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A Mindfulness-Based Physical Activity Intervention: A Pilot Randomized Controlled Trial

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A MINDFULNESS-BASED PHYSICAL ACTIVITY INTERVENTION: A PILOT RANDOMIZED CONTROLLED TRIAL

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Abstract

Introduction: The aim of this pilot randomized controlled trial was to assess the feasibility, acceptability, and preliminary efficacy of an audio-recorded mindfulness-based physical activity intervention as compared to an active control condition. I also examined affective response and distress tolerance during exercise as two putative mediators of the intervention. **Methods:** Community participants *(N* = 50) were randomized to a mindfulness intervention or active control group. **Results:** The audio-recorded mindfulness-based physical activity intervention was acceptable (i.e., well liked, *M* = 7.94, *SD* = 1.67) and feasible (i.e., percentage of use, *M* = 83.94%, *SD* = 20.65%). The intervention also resulted in greater self-reported moderate-to-vigorous physical activity (MVPA) minutes at one-week follow-up for participants in the mindfulness condition (*M* = 277.96, *SD* = 167.57) than participants in the control condition (*M* = 210.80, *SD* = 90.03), reflecting a moderate size effect (χ^2 = 3.80, *d* = .45, *p* = .05). Neither affective response during exercise nor distress tolerance during exercise mediated the relationship between condition and MVPA. **Conclusion:** The audio-recorded mindfulness-based physical activity intervention is a feasible, acceptable, and potentially efficacious approach to help individuals increase physical activity.

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PREFACE

Most U.S. adults are insufficiently active, at least partially due to an unpleasant response to physical activity and inability to tolerate distress when engaging in physical activity. One strategy that individuals could use to improve their physical activity experience and subsequently increase physical activity is to exercise mindfully. The aim of this pilot randomized controlled trial was to assess the feasibility, acceptability, and preliminary efficacy of an audio-recorded mindfulness-based physical activity intervention as compared to an active control condition. I also examined affective response and distress tolerance during exercise as two mediators of the intervention. In exploratory analyses, I examined moderators of the intervention. Community participants ($N = 50$) were randomized to a mindfulness intervention or active control group. Participants in the mindfulness intervention condition received instructions to exercise for at least 150 minutes throughout the next week while listening to an audio-recorded mindfulness-intervention, whereas participants in the control condition were instructed to exercise while using a heart rate monitor. The audio-recorded mindfulness-based physical activity intervention was acceptable and feasible. The intervention also resulted in greater self-reported moderate-to-vigorous physical activity (MVPA) minutes at one-week follow-up for participants in the mindfulness condition than participants in the control condition. Neither affective response during exercise nor distress tolerance during exercise mediated the relationship between condition and MVPA. Exploratory analyses revealed that the effects of the mindfulness-based physical activity intervention on physical activity were specific to individuals high in trait mindfulness, trait distress tolerance, exercise enjoyment, and stress/mood management reasons for exercise.

Introduction

Despite the many and varied benefits of regular physical activity, fewer than half of U.S. adults get sufficient amounts of regular exercise (CDC, 2015). Results from a recent meta-analysis suggest that physical activity promotion trials to increase physical activity typically result in only small effects, suggesting that the effectiveness of current physical activity promotion interventions is limited (Ekkekakis & Zenko, 2016). Thus, there is a need to improve current physical activity promotion strategies. A promising intervention strategy to increase physical activity may be to exercise mindfully [i.e., while paying attention to present-moment experiences with an attitude of acceptance (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; John Kabat-Zinn, 1994)]. Engaging in physical activity mindfully may enable individuals to be fully present in their physical activity experience in an accepting manner, thereby improving their physical activity experience and encouraging further subsequent physical activity.

Mindfulness involves self-regulation of attention such that it is directed to present moment experiences, with intention and purposefulness, and with an attitude of interest, acceptance, curiosity, openness, and non-judgment (Bishop et al., 2004; Brown & Ryan, 2004; Kabat-Zinn, 1994; Marlatt & Kristeller, 1999; Walach, Buchheld, Buttenmüller, Kleinknecht, & Schmidt, 2006). Mindfulness stands in contrast to mindlessness, which is characterized by only briefly holding attention to an experience and then reacting to it emotionally or cognitively by imposing judgments. Mindfulness can be a state or trait. Trait mindfulness is defined as a psychologically stable encompassing trait relating to the amount of mindfulness that an individual has across situations (Brown & Ryan, 2003). A mindful state refers to the extent to which one is experiencing mindfulness at any given moment (Brown & Ryan, 2003). Trait and state mindfulness are positively related, but they are not interchangeable (Brown & Ryan, 2003).

Mindfulness practice consists of practicing the mindful state (Lau et al., 2006) through experiential learning via silent periods of formal sitting meditation, or informal practices, such as paying purposeful attention to daily activities (e.g., walking). Both formal and informal mindfulness meditation has been successfully applied to many health domains, including smoking cessation, weight loss, and chronic pain (e.g., Bowen & Marlatt, 2009; Dalen et al., 2010; Morone, Greco, & Weiner, 2008), and may also be an important strategy in targeting physical activity.

A mindfulness-based physical activity intervention may promote exercise behavior by improving affective response during exercise and/or increasing during exercise distress tolerance. Exercising mindfully should teach individuals to observe their experiences during exercise with qualities of openness, non-reactivity, and acceptance (Kabat-Zinn, 1994), which should help individuals distance themselves from any unpleasant thoughts, feelings, and sensations that may arise during physical activity. These qualities of exercising mindfully should lead to a more pleasant affective response and/or improved distress tolerance during physical activity. Findings from numerous experimental studies outside of exercise suggest that increasing state mindfulness results in increased positive affect and decreased negative affect (Adams et al., 2012; Arch & Craske, 2006; Erisman & Roemer, 2010), and it is reasonable to expect that this would be the case for exercise as well. In addition, exercising mindfully may enable individuals to have a higher tolerance of unpleasant thoughts or physical sensations that may arise during exercise (Brown, Ryan, & Creswell, 2007; Dutton, 2008), viewing any unpleasant states that may arise during-exercise as being transient rather than states that need to be acted upon or avoided (Baer et al., 2006). Improved affect (Baldwin et al., 2016; Kwan & Bryan, 2010; Parfitt, Alrumh, & Rowlands, 2012; Parfitt, Olds, & Eston, 2015; Schneider, Dunn, & Cooper, 2009;

Williams, Dunsiger, Jennings, & Marcus, 2012) and increased distress tolerance during exercise should result in more exercise behavior over time.

It will be important to establish the mechanisms of a mindfulness-based physical activity intervention, as no study to date has evaluated the mechanisms by which exercising mindfully might work in promoting exercise behavior. Mindfulness could promote physical activity by increasing positive affect and decreasing negative affect during-exercise. Findings from numerous experimental studies outside of exercise suggest that short-term interventions that induce a mindful state reduce negative affect (Adams et al., 2012; Arch & Craske, 2006; Erisman & Roemer, 2010) and increase positive affect (Erisman & Roemer, 2010). Additionally, recent research supports the possibility that mindfulness may improve affective response during exercise specifically. Cox, Roberts, Cates, & McMahon (2018) recently found that listening to a mindfulness meditation audio during a walk was associated with higher affective valence (i.e., "feeling better") during exercise as compared to a control condition. However, this study did not examine whether listening to a mindfulness meditation audio resulted in changes in positive or negative affect specifically or whether the intervention resulted in increased exercise over time.

Mindfulness may also promote physical activity by promoting greater tolerance of unpleasant states that may arise during exercise (Brown et al., 2007). Mindfulness should enable individuals to be with whatever is happening as they exercise, with a recognition that it will pass and be replaced with new experiences (Kabat-Zinn, 2003). This quality of mindfulness should enable individuals to turn attention away from thoughts related to the unpleasant state and onto the present moment-experience with an accepting attitude (Bishop et al., 2004; Brown & Ryan, 2003), thereby potentially resulting in greater distress tolerance during exercise. A few studies outside of exercise have demonstrated in experimental manipulations that brief (i.e., 8 - 15

minutes) mindfulness practices result in greater distress tolerance (Liu, Wang, Chang, Chen, & Si, 2013; Sauer & Baer, 2012) and greater ability to manage unpleasant physical states such as mild pain (Liu et al., 2013). It is thus reasonable to expect that exercising mindfully would also result in greater tolerance for the various unpleasant states that individuals may experience during exercise. Greater tolerance of unpleasant states that arise during exercise should result in more exercise over time.

Although no studies have examined the effect of exercising mindfully on exercise behavior, some researchers have examined the effect of interventions that contain aspects of mindfulness, such as Acceptance and Commitment Therapy (ACT) (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011; Ivanova, Jensen, Cassoff, Gu, & Knäuper, 2015; Ivanova, Yaakoba-Zohar, Jensen, Cassoff, & Knäuper, 2016). The goal of ACT is to increase an individual's willingness to experience aversive feelings, thoughts, and physical sensations in order to increase value-driven behavior (e.g., exercise) (Hayes, Strosahl, & Wilson, 1999). ACT contains components of mindfulness among its core principles. Additionally, ACT and mindfulness meditation have certain common elements, such as remaining in the present moment and encouraging acceptance of all experiences. Findings from several studies evaluating ACT interventions suggest that ACT may be useful in improving the physical activity experience and increasing exercise behavior (Butryn et al., 2011; Ivanova et al., 2015, 2016). However, ACT interventions are resource intensive and require at least one group meeting facilitated by a therapist, and may therefore not be accessible to everyone due to issues such as lack of time, expense, inconvenience, and difficulties with dissemination. An audio-based mindfulness intervention for physical activity is a scalable alternative for individuals who are not able to participate in an ACT intervention.

