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Walking in (Affective) Circles: Can Short Walks Enhance Affect?

Panteleimon Ekkekakis,[1,2] Eric E. Hall,[1] Lisa M. VanLanduyt,[1] and Steven J. Petruzzello[1]

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Recent physical activity recommendations call for activities that are of moderate intensity and can be performed intermittently during the day, such as walking. These proclamations were based partly on the assumption that moderate activities are generally more enjoyable than physically demanding ones, and they are, therefore, also more likely to be continued over the long haul. However, little is actually known about the affective outcomes of short bouts of walking and extant findings are equivocal. Four experimental studies examined the affective responses associated with short (10- to 15-min) bouts of walking using a dimensional conceptual model of affect, namely, the circumplex. Results consistently showed that walking was associated with shifts toward increased activation and more positive affective valence. Recovery from walking for 10–15 min was associated with a return toward calmness and relaxation. This pattern was robust across different self-report measures of the circumplex affective dimensions, across ecological settings (field and laboratory), across time, and across samples.

KEY WORDS: walking; moderate physical activity; affect; circumplex model.

INTRODUCTION

Recent consensus statements and public health recommendations regarding the application of physical activity for the prevention of chronic

[1]Department of Kinesiology, University of Illinois at Urbana–Champaign.
[2]To whom correspondence should be addressed at Department of Kinesiology, University of Illinois at Urbana–Champaign, Louise Freer Hall, 906 South Goodwin Avenue, Urbana, Illinois 61801. Fax: (217) 244-7322. e-mail: ekkekaki@uiuc.edu.

disease and disability call for moderate doses of activity [National Institutes of Health (NIH), 1996; Pate *et al.*, 1995; United States Department of Health and Human Services (USDHHS), 1996]. Walking is being promoted as one such activity that is easy to do, familiar, generally safe, and inexpensive (Davison and Grant, 1993; Morris and Hardman, 1997; Porcari *et al.*, 1989; Rippe *et al.*, 1988). In fact, walking has been shown to be the most popular mode of health-oriented physical activity among adults (USDHHS, 1996). The reasoning behind the proclamations for moderate doses of physical activity is partly based on motivational considerations. According to the NIH consensus development panel on physical activity and cardiovascular health, "moderate-intensity activities are more likely to be continued than are high-intensity activities" (NIH, 1996, p. 243). This statement is based on the assumption that physical activities typically performed at moderate intensity, such as walking, are on average more enjoyable or less aversive than activities typically performed at higher intensity, such as running or swimming. However, despite the recent proliferation of information on the affective outcomes associated with single bouts of exercise of various dose characteristics (Ekkekakis and Petruzzello, 1999; Gauvin and Spence, 1996; Morgan, 1997; Scully *et al.*, 1998; Tuson and Sinyor, 1993; Yeung, 1996), very few studies have dealt specifically with walking and their results are equivocal. Furthermore, most previous studies examined only changes in state anxiety to the exclusion of other affective states which might be influenced by walking.

For almost 30 years, the commonly held assumption in the exercise psychology literature regarding the effects of walking on affective states was that any physical activity performed at a low to moderate intensity and for a short duration is ineffective for modifying affect. This belief grew mainly out of two early studies involving exercise of low-to-moderate intensity that produced null results. First, Morgan *et al.* (1971) randomly assigned 36 students to a 17-min walk at 3 $\text{mi} \cdot \text{hr}^{-1}$ and 0% grade, a 17-min walk at 3 $\text{mi} \cdot \text{hr}^{-1}$ and 5% grade, or a 17-min supine rest group. Posttest-only assessments of anxiety and depression showed no difference among the three groups. In a second study examining changes in state anxiety using the State-Trait Anxiety Inventory (SAI) (Spielberger *et al.*, 1970), Sime (1977) failed to show significant changes following 10 min of low- to moderate-intensity treadmill exercise (average heart rate of 100–110 $\text{beats} \cdot \text{min}^{-1}$) and a 5-min recovery period. These early studies were characterized by some important limitations. Specifically, the posttest-only design employed by Morgan *et al.* (1971) makes it impossible to infer whether walking produced any changes in anxiety and depression. Likewise, the fact that state anxiety in the Sime (1977) study was assessed not immediately following exercise, but after a 5-min recovery period, leaves open the possibility that significant changes in state anxiety had occurred but dissipated during the recovery period.

Despite these limitations, however, on the basis of the null early findings, some authors proposed that exercise must exceed certain relatively vigorous thresholds of intensity (i.e., 60–70% of maximal aerobic capacity, or $V\text{O}_2$max) and duration (i.e., 20 min) to reduce state anxiety (Dishman, 1986; Morgan, 1979, 1982, 1984; Morgan and Ellickson, 1989; Morgan *et al.*, 1980; Raglin and Morgan, 1985). Over the years and despite the lack of additional evidence, the "threshold" assumption grew so pervasive that it became accepted as part of the exercise psychology knowledge base. This is reflected in the official position statement of the International Society of Sport Psychology (ISSP, 1992) on physical activity and psychological benefits, which asserts that "low-intensity and short duration exercise has not been shown to reduce state anxiety" (p. 200).

Although the "threshold" assumption was initially discussed only in reference to state anxiety, some authors presumed that it is applicable to all affective changes associated with exercise (e.g., Kirkcaldy and Shephard, 1990; Ojanen, 1994). Even authors who have taken a more skeptical approach found it necessary to take the "threshold" assumption into account. According to Berger and Owen (1988, p. 150), for example, "until there is additional research support for stress reduction with mild exercise in the general population, exercise intensity probably should be moderate, rather than mild." Based on statements like this, authors from other exercise and health subdisciplines have also echoed the "threshold" assumption. For instance, discussing the effects of exercise on maternal health and fetal well-being, Wolfe and his associates (1989, 1994) suggested that exercise must be "moderate," because low-intensity, short-duration exercise may be ineffective for conferring psychological (and other) benefits.

Despite the popularity of the "threshold" assumption, however, there is evidence that contradicts it. For example, contrary to the assumption that the intensity of exercise must exceed 60 or 70% $V\text{O}_2$max to produce decreases in state anxiety, Porcari *et al.* (1988), using 40-min bouts of walking at 35, 50, and 65% of maximal aerobic capacity ($V\text{O}_2$max) and at a self-chosen pace, showed significant decreases in SAI scores, regardless of intensity. Felts and Vaccaro (1988), using 25-min bouts of cycling at 30 and 60% of maximal age-predicted heart rate reserve (HRR), also found decreases in SAI scores, regardless of intensity. Likewise, contrary to the assumption that the duration of exercise must exceed 20 min to produce a decrease in state anxiety, studies by Rudolph and Butki (Butki and Rudolph, 1997; Rudolph *et al.*, 1998) showed that treadmill exercise performed at "moderately hard" levels of perceived exertion for short periods (10 to 20 min) led to significant decreases in SAI scores, regardless of duration. Petruzzello and Landers (1994), comparing the effects of treadmill running at 75% $V\text{O}_2$max for either 15 or 30 min, also found significant decreases in SAI scores, regardless of duration.

In agreement with these findings, a meta-analysis of the effects of acute exercise on state anxiety (covering the literature until 1989) showed no significant difference in effect sizes between studies employing protocols of different intensities or durations (Petruzzello *et al.*, 1991).

