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Mindfulness and Affective Responses to Treadmill Walking in Individuals with Low Intrinsic Motivation to Exercise

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ABSTRACT

International Journal of Exercise Science 11(5): 609-624, 2018. An aversion to the sensations of physical exertion can deter engagement in physical activity. This is due in part to an associative focus in which individuals are attending to uncomfortable interoceptive cues. The purpose of this study was to test the effect of mindfulness on affective valence, ratings of perceived exertion (RPE), and enjoyment during treadmill walking. Participants (N=23; M_{age}=19.26, SD = 1.14) were only included in the study if they engaged in no more than moderate levels of physical activity and reported low levels of intrinsic motivation. They completed three testing sessions including a habituation session to determine the grade needed to achieve 65% of heart rate reserve (HRR); a control condition in which they walked at 65% of HRR for 10 minutes and an experimental condition during which they listened to a mindfulness track that directed them to attend to the physical sensations of their body in a nonjudgmental manner during the 10-minute walk. ANOVA results showed that in the mindfulness condition, affective valence was significantly more positive (p = .02, η_p^2 = .22), enjoyment and mindfulness of the body were higher (p < .001, η_p^2 = .36 and .40, respectively), attentional focus was more associative (p < .001, η_p^2 =.67) and RPE was minimally lower (p = .06, η_p^2 =.15). Higher mindfulness of the body was moderately associated with higher enjoyment (p < .05, r =.44) in the mindfulness but not the control condition. Results suggest that mindfulness during exercise is associated with more positive affective responses.

KEY WORDS: Attentional focus, associative attention, enjoyment, exercise adherence

INTRODUCTION

Negative affective responses (i.e., displeasure) experienced during moderate-to-vigorous exercise can be a potential deterrent to engaging in habitual physical activity (12, 8). These responses can be generated from feelings of discomfort of physical sensations during exercise and is particularly true for those who dislike and engage in lower levels of physical activity (33). Negative affective responses during exercise make it less likely that individuals will sustain exercise behavior regularly over time (28, 35). For example, affective responses during moderate intensity exercise in relatively sedentary individuals predicted physical activity levels six and 12 months later with more positive affect predicting higher physical activity (34). Thus, examining factors that impact affective responses during exercise is needed in order to understand how to support exercise adherence.

Affect is defined as the most basic valenced response (i.e., good/pleasure vs. bad/displeasure) (8, 9, 15). Basic affect does not emerge from an appraisal process, but rather refers to one's immediate experiential response. Affect can also underlie distinct emotions that do result from an appraisal process such as joy or anger. The Circumplex Model has become the most relied upon and empirically supported conceptualization of affect in the exercise domain (9). It describes affect as varying along two bipolar and orthogonal dimensions: valence (pleasant to unpleasant) and activation or arousal (high to low). In this study, we focus on the valence dimension since it holds the most relevance to the pursuit of adaptive or health-enhancing behaviors (35, 11).

The dual-mode theory proposes that affective responses to exercise are the product of two sources whose relative impact changes with exercise intensity (10). These sources are cognitive processes (e.g., self-efficacy, goals, attributions) and interoceptive cues (e.g., breathing, heart rate, muscle sensations) that are generated by physiological processes during exercise (12, 11, 10). When exercise intensity is "moderate" (i.e., below the ventilatory threshold [VT]), affective responses are generally pleasurable and associated with cognitive factors (e.g., self-efficacy). Although this level of intensity is largely characterized in the literature as producing relatively homogenous affective responses, there is evidence that there is substantial variability with studies showing up to half of participants reporting declines in valence during exercise below VT (33, 9, 31). When exercise intensity approaches and reaches a "heavy" level of intensity (i.e., right around and approaching VT), cognitive factors play a greater role, variability in affective responses increases and some respond with more positive affect than others. Finally, when exercise intensity is "severe" (i.e., above VT), affective scores more consistently reflect displeasure, are strongly linked to physiological processes and cognitive manipulation is difficult if not impossible. In sedentary individuals, this decline in affective valence begins at lower levels of exercise intensity (33). Once the exercise is complete, affective responses rebound and become more pleasurable again. This pattern of responses to exercise is thought to provide evidence that "moderate" levels of physical activity, which are associated with the most positive affect, are the most adaptive and therefore most likely to support overall health (11).

One of the variables that helps explain the shifting affective responses as exercise intensity increases is attentional focus. Associative attentional focus refers to focusing on internal stimuli or interoceptive cues such as heart rate, muscular engagement, metabolic acidosis ("feeling the burn"), and respiration (25). Dissociation can be described as the mechanism used by exercisers to either "tune out" or actively draw attention away from physiological sensations in the body. Associative focus steadily increases while dissociative focus steadily decreases as exercise intensity increases (33, 23). At 70% of heart rate reserve (23), associative thoughts begin to dominate attentional focus as uncomfortable interoceptive cues become increasingly noticeable (23, 19). This shift to a more associative attentional focus is accompanied by declines in affective valence (33, 23).

