), 117 reports of cardiovascular exercise (running, swimming; 16.5 %), 35 reports of lifestyle exercise (e.g., gardening; 4.5%), 29 reports of strength/weight training (4.1%), 25 reports of sports participation (e.g., volleyball; 3.5%), and 55 reports that were missing or could not be classified (7.7%). There were 617 intensity ratings given by participants indicating that, on average, participants engaged in exercise that was moderately intense ($M = 5.6$, $SD = 1.8$); also, there were 685 duration reports collected indicating that, on average, participants reported exercising for 38.8 min ($SD = 20.9$) per session. Participants were also asked to rate their mood immediately before and after exercise. Participants' average preexercise mood was slightly positive ($M = 1.6$, $SD = 1.5$) and their average postexercise mood was positive ($M = 2.9$, $SD = 1.3$; where *very negative mood* = −5, *neutral* = 0, *very positive mood* = 5). See Table 1 for means and standard deviations of the mood and exercise variables during first and final 4 weeks of the weight loss program.

Table 1 Means and Standard Deviations for Mood and Exercise Variables

	First 4 weeks		Last 4 weeks	
Exercise variables	***M***	***SD***	***M***	***SD***
Duration (minutes)	34.9	22.8	39.4	18.2
Intensity rating	5.4	1.8	6.1	1.7
Morning mood	1.0	2.0	1.1	1.9
Evening mood	2.5	1.6	2.5	1.6
Preexercise mood	1.4	1.6	1.7	1.5
Postexercise mood	2.9	1.3	2.9	1.4

Change in Mood and Exercise Intensity and Duration from Beginning to End of Program

Exercise diaries were collected from participants during the first and the final 4 weeks of the BWLP. Thus, the relationship between the assessment period (i.e., first 4 weeks or final 4 weeks) and intensity of exercise was examined using the following equation:

$$\text{Assessment period}_{ij} = b_{0j} + b_{1j}(\text{Intensity}) + r_{ij}$$

where

$$b_{0j} = \gamma_{00} + \gamma_{01}(\text{Intensity}) + u_{0j}$$

$$b_{1j} = \gamma_{10}$$

Results indicated that intensity of exercise was significantly related to assessment period within person, such that increases in intensity were seen during the final assessment period (see Table 2). Also, there was a strong trend for individuals to report longer duration exercise during the final 4 weeks than during the first 4 weeks ($p = .054$; see Table 2).

Separate analyses were performed to examine the relationship between the assessment period (i.e., first 4 weeks or 4 four weeks) and morning mood, evening

Table 2 Relationship Between Assessment Period and Within-Person Intensity and Duration of Exercise and Mood

Measures	β	*SE*	*t*	*p*
Exercise intensity[a]	0.080	0.03	2.59*	0.010
Exercise duration[b]	0.002	0.00	1.93	0.054
Morning mood[c]	0.016	0.02	0.96	0.336
Evening mood[d]	0.009	0.02	0.48	0.633
Change morning to evening mood[e]	0.003	0.01	0.22	0.825
Preexercise mood[f]	0.062	0.03	2.26*	0.024
Postexercise mood[g]	0.046	0.04	1.10	0.271
Change pre- to postexercise mood[h]	0.035	0.02	1.43	0.153

Note. All models analyzed separately.

[a]Assessment period and intensity model includes 35 participants (1 lost owing to insufficient data) with 617 records.

[b]Assessment period and duration model includes 36 participants with 685 records.

[c]Assessment period and morning mood model includes 36 participants with 1,137 records.

[d]Assessment period and evening mood model includes 36 participants with 1,058 records.

[e]Assessment period and change in morning to evening mood model includes 36 participants with 1,055 records.

[f]Assessment period and preexercise mood model includes 35 participants (1 lost owing to insufficient data) with 613 records.

[g]Assessment period and postexercise mood model includes 35 participants (1 lost owing to insufficient data) with 589 records.