Besides state anxiety, low-intensity (25-W), short-duration (8- to 15-min) exercise has also been shown to improve mood states (Steptoe and Bolton, 1988; Steptoe and Cox, 1988). Affective responses to short walks have also been examined in studies using the Activation–Deactivation Adjective Checklist (AD ACL) (Thayer, 1989). Thayer and his associates have conducted a series of field studies examining the effects of walks lasting for as few as 4 to 10 min. These studies have consistently shown that walking is associated with increases in perceived energy (Thayer, 1987a, b; Thayer *et al.*, 1993), and in some cases, this change was accompanied by decreases in tension and tiredness (Thayer, 1987b; Thayer *et al.*, 1993). An increase in perceived energy and a decrease in tension following 4- to 10-min walks have also been reported by Saklofske *et al.* (1992). These findings led Thayer (1989, p. 24) to conclude that "moderate exercise (a short brisk walk) proved to be one of the most reliable mood manipulators." However, the degree of methodological constraint in these field studies was minimal, making it difficult to draw strong inferences.

In summary, the extant literature contains some striking contradictions with regard to the effect of short bouts of walking on the affective domain.[3] A likely explanation is that the inconsistencies are due to methodological differences. Specifically, two elements seem to be the most important: (a) the ecological setting where the physical activity is performed (i.e., laboratory versus outdoors) and (b) the way affective responses were conceptualized and measured. In the present paper, we report the results of four studies designed to explore these issues. First, we conducted studies both outdoors (enriched environment, group setting) and in the laboratory (bland environment, solitary). Second, we used a dimensional model for the conceptualization and operationalization of affect. This approach is explained further in the next section.

A Dimensional View of Affect

In studies examining the affective changes associated with physical activity, affect has been traditionally examined from a "categorical" perspective.

[3]It should be noted that the effects of walking on mood states have been examined in two additional studies (Jin, 1992; Pronk *et al.*, 1994). However, because the duration of the walks used in these studies was too long (i.e., from 41 to 71 min), the studies fall outside the scope of this review.

In this view, affective states are organized in categories that are taken to be conceptually distinct. In contrast, "dimensional" approaches are based on the assumption that affective states are systematically interrelated, such that their relationships can be meaningfully modeled by a parsimonious set of dimensions. It is generally acknowledged that both categorical and dimensional approaches have relative strengths and weaknesses and any attempt to identify the "correct" approach raises a pseudo-issue. The decision to adopt one or the other depends on the particular nature of the question and the context being investigated. The main advantage attributed to dimensional models is their parsimony; that is, they can account for a large portion of the variation in affective states in terms of a few basic dimensions. Discussing the implications of this issue for the study of the affective changes associated with physical activity, Gauvin and Brawley (1993, p. 152) noted,

> ... [A dimensional approach] seems better suited to the study of exercise and affect because the models stemming from it are intended to be broad, encompassing conceptualizations of affective experience. Because the affective experience that accompanies exercise has not been thoroughly described, a model of affect that has a wider breadth is more likely to capture the essence of exercise-induced affect than a model that, at the outset, limits the focus of investigation to specific emotions.

As we pointed out earlier, most studies examining the effects of walking on affect focused on a single variable, namely, state anxiety. However, there is presently no evidence that changes in state anxiety are the most salient or relevant affective changes associated with physical activity, particularly among nonanxious participants and in the absence of any anxiety-inducing stimuli. Therefore, by restricting the investigative scope to state anxiety, the effectiveness of physical activity in impacting the affective domain in general might have been obscured. To address this problem, in the studies reported herein we examined affect from a dimensional perspective.

Specifically, the two-dimensional circumplex model of affect was used, as described by Russell (1978, 1980, 1989, 1997; for a review see also Larsen and Diener, 1992). According to the circumplex, the affective space is defined by two bipolar and orthogonal dimensions: an affective valence dimension and an activation dimension. Affective states are construed as combinations of varying degrees of these two constituent dimensions, such that they can be conceptualized as located around the perimeter of a circle defined by the dimensions of valence and activation. Experientially similar affective states (e.g., "happy" and "delighted") are closer together on the circle, whereas affective states perceived as antithetical (e.g., "happy" and "sad") are opposite on the circle. A division of the circle into quadrants produces the following meaningful variants: (i) unactivated pleasant affect (45°), characterized by relaxation and calmness; (ii) unactivated unpleasant affect (135°), characterized by boredom, fatigue, or depression; (iii) activated unpleasant affect

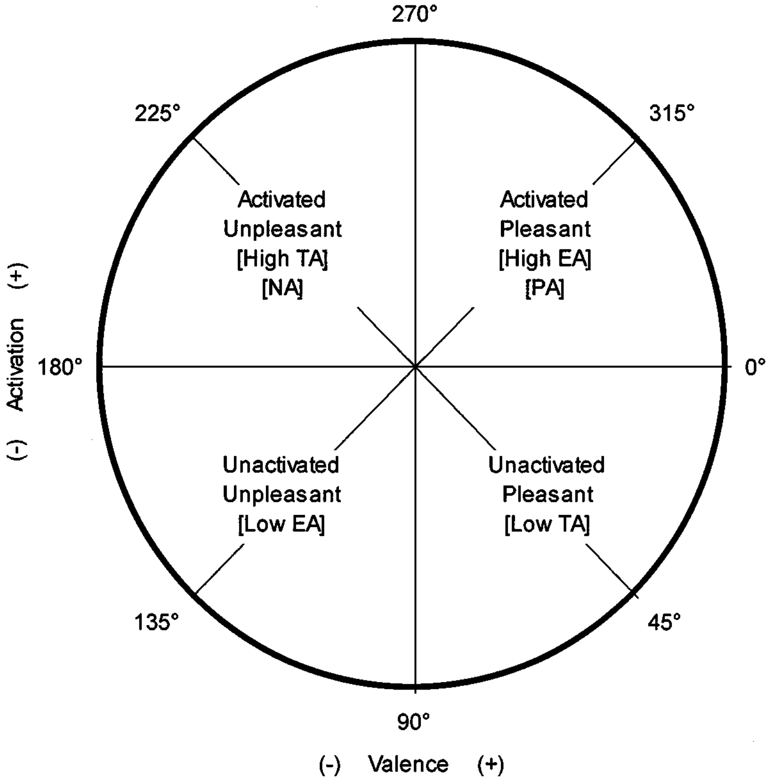


Fig. 1. The circumplex model of affect. EA and TA refer to Energetic Arousal and Tense Arousal (Thayer, 1989). PA and NA refer to Positive Affect and Negative Affect (Watson *et al.*, 1988).

(225°), characterized by tension and distress; and (iv) activated pleasant affect (315°), a state characterized by energy, excitement, and enthusiasm (see Fig. 1).

Despite its potential heuristic value for studying affect in the context of physical activity, "the circumplex has been virtually ignored by researchers in exercise psychology" (Gauvin and Brawley, 1993, p. 153). The only cases where a conceptual model of affect consistent with the circumplex has been applied in the context of physical activity were the aforementioned studies that used the AD ACL. In Thayer's theoretical framework that formed the basis of the AD ACL, the structure of mood is characterized by two bipolar dimensions: Energetic Arousal (EA) is characterized by energy–sleep and is hypothesized to vary diurnally reflecting changes in gross physical activity; Tense Arousal (TA) is characterized by tension–placidity and is thought to underlie a variety of emotions and stress reactions. At high levels of energy expenditure, EA is linked to positive affective tone (energy, vigor), whereas TA is linked to negative affective tone (tension, distress). Conversely, at low levels of energy expenditure, EA is characterized by negative affective tone (fatigue, tiredness), whereas TA is associated with positive affective tone (calmness, quietness). Thus, according to Thayer (1989, p. 164), EA and TA map directly onto the circumplex model (see Fig. 1), with EA extending from activated pleasant to unactivated unpleasant affect (315–135° on the circumplex) and TA extending from activated unpleasant to unactivated pleasant affect (225–45° on the circumplex).