One approach to addressing the shifts in attentional focus and affect that occur with increasing exercise intensity has been to attempt to distract individuals from the interoceptive cues they experience at higher levels of exercise intensity (23, 22). For example, Jones et al. (2014) investigated the effects of music and video on psychological responses at two different intensities (10% below and 5% above VT) during an exercise bout on a stationary cycling ergometer. Participants (N=34; 19 men and 19 women; M_{age}=21.1, SD=1.9 years) completed three experimental conditions (music-only, video-only, and music-and-video) and a control condition (no music or video). Results of the study demonstrated the highest scores for affective valence and enjoyment in the music-only and music-and-video groups. These findings suggest that facilitating a dissociative attentional focus can enhance the affective experience of exercise, even at an intensity that is above VT.

The evidence illustrates that these dissociative techniques can be effective for improving affective valence during exercise, but other strategies may be needed to directly address the negative affective responses that occur while attending to interoceptive cues. Since attentional focus becomes more associative at higher levels of exercise intensity, focusing on creating more positively valenced associations with interoceptive cues may be one way to generate an overall enjoyable experience that would support exercise adherence. In this study we explored the effect of mindfulness during exercise. Mindfulness refers to awareness of and attention to the present moment and can include attention to physical, mental or environmental stimuli (2, 4). Mindfulness is also characterized by nonreactivity to these stimuli and qualities of openness and nonjudgment. Although mindfulness refers to attending to one's current experience, these latter qualities distinguish it from an associative attentional focus (26). Mindfulness of physical sensations (i.e., mindfulness of the body) that become more noticeable as exercise intensity increases may hold particular relevance to affective responses to physical activity (6).

Research evidence supports the potential for mindfulness to enhance affective responses during physical activity. In one study, a sample of low-active adult women were trained in cognitive techniques related to acceptance commitment therapy (ACT) (21). ACT relies heavily on the development of mindfulness to teach individuals how to approach their thoughts and emotions in a nonreactive and accepting manner (18). Specifically, in this study, the women were taught cognitive defusion and acceptance strategies in a single 40-minute session to help them cope with uncomfortable physical sensations and negative affect that they might experience during exercise. These strategies teach individuals how to hold space for unpleasant feelings and sensations without trying to control, change or suppress them. Women in the study who were taught these strategies right before their exercise session, had higher exercise tolerance time, lower ratings of perceived exertion and higher enjoyment after the completion of the exercise compared to controls, though in-task affective valence did not differ. Thus, mindfulness may serve as a tool one can use when interoceptive cues are demanding one's attentional focus.

The purpose of this study was to test the effect of inducing mindfulness during treadmill walking on basic affective responses (i.e., pleasures/displeasure), attentional focus, perceived exertion and overall enjoyment during exercise in individuals who do not enjoy exercise. A secondary purpose was to compare the relationships among mindfulness of the body, attentional focus, perceived exertion and affective valence across control and mindfulness conditions. In order to address these aims, we compared participants' experiences during 10 minutes of treadmill walking in a mindfulness condition to a control condition at 65% of heart rate reserve (HRR) (17). We selected 65% of HRR because it is adaptive in terms of likelihood of conferring health benefits (11), is high enough for interoceptive factors to elicit some degree of discomfort in participants who do not enjoy exercise, but not to the point where cognitive manipulation (i.e., mindfulness) would not be as effective (10, 22). As individuals approach the "heavy" level of exercise intensity, variability in affective responses increases and depends in part on individual differences (11). We aimed to increase homogeneity of affective responses at this level of intensity by only including individuals who reported low scores on intrinsic motivation for exercise.

We hypothesized that attentional focus would be more associative, affective valence and overall enjoyment would be higher, and RPE lower during treadmill walking in the mindfulness condition compared to the control condition. Further, we hypothesized that a more dissociative attentional focus and lower RPE would relate to more positive affective valence during treadmill walking and an overall measure of enjoyment in the control condition (22). However, we believed these relationships would be weaker in the mindfulness condition due to the unique characteristics of mindfulness as a form of associative attention. Finally, we conducted an initial exploration of the relationships of state mindfulness of the body to attentional focus, RPE, affective valence and enjoyment.

METHODS

Power Analysis. We set the alpha level at .05 and power at .80 to conduct a power analysis using G*Power 3 (13) based on the effect size η_p^2 = .30 for attentional focus, affective valence, enjoyment and RPE (22). In G*Power 3, we selected "F tests" from test family and "ANOVA: Repeated measures, within factors" for the statistical test. We had one group and 2 measurements. We then selected the "determine" option to allow the program to calculate the F-value from η_p^2 = .30. Under options we selected "as in SPSS" since this η_p^2 was estimated based on data reported in a study that already took into account the correlations among the repeated measures. The analysis revealed that 22 participants were needed to detect an effect. We recruited 12 additional participants to account for potential outliers or individuals who did not qualify for the study.