[h]Assessment period and change in mood following exercise model includes 35 participants (1 lost owing to insufficient data) with 585 records.

*$p \leq .05$.

mood, preexercise mood, postexercise mood, change in mood from morning to evening, and change in mood pre- to postexercise. Only the relationship between preexercise mood and assessment period was significant. Individuals reported more positive preexercise moods during the final 4 weeks than during the first 4 weeks (see Table 2).

Morning Mood and Exercise

The relationship between participants' morning mood and reports of whether or not they engaged in exercise during the day, controlling for baseline BMI and assessment period was assessed using the following equation:

$$\text{Engaged in exercise}_{ij} = b_{0j} + b_{1j}(\text{Morning mood}_{ij}) + b_{2j}(\text{Assessment period}_{ij}) + r_{ij}$$

where

$$b_{0j} = \gamma_{00} + \gamma_{01}(\text{Baseline BMI}) + \gamma_{02}(\text{Morning mood}) + \gamma_{03}(\text{Assessment period}) + u_{0j}$$

$$b_{1j} = \gamma_{10}$$

$$b_{2j} = \gamma_{20}$$

As shown in Table 3, there was a significant relationship between morning mood and engaging in exercise within and between persons. Specifically, those with a better morning mood were more likely to engage in exercise during the day. When duration of exercise was examined, morning mood was not a significant predictor of the duration of exercise within person or between persons. Finally, when intensity was examined, this relationship was also not significant within person or between

Table 3 Morning Mood and Exercise Controlling for Baseline BMI and Assessment Period

Exercise characteristics	β	*SE*	*t*	*p*
Engaged in exercise[a]				
Within-person morning mood	0.03	0.01	3.72**	0.000
Between-persons morning mood	0.06	0.03	2.16*	0.050
Intensity[b]				
Within-person morning mood	–0.07	0.04	–1.86	0.063
Between-persons morning mood	0.65	0.19	0.36	0.731
Duration of exercise[c]				
Within-person morning mood	1.55	1.41	1.09	0.275
Between-persons morning mood	1.00	1.54	0.65	0.521

Note. Models analyzed separately.

[a]Morning mood and engaged in exercise model includes 36 participants with 1,137 records (engaged in exercise = 1; did not engage in exercise = 0).

[b]Morning mood and intensity of exercise model includes 36 participants with 577 records.

[c]Morning mood and duration of exercise model includes 35 participants (1 lost owing to insufficient data) with 585 records.

*$p < .05$, **$p < .01$.

persons. Thus, morning mood appeared to exert an influence only on the initiation of exercise. If a participant did engage in exercise, morning mood did not significantly affect the length or the intensity of the exercise session. BMI was unrelated to initiation of exercise, exercise duration, and exercise intensity.

Relationships Between Exercise Intensity/Duration and Mood Enhancement

This investigation also examined the relationship between exercise intensity/duration and the pre- to postexercise change in mood. This relationship was examined both within person and between persons, controlling for baseline BMI and assessment period. This relationship was assessed using the following equation:

$$\text{Intensity}_{ij} = b_{0j} + b_{1j}(\text{Mood pre}_{ij}) + b_{2j}(\text{Mood post}_{ij}) + b_{3j}(\text{Assessment Period}_{ij}) + r_{ij}$$

where

$$b_{0j} = \gamma_{00} + \gamma_{01}(\text{Baseline BMI}) + \gamma_{02}(\text{Mood pre}) + \gamma_{03}(\text{Mood post}) + \gamma_{04}(\text{Assessment Period}) + u_{0j}$$

$$b_{1j} = \gamma_{10}$$

$$b_{2j} = \gamma_{20}$$

$$b_{3j} = \gamma_{30}$$

Results indicated that mood enhancement following exercise was related to the intensity of the exercise, both within person and between persons (see Table 4). More intense exercise was associated with larger improvements in mood both within person and between persons. Also, preexercise mood was inversely related to intensity of exercise within person, $\beta = -0.9$, $SE = 0.4$; $t(32) = -2.23$, $p = 0.02$. Duration of exercise was significantly related to change in mood within person, such that longer durations of exercise were related to greater increases in mood (Table 4).