The Present Studies

The purpose of the studies described in this paper was to examine whether short bouts of walking, similar to those described in recent physical activity recommendations, can bring about significant changes in affect. This hypothesis was examined within a dimensional model of affect, to enable the "mapping" of the most salient shifts in affective space that are associated with walking. The four studies are organized in two sets. The first two studies (i.e., Studies I and II) were conducted outdoors and were aimed to investigate the external and ecological validity of any response patterns. The next two studies (i.e., Studies III and IV) were conducted in the laboratory and were aimed to establish the internal validity of the observed responses. Within each set, the first study was designed to investigate *whether* any affective changes occur and to document the *magnitude* of any such changes. Consequently, in the first outdoors study (i.e., Study I) and in the first laboratory study (Study III), we used multiple measures of the circumplex dimensions to broaden our investigative scope as much as possible, thus ensuring that no salient affective changes would escape detection. This also enabled us to examine the consistency of any emergent trends across different theoretically related measures of affective dimensions. In the two subsequent studies (i.e., Studies II and IV), we examined some important additional issues, such as the time course of the effects (Study II) and the reliability of the effects within individuals across time (Study IV). Because of the multiple repeated assessments of affect involved in these studies and the risk of reactivity to testing that such methods entail, in these studies we limited the number of self-report measures we employed to two.

STUDY I

The purpose of this study was to replicate and extend the findings of Thayer and his associates (1993; Thayer, 1987a, b) involving short walks performed in naturalistic settings and integrated in the participants' daily routines. Affective responses were assessed using multiple self-report measures of the affect circumplex dimensions.

Methods

Participants

Informed consent was obtained from 52 undergraduate students who volunteered to participate in the study. There were 26 women and 26 men (mean age, 20 years).

Psychometric Instruments

The following self-report scales were used to assess affective responses.

(i) The Feeling Scale (FS) (Hardy and Rejeski, 1989) is an 11-point, single-item bipolar measure of pleasure–displeasure, which is used for the assessment of affective responses during exercise. The scale ranges from −5 to +5. Anchors are provided at the 0 point ("neutral") and at all odd integers, ranging from "very good" (+5) to "very bad" (−5). Validation information is provided by Hardy and Rejeski (1989).

(ii) The Felt Arousal Scale (FAS) of the Telic State Measure (Svebak and Murgatroyd, 1985) is a 6-point, single-item measure of perceived activation. The scale ranges from 1 to 6, with anchors at 1 ("low arousal") and 6 ("high arousal"). The FAS has been used extensively in the context of reversal theory research, including exercise-related studies (Kerr and Vlaswinkel, 1993).

(iii) The paper-and-pencil version of the Self-Assessment Manikin (SAM) (Bradley and Lang, 1994; Hodes *et al.*, 1985; Lang, 1980) includes scales for the assessment of "Arousal," "Valence," and "Dominance," modeled according to an earlier, three-dimensional conception of the affect circumplex (Russell, 1978, 1980). Only the Arousal (SAM-A) and Valence (SAM-V) scales were used here. The SAM is presented in a graphical format. SAM-V includes a strip of five cartoon drawings of a caricature with facial expressions ranging from very happy to very unhappy. Likewise, in SAM-A, the caricatures show physical signs ranging from extreme activation (heart pounding) to sleepiness (eyes closed). No verbal anchors are provided. The SAM has been used extensively in psychophysiological research within a circumplex framework and formal evidence of its validity is satisfactory (Bradley and Lang, 1994).

(iv) The Affect Grid (AG) (Russell *et al.*, 1989) was developed by Russell and his associates as a brief measure of the two-dimensional circumplex affective space. The AG uses a 9×9 grid format, with the horizontal dimension representing valence (AG-V; ranging from unpleasantness to pleasantness) and the vertical dimension representing arousal (AG-A; ranging from sleepiness to high arousal). Validation information is provided by Russell *et al.* (1989).

(v) The Positive and Negative Affect Schedule (PANAS) (Watson *et al.*, 1988) was developed as a self-report measure of the dimensions Positive Affect (PA) and Negative Affect (NA), as described by Tellegen, Watson, and their associates (Tellegen, 1985; Watson and Tellegen, 1985; Zevon and Tellegen, 1982). PA and TA essentially represent 45° rotational variants of the circumplex dimensions of activation and valence (Larsen and Diener, 1992; Watson and Tellegen, 1985). Thus, high PA is characterized by adjectives reflecting a composite of pleasantness and high activation, whereas low PA is represented by adjectives characteristic of unpleasantness and low activation. Conversely, high NA represents a composite of high activation and unpleasantness, whereas low NA refers to pleasant low activation. It must be emphasized, however, that despite the conceptualization of PA and NA as bipolar dimensions, the PA and NA scales of the PANAS are, in fact, unipolar, assessing only the high activation poles of the respective dimensions (i.e., the upper half of the circumplex space). The PANAS includes 20 items (10 items for PA, 10 items for NA), each accompanied by a 5-point Likert-type scale. Psychometric information for the PANAS has been provided by Watson *et al.* (1988).

(vi) The Activation–Deactivation Adjective Checklist (AD ACL) (Thayer, 1989) is a self-report measure of the affective dimensions of Energetic Arousal (EA) and Tense Arousal (TA), as described by Thayer (1978a, 1985, 1989; see the Introduction for more information). As is also the case with PANAS, EA and TA represent 45° rotational variants of the dimensions of valence and activation of the affect circumplex. The AD ACL can be scored either in terms of the bipolar dimensions of EA and TA (represented by 10 items each) or in terms of four unipolar scales: Energy, Tiredness, Tension, and Calmness (represented by 5 items each). Each item is accompanied by a 4-point Likert-type scale. Psychometric data on the AD ACL have been published by Thayer (1978b, 1986).

(vii) The eight-item abbreviated version of the state anxiety scale of the SAI (Spielberger, 1979a) was included to allow comparisons to previous research. Previous work has shown a correlation of .97 between this 8-item version and the complete 20-item version of the SAI (Rejeski *et al.*, 1991). In our laboratory, this version has demonstrated acceptable internal consistency in most situations (α ranges from .71 to .87). Each item of the SAI is accompanied by a 4-point Likert-type scale.

Procedures

The study was conducted during regular class hours and it was, therefore, incorporated into the participants' regular daily routines. One of the investigators presented the battery of self-report instruments to the participants in a group setting in a classroom. The participants were then asked to carefully read the instructions accompanying each scale and to complete the questionnaires for the first time ("pretest"). Upon completion, the participants recorded their heart rates by palpating their radial arteries for 15 sec. When these assessments were concluded, the participants were randomly assigned to either a walking group ($n = 26$) or a reading control group ($n = 26$).

The members of the walking group walked outdoors (in fair weather conditions) at a self-selected pace along a predetermined path on campus. The average duration of the walk was 10 min. At the same time, the members of the control group remained seated in the classroom and were given copies of an article to read ["Guidelines for Nonsexist Use of Language in NCTE Publications"; National Council of Teachers of English (NCTE), 1985]. This article had been screened to ensure that it did not contain any reference to exercise or any statements that might induce affective reactions. Participants in both groups were allowed to socialize. When all the members of the walking group had returned to the classroom (approximately 12 min), all participants were asked to self-assess their heart rates and to complete the "posttest" battery of questionnaires.