An audio-based mindfulness intervention has an advantage over other exercise programs in that it is inexpensive, portable, does not take any extra time, and could be easily implemented in otherwise hard to access populations. However, it is not clear if such approach is acceptable or feasible. Studies evaluating mindfulness interventions in domains outside of physical activity suggest that these interventions are generally acceptable (i.e., well received and liked) and feasible (i.e., participants engage in mindfulness practice) (e.g., Krusche, Cyhlarova, & Williams, 2013; Potharst, Aktar, Rexwinkel, Rigterink, & Bögels, 2017). However, it is unclear if an exercise-specific mindfulness intervention is acceptable and feasible. Individuals may perceive certain aspects of exercising mindfully, such as a focus on the present moment (rather than distraction), as difficult to accept, as they may not like the experiences associated with exercise that they may perceive as uncomfortable and may want to avoid them rather than be present with them. Some individuals do not believe that attending to painful or unpleasant experiences will alleviate them (Cioffi & Holloway, 1993) and might therefore be hesitant to engage in a mindfulness intervention that will ask them to attend to their unpleasant experiences during exercise. Additionally, some individuals may find it too difficult to exercise mindfully and might not be able to do so.

It is also not clear the extent to which this type of approach may be more or less effective for certain populations. There are several individual differences that might moderate the effects of this intervention. First, differences in trait mindfulness may moderate the effect of this intervention, as differences in trait mindfulness may influence the extent to which individuals are able to effectively apply mindfulness in the context of exercise. Second, differences in trait levels of distress tolerance (i.e., the ability to withstand emotional distress) may also moderate the effects of the intervention, as trait levels of distress tolerance may influence the degree to which

individuals are willing to be present with the uncomfortable parts of exercise. Third, exercise enjoyment (i.e., the extent to which individuals find exercise pleasurable, fun, and satisfying) may also moderate the effects of the interventions, as the extent to which individuals enjoy exercise may influence the degree to which individuals are willing to be present with their exercise experience as well as the degree to which individuals may benefit from paying attention to their exercise experience. Finally, individuals' reasons for exercise (i.e., the extent to which individuals exercise for fitness/health reasons, appearance/weight reasons, stress/mood management reasons, and social reasons) may also moderate the effects of the intervention, as reasons for exercise may be related to the extent to which individuals are already exercising mindfully. For example, an individual exercising for stress/mood management reasons might already be paying attention to how exercising changes their mood.

Current Study

Rounsaville, Carroll, & Onken (2001) described intervention development as occurring in three stages: (1) acceptability, feasibility, and pilot testing; (2) strong efficacy testing; and (3) effectiveness testing. Consistent with the first stage of development, the primary aim of this pilot randomized controlled trial was to assess the feasibility and acceptability of an audio-recorded mindfulness-based physical activity intervention. I also assessed whether the intervention resulted in more physical activity than a control condition. Additionally, I examined affective response and distress tolerance during exercise as two putative mediators of the intervention. Finally, in exploratory analyses, I examined whether trait mindfulness, trait distress tolerance, exercise enjoyment, and reasons for exercise moderated the efficacy of the intervention.

Method

Participants

Data collection occurred from May 2018 to July 2018. Participants were recruited via Craigslist, Reddit, and Facebook from the Dallas metro area. A total of 50 participants were randomized into the study (intervention group $n = 25$, control group $n = 25$). The sample size was determined a priori to detect a small-to medium size effect ($f^2 = 0.15$). Participants were compensated up to $40. Informed consent was obtained from all participants. All study materials were reviewed and approved by the Institutional Review Board at SMU.

Inclusion Criteria. Eligible participants were those who: (1) reported less than 60-minutes of weekly moderate-to-vigorous physical activity (MVPA, moderate physical activity minutes + vigorous physical activity minutes*2), as the American College of Sports Medicine (ACSM) (2018) classifies individuals reporting less than 60-minutes of weekly MVPA as underactive; (2) were between the ages of 18 and 55 (as individuals older than 55 are at increased risk for adverse events during exercise); (3) were safe to exercise at moderate intensity without a doctor's approval according to ACSM guidelines (i.e., participants with chronic illnesses such as diabetes and asthma were excluded); and (4) had a smartphone, as a smartphone device was necessary to listen to the audio-recorded mindfulness-based physical activity intervention (see Procedures below).

Demographics. On average, participants were 34.48 years of age ($SD = 9.27$), with a range of 21 to 54 years. Most participants were female (62.0%). Participants were 62.0% non-Hispanic White, 16% Hispanic, 8.0% Black or African American, 12.0% Asian, and 2.0% American Indian or Native Alaskan. Participants had a mean BMI of 27.47 ($SD = 6.82$), and

reported that they had engaged in an average of 9.1 minutes of MVPA (*SD* = 18.07) per week for the past week. Please see Table 1 for demographics by condition.

Procedure

Screening. Interested individuals completed an online screening measure to assess for inclusion criteria. I then screened responses and called eligible participants inviting them to participate in the study. If individuals were still interested in participating, I scheduled their study visit as well as a brief phone call the day before the study visit to administer the Baseline 7-Day Physical Activity Recall (PAR). I chose to administer the 7-Day PAR the day before the study visit in order to perform a secondary screening to ensure that the participant reported less than 60 minutes of MVPA the week before beginning the study. Even though only participants reporting less than 60 minutes of calculated MVPA in the pre-screen questionnaire were invited to participate in the study, it was possible that participants eligible per the online screen would report higher levels of MVPA on the 7-Day PAR and would thus not be eligible to participate in the study. Specifically, the screening questionnaire asked about typical exercise engagement in the past six-months whereas the 7-Day PAR asked about physical activity in the past week. I wanted to verify that even physical activity in the past week was low. Please see Figure 1 for a flow diagram of participant's progression through study phases.

Study Design. The current study used a parallel trial design (i.e., intervention vs. control condition) with a 1:1 allocation ratio. Block randomization with a block size of two was used to assign participants to the mindfulness or intervention condition. I generated the random allocation sequence, and a research assistant enrolled participants using a random assignment list to assign the participant to one of the two study conditions. In order to eliminate as much bias as

possible, the interventionist followed a structured script for all aspects of the study. However, the interventionist was not blind to the participant condition.

In the baseline session, participants first completed a questionnaire with several demographic and baseline measures (see Measure section below). Participants were then asked to complete a 30-minute moderate intensity treadmill exercise bout in the lab. Participants rated their state mindfulness and affective responses just before beginning their exercise bout (i.e., baseline). Just before finishing their exercise bout, participants rated their distress tolerance during exercise and again rated their affective response during exercise. After the exercise bout, participants again rated their state mindfulness. I assessed affective response only once during the exercise (right before finishing the exercise) in order to not disrupt the mindful nature of the exercise. Additionally, affective response does not vary substantially when measured at different time-points during moderate-intensity exercise (see Sala, Baldwin, & Williams, 2016). Participants came back for follow-up assessments at the end of the 7 days. Specifically, at the end of the 7 days, participants completed the 7-Day Physical Activity Recall (7-Day PAR). In addition, on occasions when participants endorsed exercising, they were asked whether they used the mindfulness recording or heart rate monitor (see Feasibility in Measure section below). Finally, participants were asked to answer several questions related to intervention acceptability (see Acceptability in Measure section below).

Intervention Condition. Participants randomized to the mindfulness intervention received instructions to exercise at moderate intensity while listening to an audio-recorded mindfulness-based physical activity intervention. The intervention was delivered through an audio-recording which consisted of a single meditation exercise that lasted for 30 minutes. The recording, adapted from various commercial mindful walking scripts, instructed participants to

bring attention to their exercise experience with an attitude of non-judgment and acceptance (see Appendix 1). Participants were instructed to notice thoughts and emotions as they were exercising, acknowledging them and letting them pass. Participants were also asked to focus on their bodily sensations while exercising without becoming lost in unhelpful or distressing thoughts triggered by the experience. Finally, participants were asked to focus on their breathing as well as attend to their environments. It was emphasized that, at times, the experience of exercising may not be pleasant, but that this did not mean that they should stop exercising. The audio recording was uploaded online to YouTube and accessible to participants through their smartphone via a web link. Additionally, participants were emailed an mp3 file with the recording so that they could download the recording on their phone.

Control Condition. Participants assigned to the control condition were told to use their heart rate to determine the intensity of their exercise. A research assistant calculated participants estimated maximum heart rate using the age-predict equation (i.e., 220 – age), gave participants a heart rate monitor and instructed them in how to use it, and told participants to exercise within the moderate intensity range (64-76% of estimated maximum heart rate). I chose this control condition because it is a control condition that fits well with exercise, that participants can generally expect when participating in an exercise intervention, and that has been shown to increase exercise (Baldwin et al., 2016).

Measures

Acceptability. Participants were asked six questions to determine intervention acceptability (please see Appendix 2). Participants rated their responses on each of these questions from 0 (*not at all*) to 10 (*extremely*) and a mean score was calculated. Internal consistency was good ($\alpha = .89$).

Additionally, participants were asked to provide free responses to the following three questions: *(1) What aspects of this exercise program were the most useful? (2) What aspects of this exercise program were not useful?; and (3) What would you have liked added to this exercise program?* After meaningful themes were identified, a second coder and I grouped each statement into one or more themes. Inter-rater reliability was good (96.3%).