Table 4 Duration and Intensity and Postexercise Mood Controlling for Preexercise Mood, Baseline BMI, and Assessment Period

Exercise characteristics	β	*SE*	*t*	*p*
Duration[a]				
Within-person postexercise mood	2.00	0.87	2.28*	0.023
Between-persons postexercise mood	1.98	2.29	0.41	0.685
Intensity[b]				
Within-person postexercise mood	0.32	0.07	4.72**	0.000
Between-persons postexercise mood	0.99	0.26	3.87**	0.001

Note. Duration and intensity models analyzed separately.

[a]Duration of exercise and mood change post exercise model includes 35 participants (1 lost owing to insufficient data) with 585 records.

[b]Intensity of exercise and mood change post exercise model includes 35 participants (1 lost owing to insufficient data) with 570 records.

*$p < .05$, **$p < .01$.

Exercise and Daily Mood Enhancement

The relationship between exercise and daily mood enhancement (i.e., change in mood from morning to evening) was examined both within and between persons as well, controlling for baseline BMI and assessment period:

$$\text{Evening mood}_{ij} = b_{0j} + b_{1j}(\text{Engaged in exercise}_{ij}) + b_{2j}(\text{Morning mood}_{ij}) + b_{3j}(\text{Assessment period}_{ij}) + r_{ij}$$

where

$$b_{0j} = \gamma_{00} + \gamma_{01}(\text{Baseline BMI}) + \gamma_{02}(\text{Morning mood}) + \gamma_{03}(\text{Engaged in exercise}) + \gamma_{04}(\text{Assessment period}) + u_{0j}$$

$$b_{1j} = \gamma_{10}$$

$$b_{2j} = \gamma_{20}$$

$$b_{3j} = \gamma_{30}$$

Results indicated that engaging in exercise significantly predicted improved evening mood within person. That is, for each participant, engaging in exercise during the day predicted a more positive evening mood. Similarly, when intensity was examined, engaging in more intense exercise improved evening mood within person. Finally, when duration was examined, longer duration of exercise did not predict improved evening mood within person (see Table 5). Again, BMI was unrelated to evening mood.

Because mood enhancement was observed immediately after a bout of exercise and overall daily mood enhancement was observed on days when participants

Table 5 Exercise and Evening Mood Controlling for Morning Mood, Baseline BMI, and Assessment Period

Evening mood	β	*SE*	*t*	*p*
Exercise engagement				
Within-person engaged in exercise[a]	0.69	0.10	6.51**	0.000
Between-persons engaged in exercise[a]	–0.20	0.47	0.44	0.665
Exercise duration				
Within-person duration of exercise[b]	0.01	0.01	0.52	0.607
Between-persons duration of exercise[b]	0.00	0.01	0.20	0.840
Exercise intensity				
Within-person intensity[c]	0.12	0.04	2.93**	0.004
Between-persons intensity[c]	0.17	0.09	1.91	0.065

Note. Models analyzed separately.

[a]Evening mood and engaged in exercise model includes 36 participants with 1,055 records (engaged in exercise = 1; did not engage in exercise = 0).

[b]Evening mood and duration of exercise model includes 36 participants with 585 records.

[c]Evening mood and intensity of exercise model includes 35 participants (1 lost owing to insufficient data) and 536 records.