Participants

Inclusion criteria was low intrinsic motivation for physical activity (no more than '2' on any intrinsic motivation item on the Behavioral Regulation in Exercise Scale-2 (27) and between the ages of 18 and 35 in order to minimize variance in age and draw conclusions from the data about young adults and because our recruitment was focused on students on a college campus. Exclusion criteria included blood pressure higher than 140/90, more than 3 days of vigorous or 5 days of moderate physical activity (or 5 days combined vigorous and moderate physical activity) as assessed by the International Physical Activity Questionnaire-Short Form (7) and any answers of 'yes' on the Physical Activity Readiness Questionnaire-Plus (32). We wanted to target individuals who engaged in low to moderate physical activity in order to minimize the risk of injury to participants but not high levels of physical activity, which is more likely to reflect greater intrinsic motivation for exercise.

Eleven potential participants did not qualify for the study. Therefore, participants were twenty-three undergraduate students (M_{age} = 19.26, *SD* = 1.14; 19 female, 3 male, 1 "other gender") from a four-year University in the northwest region of the United States. Participants were Caucasian (*n*=12), Hispanic/Latino (*n*=3) and Asian/Pacific Islander (*n*=4) and one of each of the following: African-American/Black, multi-racial, Native American/Alaskan Native and "other". Participants were freshmen (*n*=11), sophomores (*n*=8), juniors (*n*=2) and seniors (*n*=2). The participants also represented a diverse range of majors including one each in biology, premed, business, engineering, psychology/criminal justice, food science, animal science, communications, geology, and undeclared, two each in kinesiology, hospitality business management, and accounting, five in nursing and two unspecified. Participants reported an average of walking 316.10 minutes per week, engaging in 55.65 minutes of moderate exercise and 52.83 minutes of vigorous exercise per week. Their average body mass index (BMI) was within the healthy range (25; *M* = 24.78, *SD* = 5.01). They reported relatively low average scores on intrinsic motivation (*M* = 1.17, *SD* = .72), introjected regulation (*M* = 1.14, *SD* = 1.01), and amotivation (*M* = .82, *SD* = .82) and scored a slightly higher average on external regulation (*M* = 1.29, *SD* = .93) and identified regulation (*M* = 1.48, *SD* = .74).

Apparatus and Measures. A LifeSpan Pro Series treadmill, model TR7000i/TR8000i that includes various ranges for speed and incline was used for testing participants. Target heart rate was determined and monitored via a Polar FT1 heart rate monitor and chest band to ensure accurate and continuous heart rate data. Other physiological measures obtained included blood pressure, which was assessed by trained research assistants with a manual Littmann™ Classic II S.E. stethoscope and cuff. The mindfulness script was delivered by a wireless headphone set, model ShareMe7, so the participants could listen to an audio mindfulness track while walking on the treadmill.

Development of Mindfulness Manipulation. A 10-minute audio mindfulness script was created for the participants to listen to during the mindfulness condition. The mindfulness track was based off of several online mindfulness scripts that focus on being mindful of physical sensations during movement such as walking and was recorded by a female research assistant. After an initial draft of the script was created, two mindfulness expert practitioners reviewed the script and provided feedback that was then incorporated into the final draft. The mindfulness script was written to bring attention to the physical experience of walking on a treadmill. By bringing attention to one's physical experience, we aimed to increase awareness of interoceptive cues and promote an associative attentional focus. However, distinct from the kind of associative focus that may occur naturally during exercise, the mindfulness script was intended to promote nonjudgmental acceptance of one's physical sensations on the treadmill (i.e., mindfulness of the body). The final script included phrases that directed the attention of the participant in a non-judgmental manner to various sensations in the body, such as muscles working in a certain limb, the flow of air through the body, and the rhythm of the arm swing as the body propelled itself forward on the treadmill. For example, to bring the attention of the participant back to their sensations of breathing during exercise the script stated, "Take a moment now to become aware of the sensations of breathing once again. What does the breath feel like in the body? Try to observe these characteristics of the breath with interest and curiosity; allowing yourself to experience the physical sensations, and just observing them as they are. Let go of the need to evaluate or label them. Simply continue being present in the body as it continues to move forward with each step." The audio track contained vocals only and no background sounds or music.

Measures

Affective valence was assessed just before, during (at 4 and 8 minutes) and after the exercise bout (right after cool down and again 5 minutes later). Ratings of perceived exertion were assessed at the two time points during exercise and attentional focus was assessed immediately following the 10-minute bout of exercise. The measures at 4 and 8 minutes were averaged to represent in-task responses in the main analyses. Studies using similar experimental procedures have provided evidence of score validity for all four measures (22, 20).