Feasibility. To determine feasibility, participants were asked about any exercise bouts they engaged in during the past 7-days during the follow-up visit (as part of the 7-Day PAR). If they reported exercising, they were asked to report whether they used the mindfulness recording or heart rate monitor. Feasibility was determined quantitatively by the percentage of the exercise bouts in which individuals used the mindfulness intervention or heart rate monitor for one week after coming in for the laboratory session (i.e., frequency of mindfulness recording use / total exercise sessions). I chose to measure feasibility in this way as feasibility is typically measured by measuring intervention engagement and/or use (e.g., Mendelson et al., 2010a; Zylowska et al., 2008a).

Physical Activity. Self-reported physical activity during the past week was assessed with the 7-Day PAR (Hayden-Wade, Coleman, Sallis, & Armstrong, 2003), which is a semi-structured interview that can be administered by phone or in-person. Participants were asked to recall their physical activity over the past 7 days both at baseline and at 7-day follow-up. The 7-day PAR is a valid and reliable measure of physical activity duration and intensity (Hayden-Wade et al., 2003).

Physical activity was also measured objectively with an ActiLife 6 GT3XP-BTLE accelerometer. The accelerometer was used as a secondary measure of physical activity because I did not collect baseline accelerometer data, as collecting baseline accelerometer data would have

likely have been an exercise intervention on its own (Baskerville, Ricci-Cabello, Roberts, & Farmer, 2017), thus limiting the efficacy of our intervention. Accelerometers have been found to be valid and reliable means of measuring physical activity (Plasqui & Westerterp, 2007). Participants with fewer than 4 days of accelerometer monitoring (n = 16, 32.0%) were excluded from the analyses, as it has been suggested that 4 days is the minimum number of days of monitoring for obtaining a reliable estimate of physical activity (Trost, Mciver, & Pate, 2005). The Spearman rho correlation between accelerometer weekly MVPA and PAR weekly MVPA was .24 (p = .18), which is low but within the range of other comparisons of self-report and accelerometer data (Sloane, Snyder, Demark-Wahnefried, Lobach, & Kraus, 2009; Taber et al., 2009). Correlations between accelerometer data and self-report data are often low due to the limitations of both methods. Limitations of self-report physical activity data include recall difficulties, over reporting due to social desirability biases, and difficulty determining whether an activity falls into moderate or vigorous category. Limitations of accelerometer data are accelerometer non-wear and the inability to use the device when engaging in water exercise (Sloane et al., 2009).

Affective Response. Baseline and during exercise affective states throughout the baseline exercise bout were assessed with the Physical Activity Affect Scale (PAAS; Lox, Jackson, Tuholski, Wasley, & Treasure, 2000). The PAAS has four subscales: positive affect ('enthusiastic', 'energetic', and 'upbeat'), negative affect ('miserable, 'discouraged', 'crummy'), fatigue ('tired', 'worn-out', 'fatigued'), and calmness ('peaceful', 'relaxed', 'calm'). The PAAS is considered to be valid in both sedentary and active populations (Carpenter, Tompkins, Schmiege, Nilsson, & Bryan, 2010). The PAAS was used because it assesses specific affective states that are relevant to exercise. Participants rated their current affective states on each of 12

items from 0 (*do not feel*) to 4 (*feel very strongly*). For the current study, I used the positive and negative affect subscales, and internal consistencies were adequate to excellent (positive affect αs = .86 - .89, negative affect αs = .64 -.73).

Distress Tolerance During Exercise. Distress tolerance during exercise was assessed by asking participants, "To what extent can you tolerate the distress associated with the exercise session?" Participants rated their distress tolerance during exercise on a visual analogue scale from 0 (*cannot tolerate*) to 100 (*can fully tolerate*). Of note, the correlation between state distress tolerance and baseline (trait) distress tolerance was .21.

Toronto Mindfulness Scale (TMS). State mindfulness was assessed with the TMS (Lau et al., 2006). The state TMS was created to assess the attainment of a mindful state, and was designed for use immediately after a mindfulness meditation exercise. It yields two factors, curiosity and decentering. The TMS shows good internal consistency and validity (Lau et al., 2006). The TMS was used as a manipulation check to verify that the mindfulness-based physical activity recording increases state mindfulness. Participants rated each of the 13 state-mindfulness items from 0 (*not at all*) to 5 (*very much*). For the current study, I used the total state mindfulness score, and internal consistency was excellent (α = .90).

Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006)**.** The FFMQ was administered at baseline to use in potential exploratory moderator analyses. The FFMQ measures trait mindfulness and its five facets: (1) observing; (2) describing; (3) non-reactivity; (4) non-judgment; and (5) acting with awareness. The FFMQ has been demonstrated to have good psychometric properties (Baer et al., 2006). Participants rated each of the 39-items from 1 (*never true)* to 5 *(always true*). In the current sample, I used the trait mindfulness score, and internal consistency was excellent (α = .90).

Distress Tolerance Scale (DTS; Simons & Gaher, 2005). The DTS was administered at baseline to potentially use in exploratory moderator analyses. The DTS incorporates items that assess trait levels of appraisal, tolerance, absorption, and regulation of distress. The DTS has good psychometric properties (Simons & Gaher, 2005). All items are rated from 1*(strongly agree)* to 5 (*strongly disagree)*. Higher scores represent higher tolerance of emotional distress. In the current study, I only used the total distress tolerance score, and internal consistency was excellent (α = .90).

Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004; Mullan et al., 1997). The BREQ-2 intrinsic regulation subscale is a measure of exercise enjoyment that was administered at baseline to potentially use in exploratory moderator analyses. The BREQ-2 has good psychometric properties (Markland & Tobin, 2004; Mullan et al., 1997). Participants rated items from a scale of 0 *(not true for me)* to 5 *(very true for me)*. In the current study, internal consistency was excellent (α = .95).

Reasons for Exercise Inventory (REI) (REI; Cash, Now, & Grant, 1994)The REI was administered at baseline to potentially use in exploratory moderator analyses. The REI contains four subscales: (1) fitness/health management; (2) appearance/weight management; (3) stress/mood management; and (4) socializing. All items rated items from 1 (*not at all satisfied*) to 7 (*very satisfied)*. In the current study, internal consistency was good (fitness/health management α = .79, appearance/weight management α = .84, stress/mood management α = .86, socializing α = .87).

Mindfulness meditation experience. Participants were asked if they had any current experience with mindfulness meditation. Specifically, the participants were asked, *"Do you currently practice meditation?"* and were asked to indicate *Yes* or *No*.

Yoga experience. Participants were asked if they have any current experience with yoga. Participants were asked about yoga specifically as it is a popular form of exercise in the United States that has mindfulness elements. Specifically, participants were asked *"Do you currently practice yoga?"* and were asked to indicate *Yes* or *No*.

Credibility / Expectancy Questionnaire (CEQ). The CEQ is a measure of the credibility and expectancy of treatment. The CEQ has excellent psychometric properties (Devilly & Borkovec, 2000). Participants were asked to rate each of 4 items from 1 (*not at all*) to 9 (*very*) as well as answer 2 items relating to the percentage of improvement they thought/felt would occur from the intervention from 0% to 100%. In the current study, internal consistencies were poor to excellent (credibility $\alpha = .91$, expectancy $\alpha = .58$). The CEQ was administrated to test if there were any differences in credibility or expectancy between groups.

Data Analysis

All data were analyzed in SPSS. I used descriptive statistics and t-tests to examine the acceptability and feasibility of the intervention. The open-ended acceptability questions were analyzed via thematic content analysis, which focuses on grouping together similar patterns within the text and is often used to analyze open-ended survey questions (Braun & Clarke, 2006). In order to check that the recording increased state mindfulness, I examined responses to the TMS using an ANCOVA, where TMS was the outcome variable, condition was the predictor variables, and baseline TMS was a covariate.

I conducted linear regressions using a gamma distribution with log link for all the models that had MVPA as the outcome (i.e., the primary outcome, mediation, and moderation models) in order to account for skew in MVPA. First, I tested the effect of condition on MVPA in order to determine whether the intervention was promising in regards to increasing exercise. I used

weekly MVPA at follow-up as the outcome variable, and baseline MVPA and condition as the predictor variables. Because gender and race differed significantly between the intervention and control groups, I also repeated these models with race (i.e., white vs. non-white) and gender as covariates.

Second, I analyzed whether positive affect, negative affect, and distress-tolerance during-exercise mediated the effect of the intervention on exercise behavior. In the mediation models, I examined the effect of condition on each mediator (path a), the effect of the mediator on exercise behavior (path b), and the effect of condition on exercise behavior (both mediated and unmediated, paths c' and c). Mediation was estimated by a product of the coefficients approach. All of the mediators were entered into the same model.

For exploratory moderator analyses, I included PAR MVPA at one-week follow-up as the dependent variable, each moderator (e.g., trait mindfulness) as the moderator variable, and baseline MVPA as a covariate. In order to understand the nature of each significant interaction, I examined the nature of the effect of condition (i.e., mindfulness vs. heart-rate) on weekly MVPA at two different values of each moderator (i.e., one standard deviation above the mean and one standard deviation below the mean).

Results

Descriptives

Baseline demographic and clinical characteristics for participants randomized to each condition are included in Table 1. Participants were in their mid 30s, overweight, and engaging in minimal exercise. Of note, gender and race varied significantly between groups, with the mindfulness condition having more females and a higher percentage of non-Hispanic Whites.