*$p < .05$; **$p < .01$.

reported engaging in exercise, post hoc analyses were used to examine the relationship between mood change following exercise and mood change from morning to evening assessment (daily mood enhancement) within person using the following equation:

$$\text{Mood change during exercise}_{ij} = b_{0j} + b_{1j}(\text{Daily mood change}_{ij}) + r_{ij}$$

where

$$b_{0j} = \gamma_{00} + u_{0j}$$

$$b_{1j} = \gamma_{10}$$

Results indicated that, for individual participants, mood change immediately following exercise predicted daily mood enhancement, $\beta = 0.33$, $SE = 0.13$; $t(36) = 2.57$, $p = .01$. Thus, it appears as though engaging in exercise produced a change in mood following the activity and was significantly related to changes in mood from morning to evening.

Discussion

This study's intent was to extend research regarding the relationship between mood and exercise. In this investigation, a more positive morning mood increased the likelihood of exercise throughout the day, greater exercise duration and intensity were individually associated with more positive postexercise mood, and mood was higher at the end of exercise days and days characterized by greater exercise intensity compared with nonexercise days. By capturing multiple bouts of exercise in the participants' habitual exercise environment, the ecological validity of the current study was enhanced. Also, this investigation's within-person design encompassing multiple bouts of exercise reduces threats to validity.

Morning Mood and Exercise

The first hypothesis was that a participant would be less likely to exercise on days when he or she reported greater negative morning mood compared with days when he or she reported a more positive morning mood. The within- and between-persons results indicated a relationship between morning mood and initiation of exercise. Compared with days when a participant reported a more positive morning mood, on days when a participant reported a more negative morning mood, he or she was less likely to exercise. Also, the between-persons analysis indicated that participants with greater negative morning mood exhibited a lower likelihood of exercising than participants who experienced more positive morning mood. Specifically, those who had a negative morning mood were less likely to exercise than those who had positive morning mood ratings. Although morning mood predicted whether or not an individual exercised, within- and between-persons analyses generally indicated that morning mood was unrelated to reported duration or intensity of exercise activities. That is, once exercise was initiated, morning mood appeared to exert no effect on the perceived intensity of the exercise or how long an individual exercised. As noted earlier, previous research has indicated that mood can influence goal attractiveness and optimism about goal attainment (Schwarz & Bohner, 1996). It is plausible that

among obese adults, a population characterized by low levels of habitual exercise, the initiation of exercise is susceptible to mood influences, such that negative mood in the morning may hinder exercise participation.

Exercise and Mood Enhancement

Second, it was hypothesized that within person, greater reported exercise intensity and duration would be associated with greater reported mood enhancement from pre- to postactivity (Berger & Owen, 1998; Berger & Tobar, 2007; Hansen et al., 2001). Indeed, greater reported exercise intensity was related to greater mood enhancement, both within and between persons. Therefore, not only was greater perceived exercise intensity on a given day related to greater mood enhancement within person, but also participants who generally reported exercising at a higher intensity level reported greater mood enhancement following exercise. Also, greater reported exercise duration was related to greater mood enhancement only within person. These findings appear to suggest that obese individuals may maximize their mood enhancement when their exercise is longer (e.g., a duration of 59.7 min was 1 *SD* above the mean) and/or at a greater intensity level (e.g., an intensity of 7.4 was 1 *SD* above the mean).

Interestingly, individuals reported more positive preexercise moods during the final 4 weeks than during the first 4 weeks. As participants became more comfortable with exercise and/or more confident in their ability, they may have experienced fewer concerns before initiating exercise. The within-person findings across multiple bouts of exercise in this investigation strengthen and complement previous within- and between-persons studies that found that exercise intensity and duration may be related to mood benefits (Arent et al., 2000; Berger & Motl, 2000). This investigation's within-person design minimizes heterogeneity in sample and exercise program characteristics.