Attentional focus: The degree to which participants' attentional focus was internal vs. external was assessed with Tammen's (1996) attentional focus scale. The scale is a single-item bipolar scale represented by a 10-centimeter line and anchored by "Internal focus (bodily sensations, heart rate, breathing, etc.)" and "External focus (daydreaming, external environment, etc.). Internal and external focus were thoroughly defined for the participants. At the end of each exercise bout on the treadmill, participants were asked to mark an "X" through the 10-centimeter line to indicate, "how internal or external your focus was predominately while walking on the incline." Attentional focus was scored by measuring the distance in centimeters and millimeters from the internal focus anchor on the left-hand side to the mark the participant made and multiplying by ten to obtain a score out of 100. Scores under 50 indicate a predominately internal focus whereas scores over 50 indicate a predominantly external focus.

Affective valence: Hardy and Rejeski's (1989) 11-point, single item Feeling Scale was used to assess the degree of pleasure vs. displeasure participants were experiencing in the moment. The scale ranges from 5 (*very good*) to -5 (*very bad*) with additional scale descriptors at 3 (*good*), 1 (*fairly good*), 0 (*neutral*), -1 (*fairly bad*), and -3 (*bad*). Participants were asked to verbalize a number that corresponded with how they were feeling that very moment.

Perceived exertion: The Borg RPE Scale was used to assess participants' ratings of perceived exertion (3). The scale allowed participants to rate how hard they were working on a scale from 6 to 20 with 6 representing "no exertion at all" and 20 representing "maximal exertion." Additionally, 9 signified "very light" exercise, 13 signified "somewhat hard" exercise, 17 signified "very hard" exercise, and 19 signified extremely strenuous exercise.

The following two state measures also assessed participants' experiences during their 10-minute treadmill bout but were administered while they were seated within five minutes of completing the exercise. In each case, they were asked to recall their 10-minute experience while walking on the incline on the treadmill.

State mindfulness (body): The physical subscale of the State Mindfulness Scale for Physical Activity (SMS-PA) (19) was used to assess how mindful participants were of their physical experience and sensations (mindfulness of the body) while walking on the treadmill. Responses on this measure served as a manipulation check in the experimental mindfulness condition. The SMS-PA was designed to specifically assess aspects of mindfulness most relevant in a physical activity context. The mindfulness of the body subscale measures nonjudgmental state attention to and awareness of physical events during the physical activity just completed (6 items; “I focused on the movement of my body”; “I listened to what my body was telling me”). Participants respond to each of the items using a response scale ranging from 0 *(not at all)* to 4 *(very much)*. Items are averaged and higher scores represent higher mindfulness of the body. Studies using the SMS-PA with similar samples have provided evidence of construct validity and internal consistency reliability (5).

Enjoyment: The Physical Activity Enjoyment Scale (PACES) (24) is an eighteen-item measure that assesses an individual’s enjoyment of physical activity directly following exercise using a 7-point bipolar scale. Example items included “I enjoyed it” to “I hated it” or “It was no fun at all” to “it was a lot of fun”. The average of the 18 items is used to represent overall enjoyment of the activity with higher scores indicating greater enjoyment. The PACES has been shown to have high internal consistency and Jones et al. (2014) provided evidence of score validity.

Protocol

After receiving IRB approval from our institution, participants were recruited through graduate student email listserves and word of mouth on a large university campus in the Northwest Region of the United States. Other means of recruitment included offering extra credit in undergraduate classes for students who attended all three study sessions. Then, potential participants were scheduled to come in for three separate testing sessions at the same time each day and at least two days apart. Each participant engaged in a habituation session followed by a control condition and then a mindfulness condition. All completed the three sessions within nine days. Thus the sessions were spaced 2-3 days apart. Participants were reminded of testing and preparations needed for testing via email. This included: 1) not engaging in vigorous exercise the day before or the day of testing, 2) not consuming caffeine for 12 hours prior to testing, 3) receiving a normal amount of sleep before testing, 4) no food or drink two hours prior to testing, with the exception of water.