Furthermore, there was a trend (t = -1.35, p = .18) such that the average MVPA at follow-up was higher for females (M = 264.81, SD = 148.73) than males (M = 211.05, SD = 112.36). However, average MVPA at follow-up (t = -.71, p = .48) did not significantly differ between Whites (M = 233.00, SD = 103.77) vs. non-Whites (M = 261.45, SD = 178.13). As seen in Table 2, the groups did not differ in regards to their yoga experience, meditation experience, trait mindfulness, exercise enjoyment, reasons for exercise, and trait distress tolerance at baseline.

Manipulation Check

Within condition, participants in the mindfulness condition reported a significant increase in state mindfulness after the in-lab exercise session (mean change = .40, t (24)= 3.03, p = .006). In contrast, participants in the heart-rate condition did not report a significant increase in state mindfulness after the in-lab exercise session (mean change = .05, t (23) = .30, p = .77). Between conditions, there was a trend towards a higher increase in state mindfulness for participants in the mindfulness condition than participants in the intervention condition (β = .19, SE = .21, p = .12).

Aim 1: Acceptability and Feasibility

Acceptability. Participants in the mindfulness and heart-rate conditions did not differ in their mean acceptability, t (44)= .04, p = .97, from participants in the mindfulness condition. Participants in the mindfulness condition reported a mean acceptability of 7.94 (SD = 1.67, range = 4.67 – 10.00) and participants in the heart-rate condition reporting a mean acceptability of 7.92 (SD = 1.77, range = 3.00 – 10.00). Please see Table 3 for acceptability responses for each item.

Results from the open-ended survey questions indicated general acceptance of the study for participants in the mindfulness condition. There was a 96.3% inter-rater agreement on the coded themes. Themes and examples for participants are presented in Table 4. Overall, participants from both groups (39.1% in the mindfulness condition and 41.7% in the heart rate

condition) indicated that *accountability* was one of the most helpful aspects of the study. In addition, a substantial portion of participants in the mindfulness condition indicated that *pleasure* (21.7%) and *focus / awareness* (43.5%) were the most helpful aspects of the study. A large portion of participants in both groups indicated that none of the study aspects were unhelpful (34.7% in the mindfulness condition and 37.5% in the heart rate condition). In addition, a small portion of participants in the mindfulness condition (17.4%) indicated that the *difficulty* of engaging in mindful exercise was unhelpful. Finally, although many participants indicated that no additions to the study were necessary (34.8% in the mindfulness condition and 29.2% in the heart-rate condition), a few participants indicated that *variety* would enhance the intervention (26.1% in the mindfulness condition and 20.8% in the heart-rate condition).

Feasibility. Participants in the mindfulness and heart-rate condition did not differ in their mean compliance, t (48) = 1.49, p = .14, with participants in the heart-rate condition reporting a mean compliance of 91.17% (SD= 13.05%, range = 60.00-100.00%) and participants in the mindfulness condition reporting a mean compliance of 83.94% (*SD* = 20.65%, range = 20.00 - 100.00%). Of note, there was more variability in compliance for participants in the mindfulness condition than those in the heart-rate condition (i.e., a larger standard deviation), suggesting that, in the mindfulness condition, some participants used the recording most of the time but other participants barely used it.

Credibility / Expectancy. There were no significant differences in credibility (t = 1.48, p = .15) or expectancy (t = -.27, p = .79) between the two conditions. However, as can be seen in Table 5, participants randomized to the heart-rate condition had higher levels of feeling that the intervention would help them increase their exercise than participants randomized to the mindfulness condition (t = 2.02, p = .05). Participants randomized to the heart-rate condition also

trended towards having a higher belief in how successful they thought that the intervention would be in increasing exercise ($t = 1.94$, $p = .06$) and confidence in recommending the intervention to a friend ($t = 1.31$, $p = .08$) than participants randomized to the mindfulness condition.

Aim 2: Intervention Effects on MVPA

PAR Weekly MVPA. I found a significant difference in weekly MVPA at one-week between conditions (b = -.27 [95% CI = -.54 - .00], $\chi^2 = 3.80$, $p = .05$), which corresponded to a medium effect size ($d = .45$). Participants in the mindfulness condition reported a mean weekly MVPA of 277.96 minutes (SD = 167.57, range = 60.00 – 735.00) at one-week follow-up, whereas participants in the heart-rate condition reported a mean weekly MVPA of 210.80 minutes (SD = 90.03, range = 30.00 – 430.00) at one-week follow-up. Because gender and race differed significantly between groups, I re-ran the model with race and gender as covariates, and the pattern of findings did not change (b = -.27 [95% CI = -.54 - .00], $\chi^2 = 4.03$, $p = .04$).

Accelerometer Weekly MVPA. I found no significant differences in weekly MVPA between conditions (b = -.15 [95% CI = -.41 - .11], $\chi^2 = 1.29$, $p = .26$). Participants in the mindfulness condition reported a mean weekly MVPA of 291.96 minutes (SD = 117.19, range = 104.33 – 521.67) at one-week follow-up, whereas participants in the heart-rate condition reported a mean weekly MVPA of 256.48 minutes (SD = 161.42, range = 45.67 – 787.00) at one-week follow-up. When I re-ran the model with gender and race as covariates, the model remained non-significant (b = -.22 [95% CI = -.51 - .06], $\chi^2 = 2.47$, $p = .11$).

Aim 3: Mediation Model

Please see Figure 2 for the mediation model. The indirect effects of condition on weekly MVPA through positive affect (μ = 0.001 95% CI = -.02 - .023), negative affect (μ = -.002, 95

% CI = -.056 - .049), and distress tolerance (μ = .003, 95 % CI = -.02 - .031) during exercise were not significant.

Exploratory Analyses: Moderators

Trait Mindfulness. I examined whether trait mindfulness moderated the efficacy of the intervention. I found a significant interaction between condition and trait mindfulness (*b* = -.88 [95% CI = -1.52 - -.25], χ^2 = 7.46, *p* = .006), indicating that trait mindfulness moderated the effect of condition on weekly MVPA. As illustrated in Figure 3, for participants low in trait mindfulness, condition did not predict weekly MVPA (*b* = .19 [95% CI = -.20 - .59], χ^2 = .93, *p* = .35). In contrast, for participants high in trait mindfulness, condition predicted weekly MVPA, such that weekly MVPA was higher for participants in the mindfulness condition than for participants in the heart-rate condition (*b* = -.57, *SE* = .19, χ^2 = 9.33, *p* = .002).

Baseline Distress Tolerance. I found a trend towards a significant interaction between condition and distress tolerance at baseline (*b* = -.33 [95% CI = -.68 - .02], χ^2 = 3.48, *p* = .06). As illustrated in Figure 4, for participants low in trait distress tolerance, condition did not predict weekly MVPA (*b* = .02 [95% CI = -.31 - .34], χ^2 =. 01, *p* = .92). In contrast, for participants high in trait distress tolerance, condition predicted weekly MVPA, such that weekly MVPA was higher for participants in the mindfulness condition than for participants in the heart-rate condition (*b* = -.48 [95% CI = -.87 - -.09], χ^2 = 5.71, *p* = .02).

Exercise Enjoyment. I found a trend towards a significant interaction between condition and exercise enjoyment (*b* = -.19 [95% CI = -.39 - .01], χ^2 = 3.30, *p* = .07), such that being randomized to the mindfulness group predicted higher weekly MVPA for participants who were high in exercise enjoyment (*b* = -.47 [95% CI = -.85 - -.10], χ^2 = 6.21 *p* = .01) but not participants who were low in exercise enjoyment (*b* = -.06 [95% CI = -.38 - .26], χ^2 = .13 *p* = .72) (see Figure

5).

Reasons for Exercise. I found a significant interaction between condition and mood reasons for exercise (b = -.14 [95% CI = -.29 - .01], χ^2 = 3.80, p = .05), such that being randomized to the mindfulness group predicted higher weekly MVPA for participants who were high in mood reasons for exercise (b = -.49 [95% CI = -.78 - -.21], χ^2 =11.30, p = .001) but not participants who were low in mood reasons for exercise (b = -.04 [95% CI = -.45 - .36], χ^2 = .04, p = .84) (see Figure 5). I did not find a significant interaction between condition and fitness / health (b = -.19 [95% CI = -.44 - .06], χ^2 = 2.14 p = .14), appearance / weight (b = .11 [95% CI = -.14 - .37], χ^2 = .73 p = .39) or socializing (b = -.09 [95% CI = -.31 - .13], χ^2 = .65 p = .42) reasons for exercise.

Variability of Use: I examined the extent to which the significant moderator variables were associated with frequency of intervention use. Within the mindfulness group, exercise enjoyment (r = .22, p = .28) and trait mindfulness (r = .24, p = .26) had a small-medium positive association with frequency of intervention use, and stress / mood management reasons for exercise had a small positive association with frequency of intervention use (r = .11, p = .59), whereas baseline distress tolerance was not associated with frequency of intervention use (r = .03, p = .89). Within the control group, trait distress tolerance had a medium negative association with frequency of intervention use (r = -.35, p = .09), trait mindfulness had a small-medium negative association with the frequency of intervention use (r = -.19, p = .35), and exercise enjoyment had a small-medium positive association with the frequency of intervention use (r = .26, p = .20). Exercise enjoyment was not associated with the frequency of intervention use (r = .06, p = .75).