Data Analysis

For the purposes of analysis, the self-report scales were organized in five pairs, with each pair considered to provide an independent dimensional representation of affective space. This was dictated by both conceptual and statistical considerations. Conceptually, the purpose of using multiple measures of the same space was to examine the robustness of the affective changes associated with walking across measurement instruments. Statistically, treating each set of scales separately was dictated by the necessity to avoid problems associated with multicollinearity in multivariate analyses. Thus, the following five pairs were formed: (i) FS and FAS, (ii) SAM-V and SAM-A, (iii) AG-V and AG-A, (iv) PA and NA, and (v) EA and TA. Of them, the former three (single-item scales) involved measures of the "unrotated" circumplex dimensions of valence and activation, whereas the latter two (multiitem scales) involved measures of the 45° "rotated" dimensions of affective space (see explanations in the introduction). The SAI was analyzed separately.

Multivariate analyses of variance (MANOVAs) were first performed on each of the five sets of self-report scales (as described above). To control for Type I error rate, a Bonferroni adjustment of the .05 α level was used (.01) for each MANOVA. Significant multivariate interaction effects were decomposed by examining the corresponding univariate effects for each scale, again controlling for Type I error inflation (.005). Finally, analysis of simple effects within each group was carried out using Fisher–Hayer tests (q_{FH}) for post hoc comparisons (α set at .01 for each comparison) and effect sizes were computed $[d = (M_i - M_j)/SD_{pooled}]$ to assess the magnitude of the differences from the pretest to the posttest. A similar analytic strategy was followed in all four studies.

Results

Heart rate was significantly increased in the walking group [from 71 ± 11 to 91 ± 17 beats $\cdot$ min^{-1} ($p < .01$); 15% of age-predicted maximum heart rate reserve, or HRR], whereas in the control group there was no significant change. The mean Rating of Perceived Exertion (RPE) (Borg, 1998) was 10.2, or between "very light" and "fairly light."

The internal consistency of the multi-item self-report scales was examined to ensure that the scales performed adequately in this sample. Indeed, α coefficients were found to be .90 and .94 for PA, .89 and .90 for NA, .93 and .96 for EA, .88 and .84 for TA, and .89 and .91 for SAI, for the pretest and posttest administrations, respectively.

Overall, walking was associated with significant shifts toward more activated pleasant affect, whereas no major changes were found in the control group. Specifically, while the multivariate Group × Time interaction was significant for the scales of both the AD ACL [$F(2,49) = 24.67$, $p < .001$] and the PANAS [$F(2,46) = 10.86$, $p < .001$], the effects were restricted to the scales tapping the activated pleasant–unactivated unpleasant dimension of the circumplex, namely, EA [$F(1,50) = 49.54$, $p < .001$] and PA [$F(1,47) = 18.81$, $p < .001$]. In the walking group, but not in the control group, EA (see Table I and Fig. 2a) and PA ($d = .79$) were increased significantly from pretest to posttest.

The data from the single-item scales that were used to assess the "unrotated" circumplex dimensions of valence and activation also indicated that walking was associated with a shift toward a more activated pleasant state. For FS and FAS, the significant Group × Time interaction [$F(2,48) = 11.74$, $p < .001$] was attributable to both the FS [$F(1,49) = 10.47$, $p < .005$] and the

Table I. Effect Sizes of Statistically Significant Pairwise Comparisons Between Time Points in the Walking and Control Groups in EA and TA ($p < .01$) Across the Four Studies

			EA		TA	
Study	Time points		Walk	Control	Walk	Control
I	Pre	Post	1.60			
II	Pre	Post 0′	.82	−.41		−.37
		Post 10′	.31	−.29		−.31
	Post 0′	Post 10′	−.54		−.41	
III	Pre	Post 0′	.95	−.43	.52	−.74
		Post 10′		−.64		−.44
	Post 0′	Post 10′	−1.23		−.83	
IV	Pre 1	Pre 2	−.53	No control group	−.72	No control group
		Post 0′	.40			
		Post 15′			−.87	
	Pre 2	Post 0′	.93		.44	
		Post 15′				
	Post 0′	Post 15′	−.60		−.64	

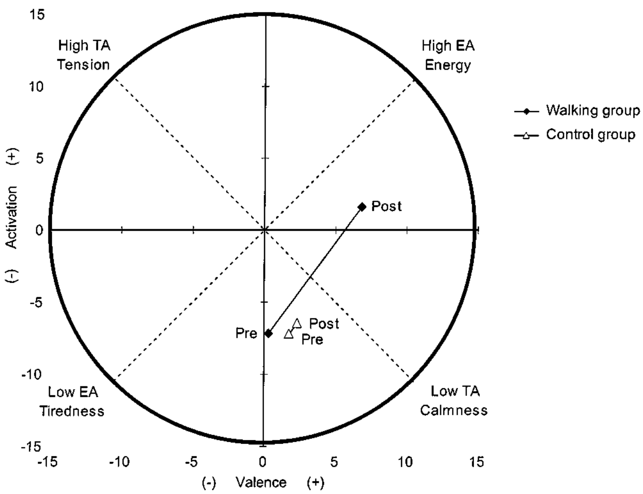
Note. Positive effect sizes signify increases from the time point on the left to the time point on the right; negative effect sizes signify decreases.

FAS [$F(1,49) = 19.26$, $p < .001$]. Both scales showed increases in the walking group, whereas no significant changes occurred in the control group (see Table II and Fig. 3a). For the scales of the AG, the significant Group × Time interaction [$F(2,49) = 8.76$, $p < .01$] was attributable only to AG-A [$F(1,50) = 11.67$, $p < .001$], which increased in the walking group (see Table II). For AG-V, although the interaction was not significant, the improvement over time was more notable in the walking group ($d = .55$) than the control group ($d = .13$). For the scales of the SAM, there was only a significant main effect of Time [$F(2,47) = 22.25$, $p < .001$], attributable to changes in both the SAM-V [$F(1,48) = 34.74$, $p < .001$] and the SAM-A [$F(1,48) = 7.81$, $p < .01$]. Valence, as indexed by the SAM-V, and activation, as indexed by the SAM-A, increased over time in both groups, but the changes were more pronounced in the walking group than the control group (SAM-V, $d = 1.12$ versus $d = .29$, and SAM-A, $d = .46$ versus $d = .14$, for the walking and the control groups, respectively).

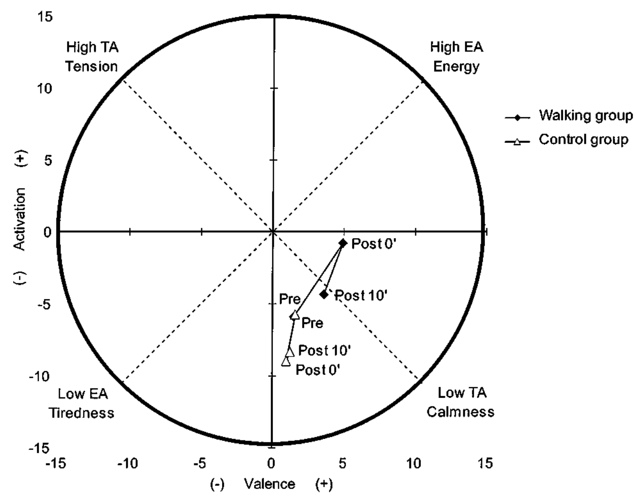
Finally, for SAI, there was only a marginally significant main effect of Time [$F(1,47) = 5.447$, $p < .05$]. In both groups, the decreases in SAI scores were small to moderate in magnitude ($d = -.30$ and $d = -.16$, for the walking and control groups, respectively).