Habituation and exercise testing: During the first testing session, participants first completed a survey assessing demographic variables, physical activity level, health status, trait mindfulness, and physical activity motivation. Next, we fit participants with a heart rate monitor and asked them to lie down for five minutes to obtain resting heart rate (HR_{rest}). Max heart rate (HR_{max}) was estimated using the equation: HR_{max} = 207-0.7*age (15); target heart rate for 65% of heart rate reserve (HRR) was calculated with the equation: HRR = HR_{max} - HR_{rest}. Sixty-five percent of HRR was chosen as the target in order to achieve a moderate level of exercise intensity at which interoceptive factors would likely be causing a more associative form of attentional focus, but not so intense that cognitive manipulations would be ineffective. Finally, participants' blood pressure was taken by a trained research assistant. Next, participants completed a graded submaximal test following a modified Balke protocol (1). Participants began with a 3-minute warm-up walking on the treadmill at 2.5 mph and 0% grade. Then, the grade was increased to 4% and the speed to 3.0 mph for two minutes and grade was increased an additional 1% every two minutes thereafter until their target heart rate was achieved. Once achieved, participants completed 10 minutes of walking at the final incline to observe the relative stability of the target heart rate. Participants completed measures of affective valence and RPE three times during the Balke protocol to practice for the next two upcoming sessions. They also completed the measure of attentional focus at the end of the ten minutes at the target heart rate. Finally, participant cooled down for three minutes (2.5 mph, 0% grade). Post exercise measurements of blood pressure and heart rate were recorded five minutes after the cool-down. This initial testing session was one hour or less in duration.

Control and mindfulness conditions: Each participant engaged in the control condition followed by the mindfulness condition, each lasting approximately 30 minutes. In both sessions, the following procedures were used. Measurements were recorded for blood pressure and resting heart rate. Baseline measures of affective valence and RPE were recorded. Participants were given an option to stretch and then began with a 3-minute warm-up walking on the treadmill at 2.5 mph and 0% grade. Then, the speed was increased to 3.0 mph and the grade was increased to that required to achieve 65% of HRR and maintained for 10 minutes. Participants completed measures of affective valence and RPE at four minutes and eight minutes (see 15) as well as immediately after the cool down, and five minutes after resting. They also completed the measure of attentional focus at the end of the ten minutes at the target heart rate. Finally, the participant cooled down for three minutes (2.5 mph, 0% grade). While participants were resting, after exiting the treadmill, they completed measures of state mindfulness and enjoyment. Post exercise measurements of blood pressure and heart rate were recorded five minutes after the cool-down. In the mindfulness condition only, participants listened to a guided mindfulness track during the 10 minutes of walking at 65% of HRR. Prior to starting the exercise, participants were read a script that asked them to have a nonjudgmental, open awareness of their body throughout the walking exercise. They were asked to gently draw their attention back to their body if they become distracted by thoughts or external stimuli and specific examples were provided.

Statistical Analysis

First, we identified univariate (z-scores ≥ 3.29) and multivariate outliers (using Mahalanobis distance, $p < .001$). Then, we evaluated missing data, normality of study variables and internal consistency of multi-item scales. Means and standard deviations were calculated to describe study variables. We conducted a manipulation check by using a repeated measures ANOVA to test for a difference in state mindfulness of the body across the two conditions. Next, a repeated measures MANOVA was used to test for differences in affective valence and RPE since these two in-task variables were expected to be correlated. A significant omnibus test was followed up by examining univariate F tests. Two 1-way repeated measures ANOVA's were conducted to test for differences in attentional focus and enjoyment across conditions. Finally, bivariate correlations were calculated and examined to evaluate the relationships among study variables in each condition. Significance level ($p < .05$) and effect sizes were examined to interpret results. For the ANOVA's, we interpreted partial eta-squared (η_p^2) with values of .04=minimal effect, .25=moderate effect, and .64=strong effect and for the bivariate correlations we interpreted r with values of .2=minimal effect, .5=moderate effect, and .8=strong effect (14).

RESULTS

Preliminary Analyses: No univariate or multivariate outliers were discovered. Two participants were missing one item each on the enjoyment scale (PACES). Thus, the average of the remaining 17 items was used to represent enjoyment for those individuals. Cronbach's alpha values for internal consistency for the SMS-PA was 0.85 for the control condition and 0.78 for the mindfulness condition and for the PACES was 0.93 for the control condition and 0.96 for the mindfulness condition. Variables were normally distributed (skewness = -.90-1.46; kurtosis = -1.37-1.72). Means and standard deviations for variables are displayed in Table 1 and Figure 1 displays the changes in affective valence over time for both conditions.

Table 1. One-way repeated measures ANOVA's (*N*=23).

Dependent Variable	Control Condition *M(SD)*	Mindfulness Condition *M(SD)*	Potential Ranges	*F*	*df*	*p*	η_p^2
Attention	57.70(25.38)	20.65(18.07)	0-100	43.84	1,22	.00	.67
Valence	0.87(2.00)	1.39(1.66)	-5-5	6.06	1,22	.02	.22
RPE	11.78(2.07)	11.37(1.97)	6-20	3.96	1,22	.06	.15
Mind_body	2.41(.77)	3.09(.54)	0-4	14.53	1,22	.00	.40
Enjoyment	3.77(1.02)	4.29(1.05)	1-7	12.29	1,22	.00	.36

Mind_body refers to Mindfulness of the body. Higher scores on attention refer to higher dissociative attention, lower scores refer to higher associative attention. Effect sizes for partial eta-squared values interpreted as .04=minimal effect, .25=moderate effect, and .64=strong effect (14).