Discussion

The primary aim of this study was to examine the acceptability and feasibility of a mindfulness-based physical activity intervention. I also collected pilot data on the preliminary efficacy of this intervention in regards to increasing physical activity as compared to a control condition. Additionally, I explored putative mediators of the intervention as well as various possible moderators of the intervention. Both acceptability and feasibility were demonstrated. I also found initial evidence that an audio-recorded mindfulness-based physical activity intervention results in more physical activity than an active control condition. However, I did not find support for my hypotheses regarding affective response and distress mediating the intervention. Exploratory analyses revealed that the positive effects of a mindfulness-based exercise intervention may be specific to individuals high in trait mindfulness, trait distress tolerance, exercise enjoyment, and stress/mood management reasons for exercise. Overall, this study provides groundwork to support future investigation of this type of intervention for increasing physical activity and raises interesting hypotheses regarding the boundary conditions of the intervention.

I found that a mindfulness-based physical activity intervention is acceptable and feasible. Participants in the mindfulness-based physical activity intervention condition reported acceptability that was high and comparable to the control condition, suggesting that an audio-recorded mindfulness-based physical activity intervention is well received and well liked.
In regards to feasibility, compliance with the intervention was over 80% and comparable to the control condition, suggesting that participants actually use the intervention. However, there was higher variability in use for participants in the mindfulness condition than participants in the control condition, suggesting that there may be differences in who is willing to use this type of

intervention. Finally, qualitative feedback suggested that many participants found that this type of intervention was helpful because it gave them accountability, allowed them to focus, and was enjoyable. However, a substantial portion of participants found it difficult to exercise mindfully, suggesting that some individuals may not be able to exercise mindfully.

I also found preliminary evidence that a mindfulness-based physical activity intervention results in more physical activity than a control condition, suggesting that this type of approach appears promising in regards to increasing physical activity. Participants in the mindfulness condition self-reported 67 more minutes of weekly exercise than participants in the control condition, which corresponded to a medium-size effect. However, given the small sample size, conclusions regarding efficacy should be made with caution. Our findings are in line with research that suggests that other forms of mindfulness training, such as training in formal mindfulness meditation and yoga, result in increased physical activity (McIver, O'Halloran, & McGartland, 2009; Tapper et al., 2009). However, it stands in contrast to findings from another study that suggests that formal mindfulness meditation training does not increase self-reported physical activity (although this study did find that the intervention resulted in increases in strength and flexibility and reductions in sedentary behaviors) (Salmoirago-Blotcher, Hunsinger, Morgan, Fischer, & Carmody, 2013).

Additionally, my hypotheses regarding affective response and distress tolerance during exercise mediating the exercise intervention were not supported. While there was good basis for me to hypothesize that mindfulness might improve affective response to exercise (Arch & Craske, 2006; Erisman & Roemer, 2010) and increase distress tolerance (Liu et al., 2013; Sauer & Baer, 2012), I did not find evidence supporting these hypotheses. It may be that the mindfulness recording may not improve affect and distress tolerance during exercise

immediately, but may do so over time (e.g., after a week of exercising mindfully). Intentional exposure to negative feeling and sensations during exercise may not lead to improved affect immediately but may do so over time by decreasing the valence of negative affect due to extinction (Hölzel et al., 2011). Future research should assess affect and distress tolerance during exercise throughout the intervention period by using ecological momentary assessment. It is also possible that affective response and distress tolerance during exercise mediated the exercise intervention in only a sub-sample of participants (e.g., those higher in trait mindfulness). However, we were underpowered to conduct moderated mediation analyses. It is also possible that rather than changing affective experience during exercise, mindfulness may enable individuals to create distance between themselves and any negative affective experiences during exercise, and not react to negative affective experiences during exercise by stopping the exercise (Keng, Smoski, & Robins, 2011; Shapiro, Carlson, Astin, & Freedman, 2006).

My findings stand in contrast with findings by Cox et al. (2018) that exercising mindfully results in higher affective valence during exercise as compared to control. However, the study by Cox et al. (2018) differed from our study in some important ways. First, Cox et al. (2018) used a unidimensional, valenced evaluation of affective response, whereas I used a measure of positive and negative affect. Changes in affective valence could be driven by changes in positive affect, negative affect, calmness, fatigue, or a combination of these affective states. It is possible that the increased affective valence seen in the study by Cox et al. (2018) may be driven by affective states other than positive and negative affect (i.e., calmness and fatigue). Second, participants in the study by Cox et al. (2018) were active and engaged in low intensity exercise (i.e., walking). It has been demonstrated that being active and engaging in lower intensity exercise is associated with finding exercise more pleasurable than being inactive (Lochbaum, Karoly, & Landers,

2004) and engaging in higher intensity exercise (Ekkekakis et al., 2011; Ekkekakis, 2013). Therefore, active individuals who engage in low intensity exercise might benefit from noticing their positive affective response during exercise, whereas inactive individuals who engage in higher intensity exercise may not benefit from noticing their less positive affective response to exercise.

In exploratory analyses, I found several significant moderators of the intervention, suggesting that there may be several boundary conditions of the intervention. First, the intervention appears promising in increasing exercise only for individuals who are higher in trait mindfulness. Conversely, this type of approach does not appear to be beneficial for individuals who are lower in trait mindfulness. Research suggests that higher trait mindfulness is associated with higher state mindfulness (Brown & Ryan, 2003). Therefore, individuals who are higher in trait mindfulness might have been able to better learn how to effectively apply mindfulness to their exercise experience and thus achieve a mindful state. In contrast, participants who were lower in trait mindfulness might not have been able to effective apply mindfulness to their exercise experience and thus might not have been able to achieve a mindful state. Mindfulness can take substantial practice to have significant effects (Carmody & Baer, 2008), and individuals lower in trait mindfulness may need much more practice than one week to learn to effectively apply mindfulness in the context of exercise.

Second, the intervention appears promising in increasing exercise only for individuals who are higher in trait distress tolerance. This may be because individuals who are low in trait distress tolerance may not have been willing to be present with the unpleasant parts of exercise. Third, the intervention may be helpful increasing exercise only for individuals who are higher in exercise enjoyment. As individuals who are higher in exercise enjoyment draw attention to their

(mostly positive) exercise experience, they may draw satisfaction from engaging in physical activity, promoting more physical activity behavior over time (Tsafou, De Ridder, van Ee, & Lacroix, 2016). In contrast, individuals who are lower in exercise enjoyment may not benefit from drawing more attention to their exercise experience, which they may not find very pleasurable. Relatedly, the intervention was promising in increasing exercise only for individuals who exercise to manage their stress and mood. This may be because individuals who exercise for stress and mood management reasons exercise may already be paying attention to their exercise experience (which would have allowed them to notice how exercising helps them regulate their mood and stress), which may have facilitated their ability to exercise mindfully and therefore benefit from the intervention. Alternatively, it may be that trait distress tolerance, exercise enjoyment, and stress / mood management reasons for exercise may overlap with trait mindfulness, as mindfulness promotes an acceptance of emotions that results in higher distress tolerance (Teper, Segal, & Inzlicht, 2013) and higher satisfaction with exercise (Tsafou et al., 2016).

Given the nature of this study as primarily an acceptability and feasibility trial, a few limitations exist. First, the study had a small sample size and short follow-up period. However, the goal of the current study was to provide pilot data on the acceptability, feasibility, and effectiveness of the intervention. Given the pilot nature of the study, a small sample size and a one week follow-up period was appropriate. Second, it is possible that the recording increased exercise by distracting individuals from their exercise experience. Future studies should use an alternative form of distraction (e.g., music, a podcast) as the control condition.

Overall, the current pilot randomized controlled trial of an audio-recorded mindfulness-based physical activity suggests that this type of approach is feasible, acceptable, and potentially

efficacious approach to help individuals increase physical activity, providing groundwork for future research of this type of intervention for increasing physical activity. The current study also suggests that there may be boundary conditions of a mindfulness-based intervention for physical activity that should be explored in further research.

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Table 1. Baseline demographics by condition.

	Mindfulness (n = 25)		Heart-Rate (n = 25)		
	M or n	M or n	M or n	SD or %	p
Age (years)	34.92	9.03	34.04	9.68	.74
Gender					
Male	6	24.0%	13	52.0%	.04
Female	19	76.0%	12	48.0%	
Race					.04
Caucasian	19	76.0%	12	48.0%	
Hispanic	4	16.0%	4	16.0%	
Black	0	0.0%	4	16.0%	
Asian	2	8.0%	4	16.0%	
American Indian	0	0.0%	1	4.0%	
BMI (kg / m^2)	27.03	5.97	27.92	7.72	.65
Baseline MVPA	8.60	17.29	9.52	19.16	.86

Note: BMI = Body Mass Index, MVPA = Moderate-to-Vigorous Physical Activity. Gender and race varied significantly between groups.

Table 2. Descriptive statistics at baseline.

	Mindfulness		Heart-Rate		
	M or *n*	*SD* or %	M	SD or %	*p*
Current Yoga					
No	24	96.0%	24	96.0%	1.00
Yes	1	4.0%	1	4.0%	
Current Meditation					
No	21	84.0%	23	92.0%	.38
Yes	4	16.0%	2	8.0%	
Trait Mindfulness (FFMQ)	3.47	.44	3.31	.42	.22
Exercise Enjoyment (BREQ-2 Intrinsic)	1.59	1.08	1.84	1.16	.44
Reasons for Exercise (REI)					
Fitness/Health	5.45	.87	5.63	.94	.48
Appearance/Weight	4.73	1.15	5.15	1.27	.36
Stress/Mood	3.97	1.50	4.23	1.67	.57
Socializing	2.39	1.31	3.15	1.86	.10
Distress Tolerance (DTS)	3.68	.70	3.62	.80	.75

Note: FFMQ = Five Facet Mindfulness Questionnaire, BREQ-2 = Behavioral Regulation in Exercise Questionnaire; REI = Reasons for Exercise Inventory; DTS = Distress Tolerance Scale. Range is 1-5 for FFMQ and DTS, 0-5 for BREQ-2, and 1-7 for REI and DIS.