Finally, it was hypothesized that daily mood enhancement would be greater on exercise days than nonexercise days because the mood benefits of exercise tend to last beyond the exercise session (Morgan, 1987; Raglin & Morgan, 1987). The current study found that, on exercise days, a participant reported a more positive evening mood than on nonexercise days (controlling for morning mood). Participants exercised at various times throughout the day in this naturalistic study. Thus, the more positive mood state at the end of exercise days supports the conclusion that the benefits of exercise last for at least 2 to 4 hr after exercise (Morgan, 1987). Future studies are needed to further examine the specific duration of exercise and its related mood benefits in obese populations. In addition, greater intensity exercise was significantly associated with more positive evening mood relative to lower intensity exercise. Also, post hoc analyses indicated that mood change after exercise predicted mood change from morning to evening. Therefore, findings that exercise enhances daily mood in healthy physically active adults (Gauvin et al., 1996) appear to generalize to obese adults. Although many studies demonstrate the acute (Arent et al., 2000; Berger & Motl, 2000) and long-standing (e.g., reductions in depressive symptoms) mood-enhancing effects of exercise (U.S. Department of Health and Human Services, 1996), the results from this and other studies (Gauvin et al., 1996) suggest that extended postexercise mood enhancement could represent an intermediate link (i.e., daily mood enhancement) between short- and long-term mood enhancement.

Limitations and Strengths

Several limitations of this investigation are worth noting. First, a unidimensional measure of mood was utilized in this investigation to facilitate compliance with multiple, daily measures of mood. Although research indicates that mood valence reflects positive or negative evaluations of a situation with intensity as an indicator of importance (Frijda et al., 1992; Schwarz & Bohner, 1996), a multidimensional measure of mood may more clearly elucidate the relationship between exercise and mood enhancement. Similarly, the assessment of affective activation as prescribed in the circumplex model (e.g., Watson & Tellegen, 1985) might further clarify the affect, arousal, and exercise relationship. Nevertheless, the findings from this investigation may form the basis for future hypotheses on mood and exercise. Second, some researchers distinguish between longer standing moods states and more fleeting affective or feeling states (e.g., "I feel bad" vs. "I am in a bad mood"; see Ekkekakis & Petruzzello, 2000, for a detailed discussion of affect and mood in the context of exercise). Even though this investigation assessed mood in the morning, evening, and before and after exercise, it is quite possible that there is a difference in the temporal patterning of mood states experienced in the morning and evening and feeling states experienced immediately following exercise. The temporal stability of the assessed mood and feelings states will be an important determination in future research. Third, not all participants in this study completed exercise diaries. It is possible that individuals who did not complete diaries were not engaging in regular physical exercise; however, it is also possible that diary noncompleters were exercising regularly and were simply noncompliant with the instructions to record mood and exercise. Similarly, some participants only completed diary entries either during the final 4 weeks of the program or during the initial 4 weeks of the program. However, significant between-persons effects for assessment period were not observed in any of the mood enhancement and exercise models. Fourth, the 19 exercise sessions per participant averages to approximately 2 exercise sessions per week. It would appear that most participants failed to meet the recommendation to walk from 30 min to 1 hr every day. However, the findings from this investigation are consistent with research on exercise adherence levels in obese people. These studies suggest high dropout rates from walking programs (Gwinup, 1975) and lower rates of exercise adoption than normal weight participants (Sallis et al., 1986). Fifth, the exercise intensity ratings in this investigation are perceived and not objectively determined, through methods such as heart rate. Sixth, the timing of mood ratings to bouts of exercise was not assessed. An assessment of the time that the exercise occurred would provide a clearer sense of the strength of the relationships between morning mood and subsequent exercise as well as exercise and subsequent evening mood. For example, does morning mood have a greater effect on individuals who are habitual morning exercisers compared with evening exercisers? Time of exercise completion will be an important methodological advancement in future research on mood's influence on subsequent exercise. Finally, the obese individuals in this investigation were participating in a behavioral weight loss program; therefore, it is unclear how these findings would generalize to normal weight or obese individuals not interested in weight loss.

Considerable research examining the relationship between mood and exercise has been performed over limited bouts of exercise in healthy normal weight

samples. A particular strength of the current investigation is the within-person examination of the exercise and mood effects across multiple bouts of exercise in an obese sample. In addition, this investigation contributes to our understanding of the reciprocal relationship between mood and exercise.