Conclusion

The results of this study showed that a short bout of walking, performed outdoors, in a group setting, and integrated into the participants'



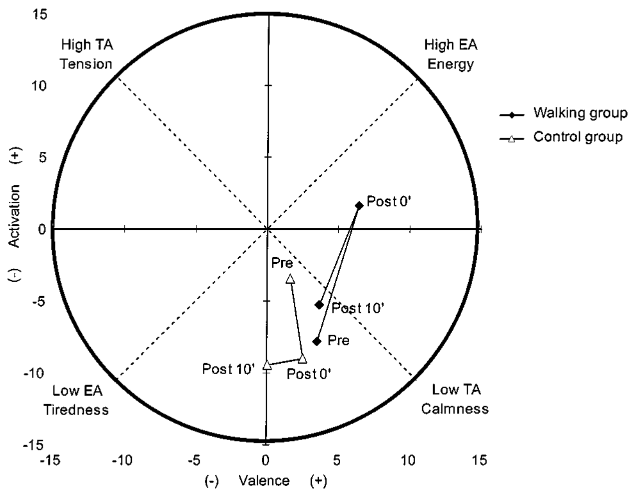
(a)



(b)

Fig. 2. Responses to the EA and TA scales of AD ACL in Studies I (a), II (b), III (c), and IV (d), plotted in circumplex space. The scales were rotated 45° for plotting using trigonometric methods.

daily routines, was associated with shifts toward higher activation and improved affective valence. This finding was consistent across the two multi-item questionnaires (i.e., AD ACL and PANAS) and the FS-FAS. The remaining two sets of single-item scales of valence and activation (i.e., AG,



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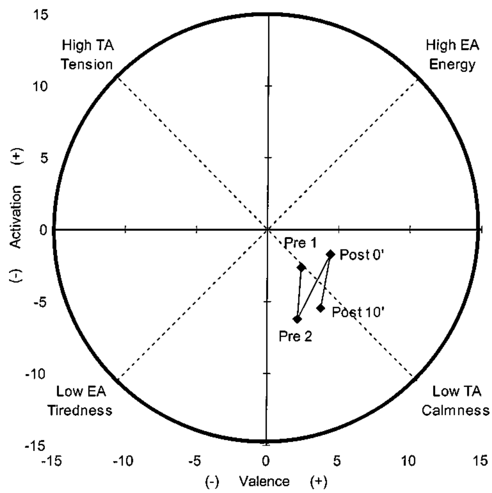

(d)

Fig. 2. (*Continued*).

SAM) also showed responses in the same direction, but the limited power afforded by the sample size of this study precluded the detection of significant Group × Time interactions. On the other hand, no shifts toward reduced tension (i.e., activated unpleasant affect) or state anxiety, as measured by the SAI, were found.

Table II. Effect Sizes of Statistically Significant Pairwise Comparisons Between Time Points in the Walking and Control (Ctrl) Groups in Affective Valence (FS, SAM-V, AG-V) and Activation (FAS, SAM-A, AG-A) ($p < .01$) in Studies I and III

			FS		FAS		SAM-V		SAM-A		AG-V		AG-A	
Study	Time points		Walk	Ctrl	Walk	Ctrl	Walk	Ctrl	Walk	Ctrl	Walk	Ctrl	Walk	Ctrl
I	Pre	Post	.86		.97		Only time main effect						1.00	
III	Pre	During	.70		.48					−.50			.91	−.57
		Post 0′	1.18		.68				.37	−.44			.75	−.48
		Post 10′		−.35		−.53			−.34	−.62			−.46	−.89
	During	Post 0′												
		Post 10′			−.84				−.63				−1.37	
	Post 0′	Post 10′	−.96		−1.10				−.68				−1.13	

Note. Positive effect sizes signify either improvements in valence or increases in activation from the time point on the left to the time point on the right. Negative effect sizes signify either deterioration of valence or decreases in activation.

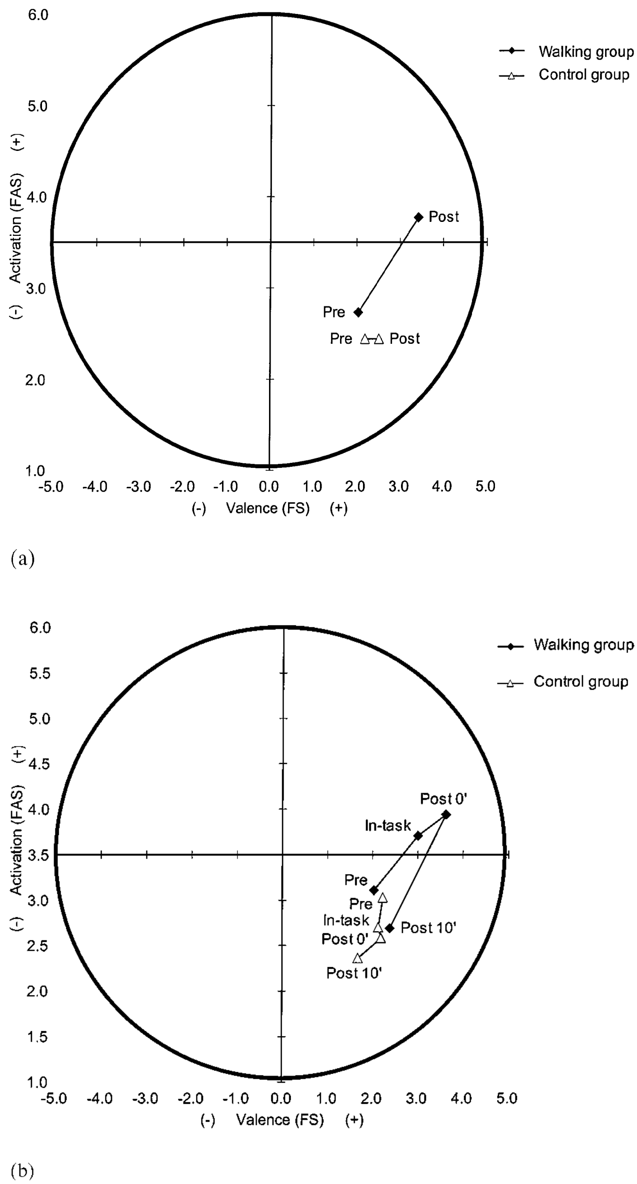

Fig. 3. Responses to the FS (affective valence) and FAS (activation) scales from Studies I (a) and III (b), plotted in circumplex space.

STUDY II

The purpose of this study was to extend the findings of Study I by adding a second postwalk assessment of affect, to track the dynamics of affective change during recovery from the walk.

Methods

Participants

Informed consent was obtained from 135 undergraduate students who volunteered to participate in the study. The sample consisted of 76 women and 59 men (mean age, 20 years).

Psychometric Instruments

Two self-report measures from Study I were used: (i) the AD ACL (Thayer, 1989) and (ii) a 10-item abbreviated version of the SAI (Spielberger, 1979b). This short version of SAI has been specifically recommended by Spielberger for repeated administrations over a short period of time. Reported α coefficients from male and female samples of Navy recruits and college students ranged from .84 to .92 (Spielberger, 1979b). For additional information on these scales, the reader is referred to the description in Study I. The 10 items of the SAI and the 20 items of the AD ACL were interspersed in random order on the same sheet, accompanied by a 4-point Likert-type scale ranging from "not at all" to "very much so."

Procedures

The procedures that were followed in this study were identical to those described previously for Study I, with the addition of a 10-min quiet rest period and a third self-assessment of heart rates and affect following the treatments ("posttest-10"). Seventy-five students were randomly assigned to the walking group and 60 were assigned to the control group. Participants in the control group read from the same article that was used in Study I (NCTE, 1985) during the treatment period and continued the reading during the recovery period. Participants in the walking group were also asked to read from the same article during the recovery period.