Manipulation Check: The first ANOVA illustrated significant differences in mindfulness of the body across conditions representing a moderate to strong effect (see Table 1). Mindfulness of the body was higher in the mindfulness condition relative to the control ($p < .001$). Thus, as expected, participants engaged in more open attention and awareness of physical sensations in the mindfulness condition.

Main Analyses: Testing differences between the control and mindfulness conditions. The MANOVA for in-task variables revealed a significant difference across conditions representing a moderate effect (Pillai's Trace = .27, $F = 3.96$, $df = 2, 21$, $p < .05$, $\eta_p^2 = .27$). Follow-up tests showed that affective valence was more positive ($p = .02$, moderate effect) and RPE was lower ($p = .06$, minimal to moderate effect) in the mindfulness condition relative to the control condition. ANOVA results showed that attentional focus was significantly ($p < .001$) more associative during the mindfulness condition and exhibited a strong effect size. Finally, overall enjoyment was significantly higher ($p < .001$) in the mindfulness condition relative to the control, representing a moderate effect size. We also conducted the analyses with only those who selfidentified as female since we only had four non-female participants (*n* = 19). Interpretation of analyses were nearly identical except for in-task valence. For in-task valence the difference across conditions was no longer significant although the effect size still fell between minimal and moderate (η_p^2 = .10). Table 1 displays *F*-values, significance and effects sizes for the univariate analyses.

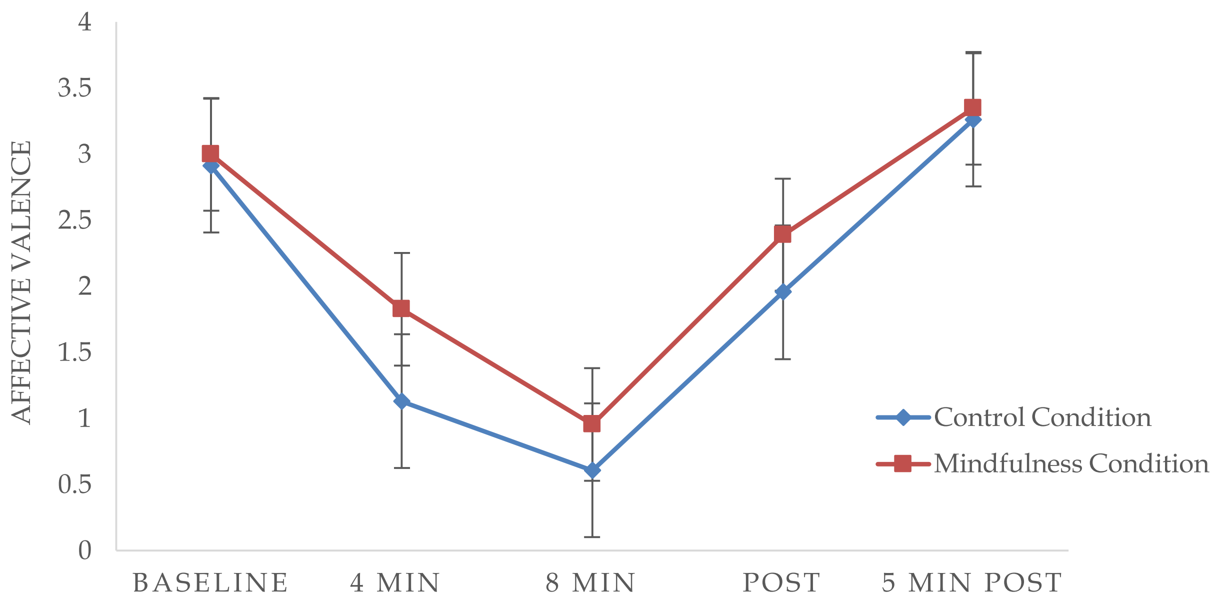

Figure 1. Changes in affective valence from baseline to five minutes post exercise in the control and mindfulness conditions.

Relationships among variables: Bivariate correlations (see Table 2) showed that in the control condition, greater dissociative focus was associated with lower RPE (minimal effect, $p > .05$) but not affective valence or affect. Higher RPE was strongly related to less positive affective valence ($p < .001$) and minimally related to lower enjoyment ($p > .05$). Higher mindfulness of the body was minimally to moderately related to more associative focus, more positive affective valence and lower RPE although none of these were significant ($p > .05$).

Table 2. Bivariate correlations between control and mindfulness condition (*N*=23).

