Immediate Effects of the Mindful Body Scan Practice on Risk-Taking Behavior

Shelley R. Upton ¹ and Tyler L. Renshaw ²

¹ Louisiana State University, Department of Psychology, Baton Rouge, LA.

² Utah State University, Department of Psychology, Logan, UT.

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Correspondence should be addressed to Shelley Upton at supton3@lsu.edu.

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Abstract

Training in mindfulness has been shown to improve a variety of psychological disorders as well as physical conditions. Additionally, mindfulness training has been shown to reduce risk-taking behaviors following several weeks of training. Reducing risk-taking behaviors is of particular importance in regard to specific mental health problems, such as substance use and eating disorders. Many studies that examine the effects of mindfulness utilize training programs that are several weeks in duration. However, some evidence indicates that brief, single-use mindfulness practices can have substantial effects on changing emotion and cognition in laboratory settings. The present study examined the immediate effects of a brief, single-use mindful body scan practice on risk-taking behavior in a laboratory setting. Participants included 153 undergraduate students at a major university in the southern United States. The experimental design was a randomized trial using an active control group, which engaged in a mind-wandering exercise. Results indicated that there was no significant interaction of condition by time on scores from the state mindfulness measure or the risk-taking task, yet main effects of time were observed for both variables. Findings suggest that the brief mindful body scan practice did not differentially effect mindfulness or risk-taking compared to the mind-wandering control exercise. However, there was a small, significant correlation observed between change in state mindfulness and change in risk-taking for the full sample, suggesting a relationship between the variables of interest, albeit in the opposite direction as expected. Implications and limitations of the present study are discussed.

Keywords: mindfulness, risk-taking behavior, body scan, college students

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Mindfulness is traditionally defined as being aware of each moment as it is happening and observing that moment without judgment (Kabat-Zinn, 1994). Those who practice mindfulness are often instructed to pay attention to the sensations in their body, the emotions they feel, their thoughts, and their interactions with others and the outside world (Nhat Hanh, 2006). Components of a mindfulness practice often include exercises such as yoga, focusing on the breath, body scan meditations, and compassion meditations (Kabat-Zinn, 1990). It is important to note the distinction between mindfulness and mindfulness-based practices and exercises: the exercises are not themselves “mindfulness”—rather, they facilitate the psychological process we call mindfulness. Therapies that incorporate mindfulness-based practices (e.g., acceptance and commitment therapy, dialectical behavior therapy) and programs that are solely focused on developing mindfulness (e.g., mindfulness-based stress reduction – MBSR, mindfulness-based cognitive therapy – MBCT) have become increasingly popular in recent years as both treatments for clinical populations and as interventions for nonclinical populations (Ederth & Sedlmeier, 2012; Khoury et al., 2013a).

Research on the effects of mindfulness-based interventions in recent years has been very promising. Mindfulness training has been shown to improve overall wellbeing while reducing anxiety, chronic pain, and depression (Ederth & Sedlmeier, 2012; Khoury et al., 2013a). Mindfulness training has also been shown to have a moderate effect on more severe mental illness, such as psychosis (Khoury, Lecomte, Gaudiano, & Paquin, 2013b). While mindfulness-based interventions have largely been studied in adult populations, the available research with children and adolescents is also growing. In youth populations,

mindfulness-based interventions and therapies have been developed to target a variety of conditions and circumstances (e.g., clinical/nonclinical populations, homeless youth, chronic pain sufferers; Kallapiran, Koo, Kirubakaran, & Hancock, 2015; Ruskin, Kohut, & Stinson, 2014; Viafora, Mathieson, & Unsworth, 2015). Meta-analyses have shown that mindfulness-based interventions and therapies with youth samples can lead to improved mental health and overall wellbeing as well as reduced problem behaviors (Kallapiran et al., 2015; Kingbeil et al., 2017a; Klingbeil et al., 2017b).

Additionally, mindfulness training in school settings has been growing in popularity (Zenner, Herrnleben-Kurz, & Walach, 2014; Renshaw & Cook, 2017). These programs have led to improvements in executive functions, aggression, social problems, resilience, and stress (Flook et al., 2010; Parker, Kupersmidt, Mathis, Scull & Sims, 2014; Zenner et al., 2014). In this setting, mindfulness-based interventions are either taught by a trained mindfulness teacher who is brought into the school, or by the regular classroom teacher who has undergone a brief training in mindfulness-based practices (Parker et al., 2014; Viafora et al., 2015). Similar to MBSR and other mindfulness-based interventions with adults, mindfulness-based interventions with youth are typically conducted over a series of several weeks or months and involve a variety of mindfulness-based exercises (e.g., yoga, breathing exercises, and other meditations), along with psychoeducation (Klingbeil et al., 2017b).