Results

In the walking group, the mean heart rate first increased [from 76 ± 14 to 93 ± 19 beats $\cdot$ min^{-1} ($p < .01$); 14% HRR] and then returned toward baseline

(78 ± 14 beats $\cdot$ min^{-1}; $p < .01$). On the contrary, in the control group, heart rate first decreased slightly (from 76 ± 9 to 72 ± 10 beats $\cdot$ min^{-1}; $p < .05$) and then remained stable.

As in Study I, the internal consistency of the scales was satisfactory: the α coefficients for EA were all .94, for TA they were .83, .80, and .84, and for SAI they were .91, .85, and .89, for pretest, posttest-0, and posttest-10, respectively.

The significant Group $\times$ Time interaction for the scales of the AD ACL [$F(4,121) = 25.43$, $p < .001$] was attributable to changes in both EA [$F(2, 248) = 52.73$, $p < .001$] and TA [$F(2,248) = 12.10$, $p < .001$]. In the walking group, EA first increased substantially and then returned toward the pretest value but remained elevated compared to the pretest. On the contrary, in the control group, EA first decreased and then remained stable, still below pretest levels. In the walking group, TA remained stable after the walk and was reduced thereafter, but the posttest-10 assessment was no different compared to the pretest. In the control group, TA first declined and then remained stable, at a level still significantly lower than the pretest (see Table I and Fig. 2b).

For SAI, there was only a significant Time main effect [$F(2,130) = 10.15$, $p < .001$]. With data from the two groups collapsed, analysis showed a small but significant initial decrease ($d = -.20$) followed by a stabilization at a level still below pretest values ($d = -.22$).

Conclusion

The increase in EA immediately following the walk that was found in Study I was replicated here. Following a 10-min recovery period, the increase in EA had begun to reverse itself, but EA levels remained elevated compared to the pretest. Interestingly, this postwalk decrease in EA occurred concurrently with a significant reduction in TA. This pattern is consistent with Thayer's (1989) multidimensional arousal theory, which predicts that EA and TA will exhibit changes in the same direction at low and moderate levels of energy expenditure. Finally, walking and quiet reading were not shown to have a differential effect on SAI scores.

STUDY III

The purposes of this study were (a) to address the issue of the internal validity of the pattern of affective changes identified in the previous studies by replicating the experiment in the laboratory, thus controlling for factors extraneous to physical activity itself (i.e., social interaction, weather and temperature conditions, etc.), and (b) to examine affective responses during the walk. As was the case with our first exploratory study in "naturalistic" settings (i.e., Study I), in this first laboratory study, we also opted to use multiple self-report measures of affect. The purpose was to broaden our investigative scope and to examine the consistency of any effects across different measures.

Methods

Participants

A total of 69 undergraduate students volunteered to participate in the study. The sample included 40 women and 29 men (mean age, 22 years). They all read and signed an informed consent form approved by the University's Institutional Review Board.

Psychometric Instruments

The following self-report scales were used: (i) the FS (Hardy and Rejeski, 1989), (ii) the FAS (Svebak and Murgatroyd, 1985), (iii) the SAM (Lang, 1980), (iv) the AG (Russell *et al.*, 1989), and (v) the AD ACL (Thayer, 1989). A description of these instruments is presented in the Methods section of Study I. Because this study involved multiple repeated measurements of affect, the battery of self-report measures had to be smaller than the one used in Study I, to avoid overburdening the participants. Consequently, the PANAS and the SAI were not used.

Procedures

Randomization of participants to a walking and a control group was achieved by alternating group assignment for each incoming participant, separately for women and men. This resulted in 34 participants in the walking group (19 women, 15 men) and 35 participants in the control group (21 women, 14 men). Upon entering the laboratory, the participants read and signed the informed consent form. They were then fitted with a heart rate monitor (Model Accurex Plus, Polar Electro, Finland) and were given a battery of questionnaires which included the self-report instruments listed above in randomized order. When the questionnaires were completed, the participants were informed of the task they were to perform (i.e., walking or reading). In this study, the duration of the treatments was increased to 15 min, to prolong the intervals between assessments and thus avoid any reactivity to repeated testing, given that the participants were required to respond to multiple self-report scales before, during, and immediately following each treatment. Participants in the walking group were taken to a treadmill and were told that they were free to adjust the speed to their liking using the controls located in front of them. While walking, the participants were facing a barren wall. Participants in the control group were given an issue of *Reader's Digest* and an issue of *Time* magazine to read while seated. The magazines had been examined to ensure that they did contain any articles on exercise or physical activity or any materials known to induce strong affective reactions (e.g., erotica, portrayals of cruelty, etc.). Affective responses during the treatments were assessed at the 8th min of each 15-min treatment using only the single-item scales selected for this study (i.e., FS, FAS, SAM-V, SAM-A, AG-V, and AG-A, a total of six items). Participants in the walking group also responded to the RPE (Borg, 1998). A clipboard was placed on the control board of the treadmill to allow them to mark their responses. Immediately upon completion of either the walking or reading treatments, participants were given a "posttest-0" battery of questionnaires containing the single-item scales, as well as the AD ACL. Participants in both groups were then given the same article used in Studies I and II (NCTE, 1985) to read for another 10 min while seated. At the end of this 10-min recovery period, all participants were given a final "posttest-10" battery of questionnaires to complete (including the single-item scales and AD ACL) and were released. Throughout the procedures, the interaction between experimenters and participants was kept to a minimum.

Results

In the walking group, heart rate rose from 75 ± 11 to 103 ± 16 beats $\cdot$ min^{-1} at the 8th min of the walk ($p < .01$; 22% HRR) and to 100 ± 20 beats $\cdot$ min^{-1} at posttest-0 ($p < .01$). At posttest-10, heart rate had returned to 77 ± 13 beats $\cdot$ min^{-1}, which was significantly lower than posttest-0 ($p < .01$) and no different from baseline. The average RPE at the 8th min was 9.9 ± 1.9 (i.e., between "very light" and "fairly light") and the average speed of the treadmill at the same time was 2.7 ± 0.8 mi $\cdot$ hr^{-1}. The average distance covered during the 15-min walk was 0.63 ± 0.17 mi. On the other hand, in the control group, the first reading period was associated with a decrease in heart rate compared to baseline (77 ± 11 beats $\cdot$ min^{-1}). This decrease was significant at both the 8th min (74 ± 12 beats $\cdot$ min^{-1}; $p < .01$) and the 15th min (74 ± 12 beats $\cdot$ min^{-1}; $p < .01$). At posttest-10, heart rate had risen slightly (76 ± 11 beats $\cdot$ min^{-1}), but to a nonsignificant degree, and was no different from baseline.

As in the previous studies, the internal consistency of the AD ACL was satisfactory. The α coefficients for EA were .92, .93, and .93 for pretest, posttest-0, and posttest-10, respectively. The corresponding values for TA were .88, .82, and .89.