Variable	Attention	Valence	RPE	Mind_body	Enjoyment
Attention	**1.00**	-.16	.08	-.56*	-.19
Valence	.11	**1.00**	-.74*	.35	.41*
RPE	-.30	-.79*	**1.00**	-.21	-.41*
Mind_body	-.36	.39	-.36	**1.00**	.44*
Enjoyment	.07	.30	-.23	.06	**1.00**

Mind_body refers to Mindfulness of the body. Control condition correlation values below diagonal, mindfulness condition correlation values above diagonal; **p* < .05 (2-tailed). Effect sizes for *r* values interpreted as .2=minimum effect, .5=moderate effect, .8=strong effect (14).

In the mindfulness condition, attentional focus, again, was not related to affective valence or enjoyment and also showed no relationship with RPE (unlike the control condition). Higher RPE was again, strongly associated with less positive affective valence ($p < .001$) and significantly ($p < .001$) and moderately associated with lower enjoyment ($p = .05$). Higher mindfulness of the body was moderately associated with greater associative focus ($p = .01$), and minimally to moderately associated with more positive affective valence and lower RPE although neither was significant ($p > .05$). Finally, higher mindfulness of the body was moderately associated with higher enjoyment ($p = .04$) unlike the control condition.

DISCUSSION

Although dissociative strategies are popularly prescribed as a method to counteract negative affective responses, particularly at higher levels of exercise intensity, in this study we aimed to manipulate the nature of associative attention instead by facilitating mindful attention and awareness of one's physical experience while exercising. The findings suggest that this open, accepting, and nonjudgmental form of associative attention may be useful for supporting more positive affective responses, reducing uncomfortable feelings of exercise and increasing enjoyment during moderate intensity exercise (i.e., 65% of HRR). The effects of the mindfulness condition on attentional focus, affective valence, RPE and enjoyment were all of a magnitude similar to research findings on the effect of dissociative methods such as music and video (22, 20). This study highlights qualitative distinctions in different types of associative focus and provides preliminary evidence of the adaptive role that open, receptive awareness may play in one's response to interoceptive cues, thus supporting enjoyment in individuals who do not typically enjoy the sensations of exercise.

The hypotheses that affect would be more positively valenced, enjoyment would be higher, RPE lower and attentional focus more associative in the mindfulness condition compared to the control condition were all supported. The data suggest that participants found the mindfulness condition more enjoyable than the control condition, thus resulting in more positively valenced affect even while reporting a strong associative focus. This contradicts past research showing that greater associative focus is accompanied by more negative affective valence (33, 23). However, it is consistent with research findings in a yoga setting where a mindful form of associative focus is more likely to be operating. Mackenzie et al. (2014) found that throughout the duration of an 80-minute yoga class, increases in associative focus corresponded with increases in positive affect. Our findings extend those found in the context of yoga to a more demanding aerobic form of exercise. These conflicting results in the literature may reflect the fact that although inducing mindfulness of the body is clearly a form of associative attention, associative attention is not always mindful. In the current study, we induced mindfulness of the body by intentionally directing attention to one's physical sensations during exercise but in a way that encouraged neutral observation, acceptance and nonjudgment (i.e., mindful associative focus). This form of associative attention is not likely to occur naturally in other exercise studies where high associative attention is observed.

The potential for mindfulness to impact exercise experiences was also evident in the differences in RPE (although the effect was small). Despite paying more attention to the physical experience of moving and having a stronger associative focus, participants felt like they were not working as hard when they were in the mindfulness condition. This suggests that the unique characteristics (e.g., openness, nonjudgment) of mindfulness relative to other forms of associative focus, may help the exercise feel less strenuous to the participant. This finding is consistent with the work of Ivanova and colleagues (2015) who found that participants reported lower RPE, higher enjoyment and were able to tolerate exercise longer when they were first taught mindfulness strategies. This is particularly notable given that participants in both conditions in the study were listening to self-selected music as well. Mindfulness strategies may work with the naturally occurring associative focus at higher levels of exercise intensity and support a more positive interpretation of physiological cues.

The correlation results partially supported the hypotheses and introduced new information about how being mindful of bodily sensations relates to psychological responses to exercise. First, contrary to the hypotheses, attentional focus did not relate to affective valence or enjoyment in either condition. However, this is consistent with other studies showing that below ventilatory threshold (VT), these relationships often do not emerge (22). Jones et al., (2014) did find that more positive affective valence was associated with greater dissociation above VT. In support of our hypotheses, participants reported more positive affective valence and greater enjoyment when they felt like they were not working as hard (i.e., RPE) in both conditions. Not surprisingly, the relationship was much stronger between the two in-task variables (valence and RPE) than between RPE and enjoyment. One finding that we did not anticipate was that the small relationship between higher RPE and a more associative focus in the control condition disappeared in the mindfulness condition. This possibly reflects how participants in the mindfulness condition were directed not only to pay attention to their physical sensations but to do so with a sense of curiosity and acceptance. Therefore, the nature of their associative focus may have taken on a distinct quality that did not fuel RPE. Larger sample sizes are needed in future research to confirm these relationships.