Clinical Implications

This investigation has several important clinical implications. These findings help to clarify the relationship between mood and exercise using a within-person design. The results indicate that mood may play a role in the daily initiation of exercise, that exercise of moderate duration and intensity contributes to mood enhancement postexercise (compared with low duration and intensity), and that the mood-enhancing benefits of exercise likely extend beyond the acute postexercise period. The relationship between morning mood and exercise initiation may be an especially important finding. Overweight individuals are less likely than normal weight individuals to engage in regular exercise (Centers for Disease Control, 2000) and may be more susceptible to the influence of mood on exercise initiation. Increased awareness of mood influences on exercise initiation among obese adults and, perhaps, other populations characterized by low levels of habitual exercise, may be important information for individuals contemplating such changes. Education on the sustained mood benefits of exercise may be an important teaching point for individuals interested in initiating exercise or losing weight.

Finally, in the current investigation, individuals reported more positive preexercise moods during the final 4 weeks compared with the first 4 weeks of the BWLP. As participants became more comfortable with exercise and/or more confident in their ability, they may experience fewer concerns before initiating exercise. It may be important to educate individuals that preexercise concerns are likely to diminish as they become more comfortable and confident with exercising.

Conclusions

As noted earlier, considerable evidence indicates that mood influences evaluative judgments about goal attractiveness and goal attainment (Schwarz & Bohner, 1996; Schwarz & Clore, 1996). In addition, chronic mood conditions, such as depression, can negatively influence behavioral and medical adherence (Lin et al., 2004). Even relatively stable social cognitive variables are greatly influenced by acute situational and affective determinants. For example, ecological momentary assessment research indicates that smokers experience diminished self-efficacy in response to negative affect (Gwaltney, Shiffman, & Sayette, 2005). Models of behavioral change would benefit from a closer examination of reciprocal relationship between social cognitive factors and mood influences.

Future research concerns include further clarifying the relationship between exercise intensity and duration and mood in obese participants, as well as other segments of the population. Findings at present are inconclusive regarding the mood benefits of low-intensity exercise, as well as the optimal level of intensity for mood enhancement (see Berger, Pargman, & Weinberg, 2007, for a review). The relationship between mood alteration and exercise intensity and duration considerations are particularly important because most people, especially those who are obese,

often do not achieve the recommended 30 min of exercise most days of the week (American College of Sports Medicine, 2006). The optimal duration of exercise for mood enhancement should also be further examined. Also, the within-person differences between actual and perceived intensity of exercise and mood benefits could be studied. In conclusion, the results from this study indicate relationships between mood and exercise initiation, intensity, and duration. The information found in the present study may prove useful as an educational tool for obese individuals who are concerned with initiating exercise.

Note

As discussed in Snijders & Bosker (1999), multilevel analysis is not conducive to the methods of calculating the explained proportion of variance commonly used in least-squares regression. The methods described for calculating the R^2 result in *estimates* of the variance accounted for by the models and should be interpreted with caution. It is not uncommon for additional predictor variables to *decrease* the proportion of variance accounted for by the model, especially if the variable has little variation at one of the levels (i.e., adding a predictor at Level 2 may decrease the between-group variance but increase the within-group variance). This increase in variance serves to reduce the resulting estimate of the explained proportion of variance, and it is not uncommon for this estimate to be a negative value (Hox, 2002, p. 66), especially for Level-2 models. A pseudo-R^2 statistic was calculated for all Level-1 and Level-2 models in the current investigation. On average, estimates of the proportion of explained variance for within-person models ranged from –0.1% to 43%, with the average explained variance equaling 10.4%. As mentioned, these values should be interpreted with caution and viewed as lower level estimates of the explained variance. Many of the Level-2 models suffered the problematic consequences of estimating an R^2 value with multilevel data and were found to account for a negative amount of variance. These values should not be interpreted as actual estimates of the variance accounted for by the model and are not reported in this article.