The significant Group × Time interaction [$F(4,59) = 20.14$, $p < .001$] for the scales of the AD ACL was attributable to both EA [$F(2,124) = 22.38$, $p < .001$] and TA [$F(2,124) = 20.18$, $p < .001$]. In the walking group, EA increased significantly following the walk and then returned to a level no different from the pretest. On the contrary, in the control group, EA decreased significantly compared to the pretest, both at posttest-0 and at posttest-10, with no difference between the two reading conditions. In the walking group, TA was increased after the walk, but decreased during recovery, reaching a level slightly below the pretest (see Table I and Fig. 2d). This walk-associated increase in TA was investigated further by examining changes separately for each of its two poles, namely, Tension and Calmness (see description of AD ACL in Study I). This analysis revealed that the increase in TA following the walk was due only to a decrease in Calmness ($d = -.80$), whereas Tension remained unchanged during this time. On the other hand, the decrease in TA during recovery was attributable to both a significant reduction in Tension ($d = -.37$) and a significant increase in Calmness ($d = 1.02$). Similar to EA, TA in the control group was reduced compared to the pretest at both posttest-0 and at posttest-10, with no difference between the two reading conditions.

The findings from the multiitem scales were generally consistent with those from the single-item scales of valence and activation (see Table II). For FS and FAS, the significant Group × Time interaction [$F(6,58) = 5.67$, $p < .001$] was attributable to both the FS [$F(3,189) = 8.51$, $p < .001$ and the FAS [$F(3,189) = 8.80$, $p < .001$]. In the walking group, FS and FAS were significantly increased compared to the pretest both during the walk and at posttest-0, trends that reversed themselves during recovery. In the control group, the only significant comparisons were decreases in both the FS and the FAS from pretest to posttest-10. For the SAM and the AG, the significant Group × Time interactions [for SAM, $F(6,58) = 4.83$, $p < .001$; for AG, $F(6,60) = 6.20$, $p < .001$] were attributable only to the activation scales, namely, the SAM-A [$F(3,189) = 10.16$, $p < .001$] and the AG-A [$F(3,195) = 12.95$, $p < .001$]. In the walking group, activation, as assessed by both the SAM-A and the AG-A, increased gradually during the walk and decreased during recovery. On the other hand, in the control group, SAM-A was significantly decreased compared to the pretest at all three subsequent assessments and AG-A, following a significant initial decrease, remained at a below-pretest level through posttest-0 and posttest-10. The absence of significant interactions for the valence scales (i.e., SAM-V and AG-V) was due to the fact that the pattern of walk-associated improvements and postwalk declines was mimicked by the control group, albeit with changes of smaller magnitude compared to those in the walking group.

Conclusion

The findings from the AD ACL, the FS, and the FAS again showed that a short bout of walking is associated with shifts toward increased activation and improved affective valence. The data from the SAM and the AG, although in the same direction, were made less clear by similar changes in the control group. This raises the possibility that the type of response format (i.e., simple rating scales in FS and FAS versus the less familiar grid format of the AG and graphical format of the SAM) might influence the reliability and, consequently, have an impact on the validity of the SAM and the AG. As Study II had indicated, the affective changes associated with the walk appear to be short-lived and most reverse themselves during a 10-min recovery period. An increase in TA was found following the walk, but it was shown to be due to a decrease in Calmness rather than an increase in Tension. In conjunction with the data from the single-item scales used in this study, this means that the reduction in Calmness (and the increase in TA) is not necessarily associated with a negative affective tone. Furthermore, Calmness was shown to increase and Tension was shown to decrease significantly compared to the immediate postwalk assessment following a 10-min recovery period.

STUDY IV

The purpose of this study was to examine the stability of the pattern of affective changes found in the previous studies within individuals across time. This was done by scheduling two experimental sessions on separate days. The study also included an examination of electroencephalographic (EEG) indices; these data are reported elsewhere (Hall *et al.*, 2000). Only data on self-reported affective responses are presented here.

Methods

Participants

A total of 42 undergraduate students volunteered to participate in the study. The sample included 19 women and 23 men (mean age, 20 years). They all read and signed an informed consent form approved by the University's Institutional Review Board.

Psychometric Instruments

The same self-report scales of affect as in Study II were used, namely, the 10-item version of the SAI (Spielberger, 1979b) and the AD ACL (Thayer, 1989). As in Study II, the 10 items of the SAI and the 20 items of the AD ACL were interspersed in random order on the same sheet and were accompanied by a 4-point Likert-type scale ranging from "not at all" to "very much so."

Procedures

Each participant visited the laboratory on two occasions, separated by intervals ranging from 2 days to a month. The duration of the interval was not found to affect the results, so for the remainder of this report this variable is ignored. Identical procedures were followed on both occasions and both visits were scheduled for the same time of day to control for possible diurnal effects. Upon entering the laboratory, the participants read and signed the informed consent form. They were then fitted with a heart rate monitor (Model Accurex Plus; Polar Electro, Finland). Next, they were given the first set of self-report scales to complete ("pretest-1"). Upon completion, participants sat comfortably while an experimenter prepared them for the assessment of EEG activity. When EEG signal integrity was established (typically 30 min after pretest-1), participants were given a second set of self-report scales to complete ("pretest-2"). It is important to point out that the preparation for and the assessment of EEG activity were associated with a decrease in the level of activation reported by participants (which was expected given the sedentary nature of this procedure) but did not have a significant impact on the positivity or negativity of their affective state (see Results). Approximately 15 min later (following assessment of baseline EEG), the participants were taken to a treadmill. It was explained to them that they would walk for 10 min and that they were free to adjust the speed of the treadmill using buttons located directly in front of them. During the walk, the participants were facing a barren wall. Furthermore, the experimenter remained mostly out of sight, except when it was necessary to record heart rate values, obtain ratings of perceived exertion, or provide assistance to the participants. Heart rates and RPEs were recorded on the 5th and the 10th (final) minute of the walk. At the same times, the experimenter also recorded the speed of the treadmill and the distance covered. Upon completion of the walk, the participants sat on a chair and were asked to complete a "posttest-0" set of self-report scales. This was followed by unobtrusive recording of EEG activity. A second postwalk assessment of self-reported affect took place 15 min after the completion of the walk ("posttest-15"). During the time between posttest-0 and posttest-15, the participants sat on a chair doing nothing.

Results

A 2 (Day: 1st, 2nd) by 3 (Time: prewalk, 5th min of walk, 10th min of walk) repeated-measures ANOVA on the heart rate data indicated that only the main effect of Time was significant [$F(2,33) = 6.44$, $p < .001$]. With the data from the 2 days collapsed, mean heart rate showed an increase from prewalk to the 5th min of the walk from 74 ± 9 to 96 ± 14 beats $\cdot$ min^{-1} ($p < .01$) and then to 100 ± 18 beats $\cdot$ min^{-1} at min 10 ($p > .05$; 20% HRR). Besides heart rate, all other indices of walking intensity (i.e., RPE, speed, distance) were also remarkably consistent across the 2 days (r_s ranged from .64 to .83; for all r_s, $p < .001$). The average terminal RPE was 9.6 ± 2.3 (i.e., between "very light" and "fairly light") and the average speed of the treadmill at the same time was 2.8 ± 0.9 mi $\cdot$ hr^{-1}. The average distance covered during the 10-min walk was 0.44 ± 0.13 mi.

As in the previous studies, the AD ACL and the SAI exhibited internal consistency in the acceptable range. Alpha coefficients ranged between .88 and .93 for EA, between .72 and .83 for TA, and between .73 and .86 for SAI.