Table 3. Acceptability by condition.

	Mindfulness			Heart-Rate			
	M	SD	Range	M	SD	Range	*p*
How helpful do you think this program was in increasing your exercise?	8.10	2.32	1 – 10	8.57	1.60	5 – 10	.44
How comfortable would you be in recommending this program to a friend who is looking to become more active?	7.83	1.97	3 – 10	8.05	2.24	2 – 10	.73
How likely would you be to participate in this program again for further help?	8.04	2.38	1 – 10	8.27	2.35	1 – 10	.74
Overall, how satisfied are you with the exercise program you received?	8.35	1.64	5 – 10	8.32	1.99	3 – 10	.96
How enjoyable did you find to participate in this exercise program?	7.36	2.11	3 – 10	6.96	2.06	2 – 10	.52
How much did this exercise program help in improving how you feel during exercise?	7.91	2.17	1 – 10	7.43	2.73	1 – 10	.51

Note: Participants rated their responses on each of these questions from 0 to 10. There were no significant differences between the two groups on any of these questions.

Table 4. Participant comment themes by condition.

Categories	Themes (%)	Example
Mindfulness Condition		
Most helpful aspects of study	Accountability (39.1%)	"It held me accountable for working out."
	Pleasure (21.7%)	"The mindfulness track helped me to enjoy the moment."
	Relaxation (13.0%)	"It also showed me exercise can be a way to relax after a stressful day."
	Focus / awareness (43.5%)	"Gave me something to focus on instead of how much I don't like exercising."
	Length (8.7%)	"That the recording only lasted 30 minutes."
	Entire recording (17.4%)	"The mindful exercise"
Not useful aspects of study	Specific parts (13.0%)	"Sometimes the directions to listen or smell were odd and didn't do much for me, visual or tactile were more effective instructions."
	Difficulty (17.4%)	"It was really hard to relax/meditate while sweating/increasing my heart rate."
	Entire recording (13.0%)	"The mindfulness recording was not at all helpful."
	Lack of encouragement (8.7%)	"Did not provide any encouragement."

	None (34.7%)	"There wasn't anything that was not useful!"
Additions to the study	Variety (26.1%)	"Maybe more variety of exercises."
	Music (17.4%)	"I would have added calming music to the mindfulness recording."
	Heart rate (8.7%)	"I would like to know how the mindfulness track correlated with my heart rate."
	None (34.7%)	"Nothing."
Heart-Rate Condition		
Most helpful aspects of study	Accountability (41.7%)	"Being held accountable."
	Money (8.3%)	"The money."
	Having a goal (8.3%)	"Having a goal (150 min at a certain range heart rate)."
	Guidance on intensity (8.3%)	"The heart rate monitor allowed me to know if I was doing adequate exercise and I didn't have to push all the way just to get my exercise in."
	Heart rate monitoring (41.7%)	"Reading a heart rate."
Not useful aspects of study	Accelerometer (29.2%)	"Wearing the accelerometer."
	HR range (12.5%)	"I wonder if 124 through 147

		was the ideal range for me."
	Lack of specificity (12.5%)	"The lack of specificity in what to do during exercise was both good and bad. For someone who is not familiar with types of exercise, this could be seen as limiting."
	None (37.5%)	"All aspects were useful."
Additions to the study	Different intensity (20.8%)	"More intensive workout."
	Variety (20.8%)	"Recommendations of types of exercises to engage in other than walking."
	Diet (8.3%)	"A food plan too maybe."
	None (29.2%)	"Don't think it needed anything else."

Note: Theme percentage indicates the percentage of responses containing that theme. Some responses included more than one theme.

Table 5. Credibility / expectancy by condition.

	Mindfulness		Heart-Rate		
	M	SD	M	SD	*p*
CEQ 1: At this point, how logical does the intervention offered to you seem?	7.12	1.88	7.33	1.93	.70
CEQ 2: At this point, how successful do you think this intervention will be in increasing your exercise?	6.52	1.83	7.50	1.69	.06
CEQ 3: How confident would you be in recommending this intervention to a friend who is experiencing similar problems?	6.00	2.16	7.04	1.94	.08
CEQ 4: By the end of the intervention period, how much improvement in exercise do you think will occur?	52.80%	25.90%	40.4%	27.10%	.11
CEQ 5: At this point, how much do you really *feel* that the intervention will help you increase your exercise?	6.28	1.97	7.38	1.81	.05
CEQ 6: By the end of the intervention period, how much improvement in exercise do you really *feel* will occur?	46.80%	25.29%	44.20%	25.70%	.72
Credibility Total	6.55	1.78	7.29	1.75	.15

Expectancy Total	5.42	1.85	5.28	1.73	.79

Note: Range for CEQ items is 1 – 9, with exception of item 4 and item 6, where the range is 0-100%.

Figure 1. CONSORT Participant Flow Chart.

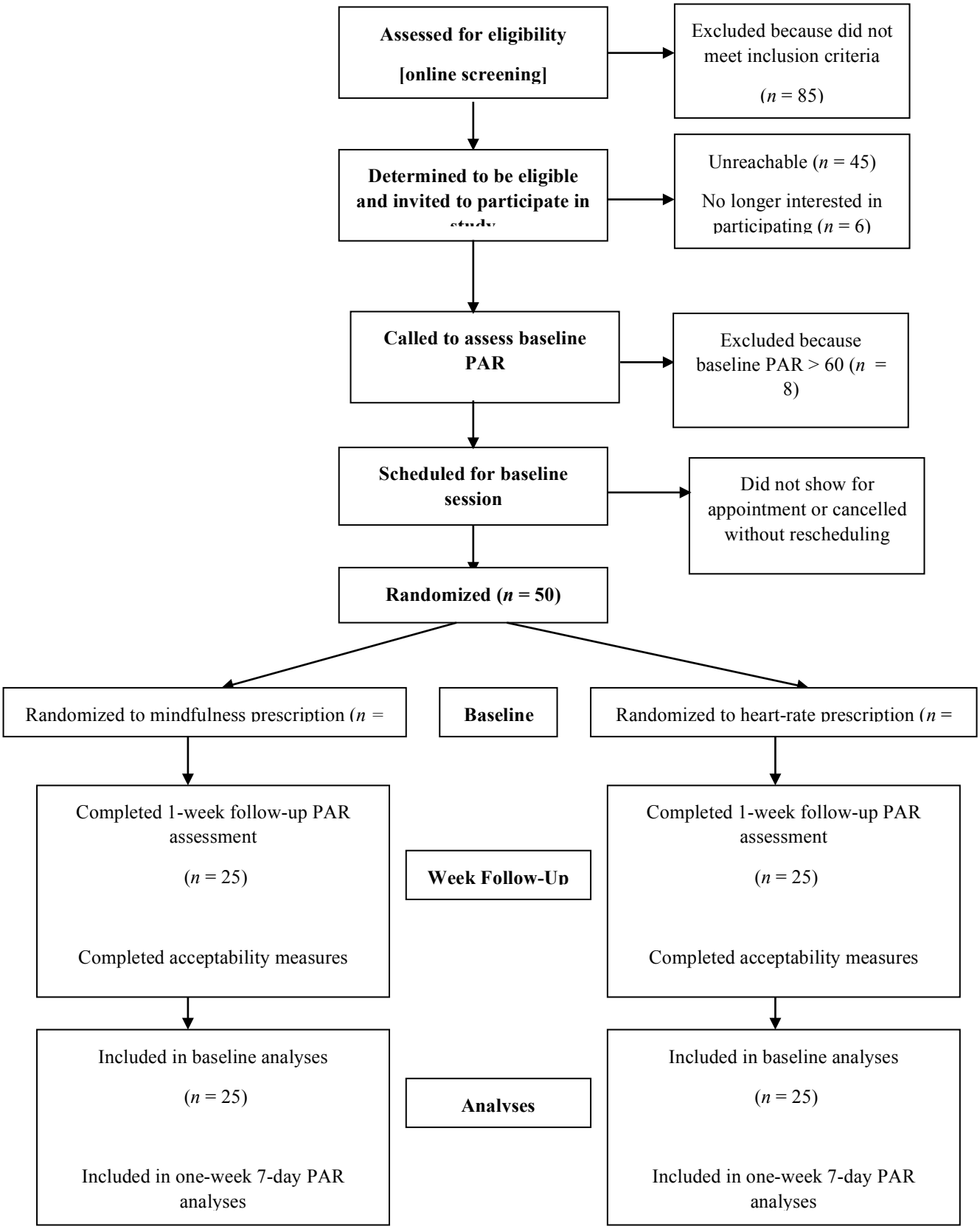
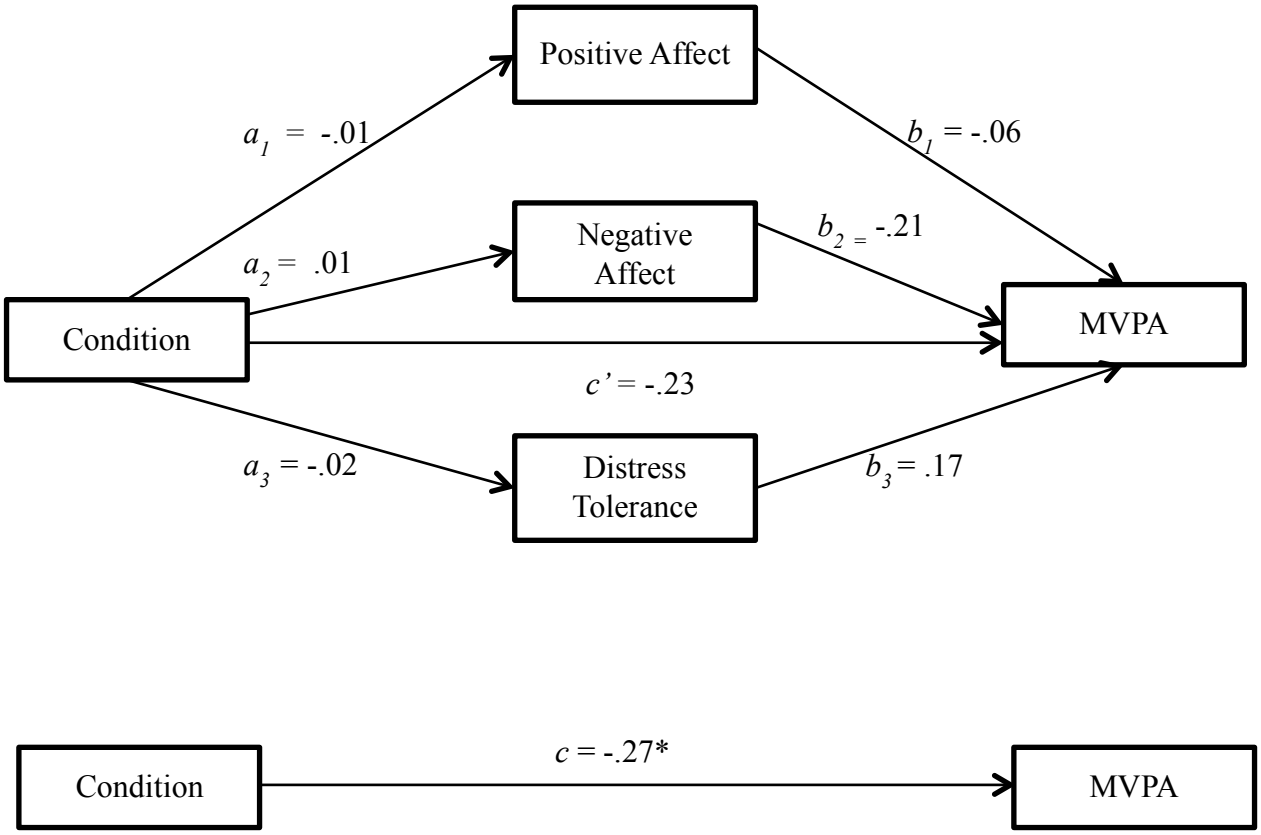