References

American College of Sports Medicine (2006). *ACSM's guidelines for exercise testing and prescription.* Philadelphia: Lippincott Williams & Wilkins.

Arent, S.M., Landers, D.M., & Etnier, J.L. (2000). The effects of exercise in older adults: A meta-analytic review. *Journal of Aging and Physical Activity, 8,* 407-430.

Bandura, A. (1997). Self-efficacy: Towards a unifying theory of behavioural change. *Psychological Review, 84,* 191-215.

Berger, B.G., & Motl, R.W. (2000). Exercise and mood: A selective review and synthesis of research employing the profile of mood states. *Journal of Applied Sport Psychology, 12,* 69-92.

Berger, B.G., & Owen, D.R. (1992). Preliminary analysis of a causal relationship between swimming and stress reduction: Intense exercise may negate 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 changes in college joggers. *Perceptual and Motor Skills, 87,* 611-621.

Berger, B.G., Pargman, D., & Weinberg, R.S. (2007). Practice guidelines for optimal psychological benefits: Exercise frequency, intensity, and duration. In *Foundations of exercise psychology* (pp. 389-413). Morgantown, WV: Fitness Information Technology.

Berger, B.G., & Tobar, D.A. (2007). Physical activity and quality of life: Key considerations. In G.Tenenbaum & R.C. Eklund (Eds.), *Handbook in sport psychology* (pp. 598-620). New York: Wiley.

Brownell, K.D. (2004). *The LEARN program for weight management 10th edition*. Dallas, TX: American Health Publishing Company.

Carels, R.A., Berger, B.G., & Darby, L.A. (2006). Mood states in obese, sedentary, post-menopausal women: Predictors of physical activity and fitness. *Journal of Aging and Physical Activity, 14,* 12-28.

Centers for Disease Control and Prevention. (2000). Prevalence of leisure-time physical activity among overweight adults—United States, 1998. *Morbidity and Mortality Weekly Report, 49, 326-330.*

Cohen-Mansfield, J., Marx, M.S., & Guralnik, J.M. (2003). Motivators and barriers to exercise in an older community-dwelling population. *Journal of Aging and Physical Activity, 11,* 242-253.

Ekkekakis, P., & Petruzzello, S.J. (2000). Analysis of the affect measurement conundrum in exercise psychology. I. Fundamental issues. *Psychology of Sport & Exercise, 1,* 71-88.

Finkelstein, E.A., Fiebelkorn, I.C., & Wang, G. (2003). National medical spending attributable to overweight and obesity: How much and who's paying. *Health Affairs, W3,* 219-226.

Frijda, N.H., Ortony, A., Sonnemans, J., & Clore, G.L. (1992). The complexity of intensity: Issues concerning the structure of emotion intensity. In M.S.Clark (Ed.), *Review of personality and social psychology* (pp. 60-89). Beverly Hills, CA: Sage.

Gauvin, L., Rejeski, W.J., & Norris, J.L. (1996). A naturalistic study of the impact of acute physical activity on feeling states and affect in women. *Health Psychology, 15,* 391-397.

Gwaltney, C.J., Shiffman, S., & Sayette, M.A. (2005). Situational correlates of abstinence self-efficacy. *Journal of Abnormal Psychology, 114,* 649-660.

Gwinup, G. (1975). Effect of exercise alone on the weight of obese women. *Archives of Internal Medicine, 13,* 676-680.

Hansen, C.J., Stevens, L.C., & Coast, J.R. (2001). Exercise duration and mood state: How much is enough to feel better? *Health Psychology, 20,* 267-275.

Hardy, C.J. & Rejeski, W.J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology, 11,* 304-317.

Hox, J. (2002). *Multilevel analysis: Techniques and applications*. Mahwah, NJ: Lawrence Erlbaum.