Unlike many psychological treatments, which were built around extant literature, mindfulness-based treatments have mostly been adaptations from MBSR, an already formed treatment package. When MBSR was shown to have desirable outcomes, its intervention format (i.e., group-based weekly sessions) was adapted to create more specialized treatment

programs that fit particular target populations. These adapted treatments have largely demonstrated desirable outcomes (Khoury et al., 2013a); however, these programs have not been subjected to component analyses and are therefore based on several assumptions that have not been empirically validated (Klingbeil et al., 2017b; Renshaw & Cook, 2017). Among these assumptions are the need for the implementer to personally practice mindfulness in order to teach it effectively to others, and the requirement that multiple treatment sessions are necessary—consisting of several types of mindfulness-based practices—in order to obtain a therapeutic effect (Kabat-Zinn, 1990; Shonin & Van Gordon, 2015). So far, no formal research has compared the outcomes of mindfulness-based treatments between implementers who practice mindfulness daily, those who do not, and automated treatment delivery technologies, such as audio recordings (Samson & Tanner-Smith, 2015). Additionally, nuanced studies that differentiate the effectiveness of the several mindfulness-based exercises included in each treatment package are rare (e.g., mindful breathing versus loving-kindness meditation; Feldman, Greeson, & Senville, 2010). Examining the immediate effects of mindfulness-based exercises within a controlled lab setting—as opposed to the cumulative effect of mindfulness training over a period of weeks or months—is thus a worthwhile scientific endeavor, as it allows researchers to investigate the traditional assumptions of mindfulness-based treatments (e.g., highly-trained interventionist, several sessions, multiple types of practices) for the purposes of optimizing intervention for both clients and clinicians.

To date, only a few studies exist that have examined the immediate effects of mindfulness training in an experimental lab setting. One study by Ostafin and Kassman (2012) examined how a single-use mindfulness induction—the mindful body scan practice—may

impact individual's ability to solve insight problems (e.g., problems that are not solvable through a series of steps, but rather an "Aha!" moment). The authors theorized that mindfulness may facilitate cognitive restructuring of the problem (i.e., looking at the problem differently to avoid getting stuck) and thus allow individuals to solve the problems more effectively. Results from this study showed that mindfulness induction in a lab setting led to participants solving more insight problems and that this relationship was mediated by participants' level of state mindfulness (Ostafin & Kassman, 2012). Additionally, Cropley, Ussher, and Charitou (2007) investigated the effects of a single-use lab induction of mindfulness—again using the mindful body scan practice—on participants' urge to smoke. Findings from this study showed that the mindfulness induction immediately reduced participants' urge to smoke in abstinent smokers, compared to a control group. Those in the mindful body scan group also reported decreased irritability, tension, and restlessness (Cropley et al., 2007).

Another laboratory-based study explored how mindfulness may pose some immediate disadvantages when recalling memories (Wilson, Mickes, Stolarz-Fantino, Evrard, & Fantino, 2015). Participants first completed the Deese-Roediger-McDermott (DRM) paradigm, a widely used task for assessing one's susceptibility to creating false memories. Following, participants listened to a mindfulness meditation or mind wandering (control) audio, and then they completed the DRM paradigm again. Results showed that those in the mindfulness meditation group were more likely to create false memories after listening to the mindfulness induction than those in the control group. A subsequent study, also reported in Wilson et al. (2015), showed that those who listened to the mindfulness audio performed significantly worse in a

reality-monitoring paradigm. The researchers posit that this may be because mindfulness meditations instruct listeners to suspend judgment of thoughts and feelings, thus making it more difficult to discern whether a memory was fabricated or real (Wilson et al., 2015).

Taken together, the above lab-based studies show that single-use mindfulness-based practices can have an immediate effect on cognitive and psychological functioning, without participating in a multi-week intervention program (e.g., MBSR, MBCT), without receiving the manipulation from a highly-trained interventionist, and without engaging in multiple types of mindfulness-based practices. These studies provide initial evidence contradicting the assumptions regarding the delivery of traditional mindfulness-based treatments (described above) and suggest that the immediate effects of mindfulness may not be universally beneficial, but rather task-dependent. The practical upshot of this line of research is that evidence might be used to inform which mindfulness-based exercises could be utilized in a more targeted and feasible fashion, without the need for extensive training or resources. Because programs such as MBSR, MBCT, and MBRP incorporate many different elements and are used for numerous presenting problems (Khoury et al., 2015; Klingbeil et al., 2017b), differential effects of the many components of these treatment packages are not well known and warrant refinement. Evidence from these brief lab studies suggests, however, that participants with particular presenting problems may need to only practice one mindfulness-based exercise in order to glean the necessary therapeutic benefits (Cropley et al., 2007; Wilson et al., 2015). Although there are many potential therapeutic targets that could be explored in laboratory-based settings, the purpose of the present study is to investigate the immediate effects of a mindfulness-based exercise on risk-taking behavior.