Figure 2. Mediation model.

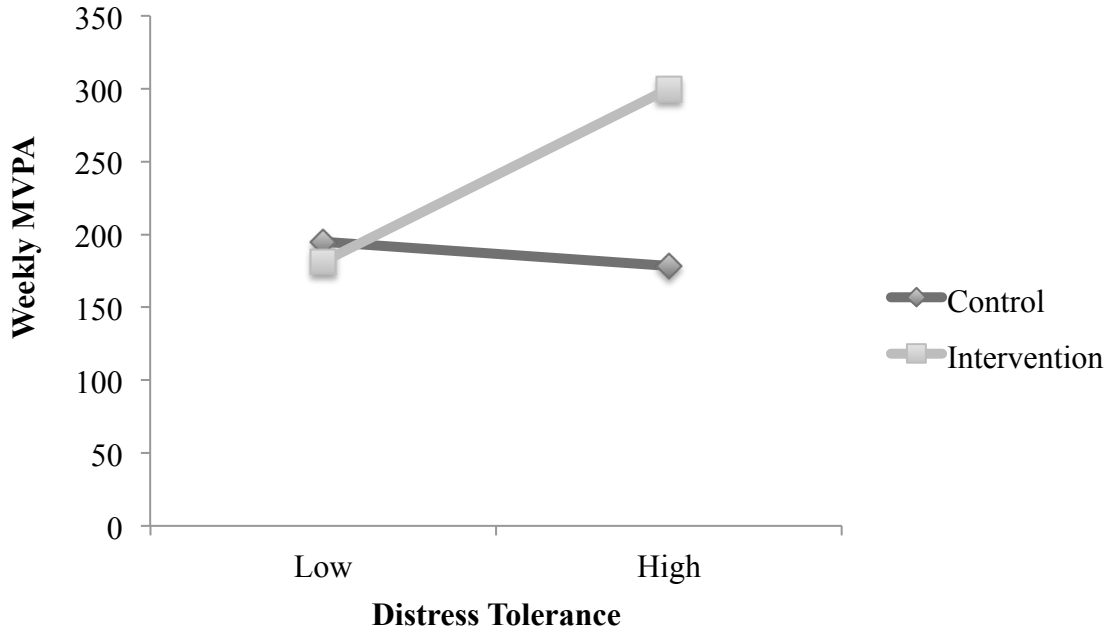


Note: * $p < .05$

Figure 3. Trait Mindfulness Moderating the Group – PAR Weekly MVPA Relation.

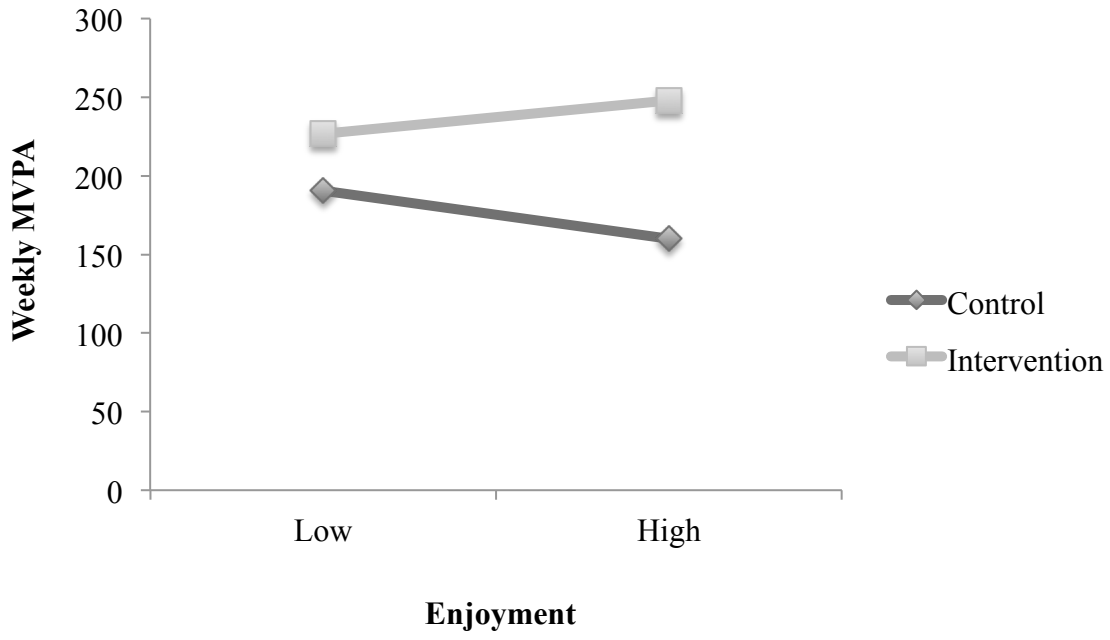
Note: PAR = Physical Activity Recall; MVPA = Moderate-to-Vigorous Physical Activity.

Figure 4. Distress Tolerance Moderating the Group – PAR Weekly MVPA Relation.



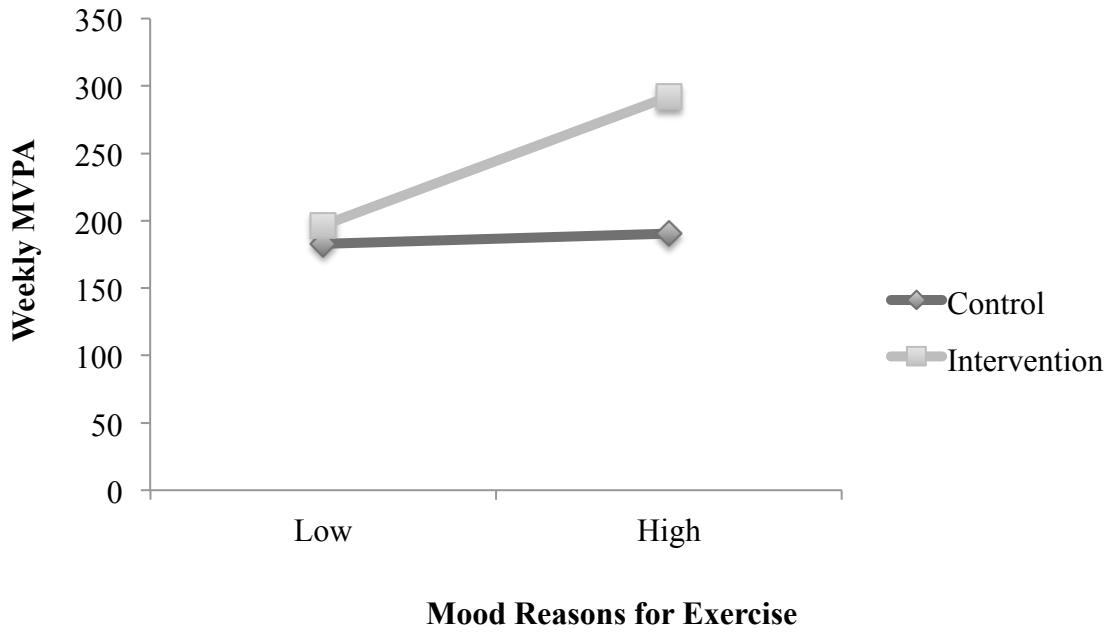
Note: PAR = Physical Activity Recall; MVPA = Moderate-to-Vigorous Physical Activity.