In exploring the relationship of state mindfulness of the body to other psychological responses during exercise, we found that higher mindful awareness of physical sensations was related to more associative focus, more positive affective valence, lower RPE and higher enjoyment. The relationship to overall enjoyment only emerged in the mindfulness condition. In the mindfulness condition, participants were encouraged to simply acknowledge and accept interoceptive cues, allowing them to be present in their body. As opposed to resisting sensations of discomfort, the acceptance of one's physical experience could reduce feelings of exertion and unpleasant affect (21). Thus, despite increased awareness of physical sensations, the unique qualities of mindfulness appear to make the exercise more rather than less enjoyable (26).

Since this was the first laboratory-based study to test the effects of an in-task mindfulness manipulation during exercise, there are a number of limitations that need to be systematically addressed in future research studies. First, the sample was predominantly female college students who engaged in moderate levels of physical activity. When we examined only the female participants in our study, we did find the magnitude of the difference in affective valence between conditions decreased. Although past studies on attentional focus and affective responses have revealed no gender differences (22), this should be tested directly in future studies on mindfulness. Future research is also needed to test the effects of mindfulness across different age ranges and in more sedentary populations. Another key limitation was relying on percent of HRR rather than using ventilatory threshold (VT) to standardize exercise intensity across individuals. Since we were interested in examining a level of exercise intensity that would be health-enhancing and elicit significant interoceptive cues, but not above VT where cognitive manipulation is more difficult (10), we determined the cost to participants outweighed the benefits in this initial laboratory test of the effects of mindfulness. In the future, research designs could be strengthened both by using VT to define intensity levels and perhaps employing a graded exercise test where intensity is increased to volitional exhaustion in order to test the effects of mindfulness as exercise intensity increases as has been done with music (23). Finally, more rigorous experimental designs need to be employed to replicate and extend the findings from this study. In this inaugural study, we chose not to randomize the order of the conditions so that participants would not use mindfulness strategies in the control condition. Researchers could consider increasing the sample size to employ a between-subjects design or including additional experimental conditions (e.g., music, other cognitive strategies) in a random order to compare the effects of mindfulness to the use of other cognitive strategies.

Despite the limitations of this initial study on the effect of a mindfulness manipulation on affective valence, RPE and overall enjoyment, it makes several key contributions to the current literature. First, the findings offer new insights into how the quality of associative focus might impact participants' exercise experiences. Results suggest that mindfulness strategies should be investigated further perhaps alongside dissociative strategies as a means of increasing pleasure during exercise. Second, this study extends the broader literature on the effects of mindfulness in physical activity settings to a more demanding form of exercise at 65% of HRR. Third, we measured state mindfulness directly in order to examine how it relates to other responses to exercise which had not been done before in similar studies investigating mindfulness during exercise (21, 26). Finally, in this study, we controlled for a key individual difference variable by screening for low intrinsic motivation for exercise. It was notable that drawing more attention to the physical experience of moving in these individuals who do not exercise for enjoyment was able to create a more pleasurable experience and lower feelings of exertion.

Although the predominant approach to increasing exercise enjoyment includes dissociative strategies such as music, an important question for future research is whether this dissociative strategy truly promotes motivation regulations needed for long-term exercise adherence (30). Evidence shows that motivation is higher when music and video is used to encourage dissociation (19), however the type of motivation this elicits has not be investigated. An individual may very well enjoy the experience of exercising while listening to music; however, if the music is being used to distract one from the experience of exercise itself, an important question is if this strategy deters the development of intrinsic motivation where the enjoyment is derived from the very act of exercise. Mindfulness capitalizes on this optimal source of motivation by directing attention to the very experience of exercise. Mindful attention to the experience of exercise may foster the development of key motivation variables such as self-efficacy and support more internalized or intrinsic motivation. These important motivation variables should be considered in future tests of the effects of mindfulness and dissociative strategies during exercise.

The present findings demonstrate that the mindfulness condition resulted in a better exercise experience for individuals who do not enjoy exercise. Although their attention was significantly more associative during the mindfulness condition, participants experienced more positive affective valence and enjoyment and slightly lower ratings of perceived exertion, suggesting that the mindfulness intervention shifted the quality of their attention. Mindfulness-based strategies may be helpful for individuals who have a strong aversion to the physical sensations of exercise, but more research is needed before specific practical recommendations can be forwarded. Finding effective ways to enhance affective responses during exercise is crucial to supporting long-term adherence to an exercise program of an intensity that would be beneficial to the exerciser's overall health profile.

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