A 2 (Day: 1st, 2nd) by 4 (Time: pretest-1, pretest-2, posttest-0, posttest-15) repeated-measures MANOVA on EA and TA showed only a significant main effect of Time [$F(6,30) = 8.83$, $p < .001$]. That is, AD ACL responses on Days 1 and 2 were not significantly different. The significant effect of Time was attributable to both EA [$F(3,105) = 14.98$, $p < .001$] and TA [$F(3,105) = 14.03$, $p < .001$]. The initial sedentary phase of preparing for EEG assessment led to a decrease in activation which was evidenced by significant decreases in both scales. On the contrary, the subsequent walk led to a large increase in EA and a smaller but significant increase in TA (see Table I and Fig. 2c). As was done in Study III, the increase in TA was investigated further by examining separately the changes in each of its opposite poles, namely Tension and Calmness (see description of AD ACL in Study I). Consistent with the finding from Study III, this analysis again revealed that the increase in TA was attributable only to a reduction in Calmness [$F(1,41) = 13.53$, $p < .001$], whereas Tension remained unchanged. Finally, the postwalk recovery period was associated with significant decreases in both EA and TA.

In the analysis of SAI data, only the effect of Time was significant [$F(3,32) = 5.63$, $p < .01$]. With scores from the 2 days collapsed, SAI scores exhibited a stepwise decrease throughout the session, with the only significant comparisons being between pretest-1 and both posttest-0 ($d = -.34$) and posttest-15 ($d = -.52$).

Conclusion

This study showed that the increase in EA that was found in the previous studies was reliable within individuals across two experimental sessions. The walk-associated increase in TA that was reported in Study III was also replicated, as was the secondary finding that this effect was accounted for only by a decrease in Calmness (i.e., without a concomitant increase in Tension). Both EA and TA were again shown to decrease significantly during the recovery period. Similar to the between-subject comparisons in previous studies, the comparison between the repeated assessments in the present study (i.e., within-subject) showed that walking and sitting quietly did not have a differential effect on SAI-defined state anxiety. Finally, it is noteworthy that participants chose to walk at similar speeds and had similar heart rate responses and reports of perceived exertion across the two walk sessions.

GENERAL DISCUSSION

The primary goal of the present investigation was to assess the effects of short (i.e., 10- to 15-min) bouts of walking on affect. As a basis for our approach, we used a dimensional model of affect, namely, the affect circumplex (Larsen and Diener, 1992; Russell, 1978, 1980, 1989, 1997). Using multiple measures of the circumplex dimensions, we demonstrated that short bouts of walking were associated with significant and often substantial shifts toward higher activation and more pleasant affect. This effect occurred while heart rates were increased by only 14–22% of age-predicted HRR. Assessments of affect following short recovery periods (10 to 15 min) showed that the energizing effects associated with walking tend to be short-lived. Although in most cases recovery periods were associated with decreases in Tension and increases in Calmness, leaving participants in a pleasant low-activation state, the affective states following these recovery periods were, in general, not different from baseline.

While these effects were found using measures of affective dimensions, assessments of state anxiety using the SAI showed that walking was not associated with a consistent pattern of changes that could be distinguished from the effects of sedentary control conditions. This finding has some important implications. As we have argued elsewhere (Ekkekakis *et al.*, 1999), using state anxiety as a general index of affective changes, as is common in the literature, makes little conceptual sense. There is no reason to assume that the affective impact of any given physical activity stimulus will be limited to state anxiety, a fairly rigidly demarcated emotional state. This underscores the advantages afforded by dimensional models of affect in this respect. A model with the broad and balanced scope of the affect circumplex appears to be better suited to investigations aimed to describe the general nature of affective changes associated with a particular type of physical activity.

Across the four studies described herein, we were able to demonstrate that the effects summarized above were relatively robust across different single- and multiple-item scales measuring both the "unrotated" (i.e., activation and valence) and the "rotated" dimensions of the circumplex affective space (i.e., activated pleasant–unactivated unpleasant and activated unpleasant–unactivated pleasant affect) and involving diverse formats (words and pictures, bipolar and unipolar rating scales). The pattern of affective responses associated with participation in and recovery from walking were also shown to be robust within individuals across two time points, robust across four samples, and robust across ecological settings (outdoors in social environment and in the laboratory in solitary conditions). Finally, in analyses not reported here, we found no mediation of the effects by gender or the time of day the activity was performed. Our findings did, however, raise the possibility that single-item measures of affective dimensions that use unfamiliar response formats (i.e., SAM, AG) might be less stable compared to scales that use the conventional rating scale format (i.e., FS, FAS). Given the value of dimensional models of affect in investigating the effects of physical activity, further investigations that focus on measurement issues are warranted.

Our interest in the effects of walking on affect was driven by recent physical activity recommendations targeting common activities, such as walking, that are typically associated with moderate amounts of energy expenditure and exertion and can be performed intermittently (in multiple short bouts) during the day (NIH, 1996; Pate *et al.*, 1995; USDHHS, 1996). The extension of these public health guidelines to include modes and doses of physical activity that do not *guarantee* substantial improvements in cardiorespiratory fitness (although such changes may occur in some populations) was dictated at least in part by motivational considerations. Traditional prescriptions of structured exercise for 20 to 30 min at a relatively vigorous intensity, 3 to 5 days per week, are suspected to have contributed to the current prevalence of inactivity (Blair *et al.*, 1997), which remains considerably higher than the Healthy People 2000 targets (McGinnis and Lee, 1995).

Researchers in the area of public health recognize that "there may be unique challenges . . . for those involved with the effective dissemination and interpretation of the guidelines" (Phillips *et al.*, 1996, p. 4). According to the NIH consensus statement on physical activity and cardiovascular health, "many people . . . fail to appreciate walking as 'exercise' or to recognize the substantial benefits of short bouts (at least 10 minutes) of moderate level activity" (NIH, 1996, p. 243). While the knowledge base pertaining to biological benefits associated with walking is expanding (Davison and Grant, 1993; Duncan *et al.*, 1991; Morris and Hardman, 1997; Porcari *et al.*, 1989; Rippe *et al.*, 1988), as noted in the Introduction, the literature on affective outcomes is characterized by antithetical views and perplexing inconsistencies. The consistent findings contained in the present report challenge the long-held assumption that physical activity of low to moderate intensity and short duration is ineffective in modifying affect. Thus, we are hopeful that researchers will reassess the validity of this assumption and future studies will continue to investigate the effects of small "doses" of physical activity on the affective domain.

In evaluating the findings of the present studies, researchers and practitioners should take into account two main issues. The first consideration is the possibility of expectancy bias, a vexing problem which is almost-inherent in studies of physical activity (Berger *et al.*, 1998). The problem lies in the fact that there can be no true "placebo" physical activity intervention (Ojanen, 1994). In the studies we report herein, we made every effort to minimize the likelihood of expectancy bias. The randomized assignment to experimental and control groups (which took place after the pretreatment questionnaires had been completed) ensured that there was no preponderance of "motivated" participants among the walkers. Furthermore, the use of within-subject controls allowed us to screen the data within the walking groups for characteristic signs of expectancy bias. If there was a tendency on the part of the walkers to "please" the experimenters, we would probably have seen sustained positive changes in our repeated postwalk assessments of affect. Instead, we observed reversals of the initial positive shifts. Likewise, if expectancy had played a significant role, the walkers would probably have painted an indiscriminately positive picture, without any qualitative subtleties. Instead, the shifts toward activated pleasant affect that we observed immediately following the walks occurred concurrently with decreases in Calmness. In short, although it would be imprudent to dismiss the possibility of expectancy bias, our critical analysis did not reveal any indications that expectancy had a significant impact on the results.

Second, as a first systematic attempt to assess the effects of walking on affect, the studies we reported were limited to samples of young, healthy, and mostly physically active individuals. Despite the fact that the walking intensity involved was minimal and the results were generally consistent across samples, whether the findings reported here will generalize to other populations, such as the sedentary, the elderly, the overweight, or various patient and medically vulnerable populations, remains unknown. Future research can utilize the same conceptual and methodological framework described here as a basis to extend the investigation to such populations.

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