King, A.C., Pruitt, L.A., Phillips, W., Oka, R., Rodenburg, A., & Haskell, W. (2000). Comparative effects of two physical activity programs and measure and perceived physical functioning and other health-related quality of life outcomes in older adults. *Journal of Gerontology, 55,* M74-M83.

Lin, E.H.B., Oliver, M., Katon, W., Ciechanowski, P., Von Korff, P., Ludman, E.J., et al. (2004). Relationship of depression and diabetes self-care, medication adherence, and preventive care. *Diabetes Care, 27,* 2154-2160.

Litwin, H. (2003). Social predictors of physical activity in later life: The contribution of social-network type. *Journal of Aging and Physical Activity, 11,* 389-406.

Marcus, B.H., Dubbert, P.M., Forsyth, L.H., McKenzie, T.L., Stone, E.J., Dunn, A.L. et al. (2000). Physical activity behavior change: Issues in adoption and maintenance. *Health Psychology, 19*(Suppl.), 32-41.

McKenzie, N. & Marks, I. (1999). Quick rating of depressed mood in patients with anxiety disorders. *British Journal of Psychiatry, 174,* 266-269.

McNair, D.M. & Heuchart, J.W.P. (2005). *Profile of Mood States technical update*. Tonawanda, NY: Multi-Health Systems.

McNair, D.M., Lorr, M., & Droppleman, L.F. (1992). *POMS manual*. North Tonawanda, NY: Multi-Health Systems.

Morgan, W.P. (1987). Reduction and state anxiety following acute physical activity. In W.P. Morgan & S.E. Goldston (Eds.), *Exercise and mental health* (pp. 105-109). Washington, DC: Hemisphere.

Osei-Tutu, K.B., & Campagna, P.D. (2005). The effect of short- vs. long-bout exercise on mood, VO_2max, and percent body fat. *Preventive Medicine, 40,* 92-98.

Pavot, W., & Diener, E. (1993). The affective and cognitive context of self-report measures of subjective well-being. *Social Indicators Research, 28,* 1-20.

Pratt, M., Macera, C.A., & Wang, G. (2000). Higher direct medical costs associated with physical inactivity. *The Physician and Sports Medicine, 28,* 1-11.

Raglin, J.S., & Morgan, W.P. (1987). Influence of exercise and quiet rest on state anxiety adn blood pressure. *Medicine and Science in Sports and Exercise, 19,* 456-463.

Sallis, J.F., Haskell, W., Fortmann, S., Vranzium, K.M., Taylor, C.B., & Solomon, D.S. (1986). Predictors of adoption and maintenance of physical activity in a community sample. *Preventive Medicine, 15,* 331-341.

Salovey, P., & Birnhaum, D. (1989). Influence of mood on health-relevant cognitions. *Journal of Personality and Social Psychology, 57,* 539-551.

Schwarz, N., & Bohner, G. (1996). Feelings and their motivational implications: Moods and the action sequence. In P.M.Gollwitzer & J.A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 119-145). New York: The Guilford Press.

Schwarz, N., & Clore, G.L. (1996). Feelings and phenomenal experiences. In E.T. Higgins & A.W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 433-465). New York: Guilford Press.

Snijders, T., & Bosker, R. (1999). *Multilevel analysis: An introduction to basic and advanced multilevel modeling.* London: Sage Publications.

Tobar, D.A. (2005). Overtraining and staleness: The importance of psychological monitoring. *International Journal of Sport and Exercise Psychology, 3,* 455-468.

Tremblay, A.D.E., & Imbeault, P. (1999). Physical activity and weight maintenance. *International Journal of Obesity, 23*(Suppl.), 50-54.

U.S. Department of Health and Human Services (1996). *Physical activity and health: A report of the surgeon general.* Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion.

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin, 98,* 219-235.

Manuscript submitted: January 11, 2007
Revision accepted: June 24, 2007