Figure 5. Exercise Enjoyment Moderating the Group – PAR Weekly MVPA Relation.



Note: PAR = Physical Activity Recall; MVPA = Moderate-to-Vigorous Physical Activity.

Figure 6. Mood Reasons for Exercise Moderating the Group – PAR Weekly MVPA Relation.



Note: PAR = Physical Activity Recall; MVPA = Moderate-to-Vigorous Physical Activity.

Appendix

Appendix 1. Mindfulness Intervention.

Welcome to the mindful exercise audio recording. This exercise is designed to be done while walking briskly, either on a treadmill or outside. Very often, when we are exercising, we get caught up in our thinking, in our mind. This recording is designed to get you to step out of your thinking and to help you experience the richness of your exercise session.

Throughout this exercise, you may find yourself distracted by your thoughts. This is normal. Just pause, notice what is distracting you, and bring your awareness back to the present moment. Remember that there is no right way to exercise mindfully. Sometimes your focus will wander. That is OK. It is part of the experience. The journey is more important than the destination [PAUSE 3 seconds]

Begin your exercise by acknowledging your intention to exercise. Notice any thoughts that may come up, and simply observe them. Try to do this with mindful awareness, without judging your thoughts or anything about your experience – just being fully aware of what is happening and letting it be. Please take a moment to notice any thoughts that you may have about exercising. [PAUSE 30 seconds].

Now, please take a moment to connect with your breath. Pay attention to your breathing. [PAUSE 1:57-2:12]. Often we will spend hours walking, sitting, talking, and going through our day without ever noticing our breath. But it's always with us, a constant companion throughout our day. So I invite you now to bring focus to your breath, even as you continue to exercise. Breathe naturally. Do not change the pattern of your breathing. [PAUSE 15 seconds] Feel the

cooling air as it enters your lungs, traveling through your body. Can you feel the breath flowing through your nose? [PAUSE 15 seconds]. Can you feel the rise and fall of your chest as you breathe in and out? [PAUSE 15 seconds]. As you exhale, you can let go of the stress, push it away. Release all the stress, all that's on your mind, all the chaos.
[PAUSE 30 seconds]

As you are exercising, you may notice your mind begin to wander. Thoughts may arise, trying to get your attention. You may be daydreaming, worrying, remembering, thinking. This is absolutely normal. Your mind is your body's most powerful muscle. Allow it to exercise, set it free. But, each time a thought arises, let it float by without giving it any attention, any judgments or criticism. This is may happen over 100 times, but each time gently escort your mind back to your breath. And each time you return to your breathe, congratulate yourself. You are awakening your mind by returning to the present. Stay with this pattern for a short time, noticing your breath. And if lost in thought, slowly return your focus to your breath.
[PAUSE 1 minute]

Continue to allow your breath to flow naturally and release any tension in your body. Release any tension in the top of your head. [PAUSE 15 seconds] Release any tension that you may have in your forehead or your eyes. [PAUSE 15 seconds] Release any tension in your cheeks [PAUSE 15 seconds]. Release any tension in your jaw [PAUSE 15 seconds]. Let go of the tension that's in your neck [PAUSE 15 seconds] Release any tension that's in your shoulder area [PAUSE 15 seconds]. Release any tension in your abdomen area. [PAUSE 15 seconds] Let go of the tension in your arms [PAUSE 15 seconds] Let go of any tension in your hands [PAUSE 15 seconds].

Release any tension in your legs [PAUSE 15 seconds[. Release any tension in your feet. [PAUSE 15 seconds] Just let go of all the tension in your body, let it fall away as you exercise. [PAUSE 30 seconds]

Now shift your attention to your environment. Often, we exercise buried in thoughts, so we miss the trees, the sun, and the eyes of the people who pass us by. Right now I invite you to immerse yourself in what is around you. Be aware of your location in space. The sights and sounds around you. The smells. The air temperature. Experience them fully, becoming aware of where you are. [PAUSE 20 seconds] Notice what you see. Pay attention to the present moment, without trying to be anywhere else. Notice what is going on around you. [PAUSE 20 seconds]. Notice the colors and the shapes, the movement and the stillness. What colors do you see? What textures? Are there people, buildings, or trees around you? [PAUSE 20 seconds]. Can you notice something new, something that you have never seen before? Or, if you are looking at familiar objects, can you pick up details that you have never noticed previously? [PAUSE 20 seconds]. Next, please bring your attention to the sounds around you. Even as we are exercising, we are receiving information through our ears. What do you hear? Can you hear the buzz of traffic, people talking, birds singing, or perhaps the sound of your feet hitting the ground? Without getting caught up in thinking about the objects of the sounds, just take a moment to be aware of them, as though they are just coming and going into your field of awareness. [PAUSE 20 seconds]. Please focus now on the sound closest to you. What sounds do you hear close to your body? [PAUSE 20 seconds]. Now, what sounds do you hear from a medium distance? [PAUSE 20 seconds]. And what sounds, if any, can you perceive from far away? [PAUSE 20 seconds]. Now, as you exercise, see if you can focus on a very subtle sound, a sound that you may not have

even noticed until you started paying attention to your surroundings [PAUSE 20 seconds]. Hear also the silence, the quieter space between the sounds. [PAUSE 20 seconds].

Now, I invite you to bring attention to the smells around you. What do you smell? [PAUSE, 20 seconds]. Notice how your mind might want to create a story about each smell, each sound, how it reminds you of somewhere, something…someone. Do you notice a reaction to these smells, or perhaps to the lack of smell? [PAUSE 20 seconds]. Finally, make a point of noticing any physical sensations, without the need to get involved in thinking about the feeling [PAUSE 20 seconds]. As you continue to exercise, observe what you see, hear, feel, or smell. Just acknowledge it, without thinking about it. Don't prevent any of these things from entering your field of awareness – simply notice, as they come and go, how one thing is constantly being replaced by the next.

[PAUSE 30 seconds]

Now shift your attention inward, to your body. Notice the physical sensations, how your body is moving. Your legs, your feet, your arms. [PAUSE 20 seconds]. Your body is a miracle. Enjoy it. [PAUSE 2 seconds] As you walk, notice how your body feels. Does it feel heavy or light, stiff or relaxed? [PAUSE 15 seconds] Notice your feet. How do they feel? [PAUSE 15 seconds]. Feel the contact your feet make with the ground [PAUSE 15 seconds]. Focus on your steps. Notice as you press one foot into the ground, then shift your weight, then press the other foot into the ground and step. [PAUSE 15 seconds]. Feel your legs and feet tense as you lift your leg. Feel the movement of your leg as it swings through the air [PAUSE 15 seconds]. Feel the bend of your knees as you move them [PAUSE 15 seconds]. Notice the alternating flexing and contracting of muscles in your calves [PAUSE 15 seconds]. Pay attention to your thighs

[PAUSE 15 seconds]. Pay attention to your hips. How are they moving? [PAUSE 15 seconds]. Now pay attention to your back and chest. [PAUSE 15 seconds]. Notice your lungs expanding and contracting as you breathe [PAUSE 15 seconds]. Pay attention to your arms. How are they swinging? [PAUSE 15 seconds].

As you continue exercising, allow your awareness to move up through every part of your body, noticing the sensations as you walk. Gradually scan all parts of your body as you bring your attention to your feet [PAUSE 5 seconds], ankles [PAUSE 5 seconds], calves [PAUSE 5 seconds], knees [PAUSE 5 seconds], thighs [PAUSE 5 seconds], hips [PAUSE 5 seconds], pelvis [PAUSE 5 seconds], back [PAUSE 5 seconds], stomach [[PAUSE 5 seconds], hands [PAUSE 5 seconds], arms [PAUSE 5 seconds], shoulders [PAUSE 5 seconds], neck [PAUSE 5 seconds], and head

[PAUSE 30 seconds]

Now shift to using the rhythm of the exercise as your base of awareness, a place you can mentally come back to once you realize your mind has wandered off. For example, you may choose the movement of your legs and the feelings of you feet as they come to the ground as a rhythmic sensation to come back to. Or, if you prefer, you can focus on the feeling of your arms swinging, or the feeling of your lungs expanding and contracting as you breathe.

[PAUSE 1 minute]

There's no need to focus so intently that you start to exclude everything around you. In fact, be open to things happening around you, and, when you know the mind has wandered off, just

gently bring the attention back to the movement of the body and the sensation of the soles of the feet striking the ground each time.

[PAUSE 1 minute]

In a world where we are doing so many things at a time, there's something healing and relaxing about doing just one thing at a time. So I am going to stop talking and you can just enjoy your exercise. Continue exercising mindfully as long as you wish.

Appendix 2. Acceptability Questions.

(1) *How helpful do you think this program was in increasing your exercise?*

(2) *How comfortable would you be in recommending this program to a friend who is looking to become more active?*

(3) *How likely would you be to participate in this program again for further help?*

(4) *Overall, how satisfied are you with the exercise program you received?*

(5) *How enjoyable did you find to participate in this exercise program?*

(6) How much did this exercise program help in improving how you feel during exercise?