Risk-taking behaviors are a key clinical component of several psychological disorders outlined in the *Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition* (DSM-5), including attention-deficit/hyperactivity disorder (ADHD), bipolar disorder and related disorders, binge-eating disorder, intermittent explosive disorder, conduct disorder, antisocial personality disorder, borderline personality disorder, and substance-related and addictive disorders (DSM-5; American Psychiatric Association, 2013). Risk-taking behaviors have been shown to develop in early childhood, as elementary-school age youth display intentions to use alcohol or other substances (van der Vorst, Schuck, Engels, & Hermans, 2014). Risk-taking behaviors may develop for numerous reasons, and meta-analyses have shown that males are more likely to engage in risk-taking behaviors than females. However, patterns of risk-taking differ across age and context (Byrnes, Miller, & Schafer, 1999). Risk-taking behaviors can lead to a host of deleterious consequences, including patterns of behavior characteristic of the psychological disorders listed above as well as physical injury to self and others (Turner, McClure, & Pirozzo, 2004).

Some preliminary correlational findings suggest that mindfulness may play a role in mediating risk-taking behaviors. Trait mindfulness, which is conceptualized as an individual's general mindful state, has been inversely associated with numerous problem behaviors, including risk-taking frequency and severity (Brown & Ryan, 2003; Lakey, Campbell, Brown, & Goodie, 2007). Higher levels of trait mindfulness have also been shown to be a protective factor for smoking during adolescence (Black, Sussman, Johnson, & Milam, 2012). Research has also shown that trait mindfulness is negatively correlated with drinking behaviors (Reynolds, Keough, & O'Connor, 2015) and that lower levels of trait mindfulness (e.g., not acting with

awareness, reactivity, being judgmental) are associated with more severe levels of substance use disorders (Levin, Dalrymple, & Zimmerman, 2014).

Beyond correlational research, mindfulness-based therapies have shown utility for reducing risk-taking behaviors. Notably, dialectical behavior therapy (DBT) was developed specifically to treat disorders characterized by risk-taking (Linehan, 1993). DBT, considered a “third wave” behavior therapy, incorporates mindfulness-based exercises that target suicidal behavior in individuals diagnosed with borderline personality disorder. Meta-analyses that examine the efficacy of DBT have shown that the treatment substantially improves suicidal and self-injurious behaviors (Panos, Jackson, Hasan, & Panos, 2014). Beyond DBT as a general therapeutic approach, a study by Hendrickson and Rasmussen (2013) demonstrated that a single mindfulness-based practice—mindful eating—can reduce risk-taking behavior in obese individuals, who have a higher propensity for risk-taking. Meta-analyses confirm that other mindfulness-based treatments have moderate to large effects on binge eating behaviors (Godfrey, Gallo, & Afari, 2015). Training in mindfulness has also been shown to improve externalizing behaviors, such as those related to ADHD and conduct disorder, which are often characterized by high levels of risk-taking (Bogels, Hoogstad, van Dun, de Schutter, & Restifo, 2008). Additionally, newer research investigating mindfulness-based addiction treatment (MBAT) shows that it may be more effective than traditional cognitive-behavior therapy at treating addiction, which is strongly characterized by risk-taking behaviors (Vidrine et al., 2016). Taken together, these correlational and experimental findings suggest an empirical relationship between mindfulness and broad risk-taking. Yet it is notable that evidence for these intervention effects are all observed at the cumulative level (i.e., after several weeks or months

of treatment), and thus the immediate effects of mindfulness-based exercises on risk-taking behavior is currently unknown.

The purpose of the present study was to examine the immediate effects of a single-use mindful body scan exercise—administered via audio recording—on analog risk-taking behavior within a lab setting. Participants completed self-report measures of state and trait mindfulness and a behavioral measure of risk-taking, were randomly assigned to listen to a 10-minute mindful body scan or control audio recording, and then completed the self-report and behavioral measures once more. Changes in risk-taking behavior and their relation with changes in state and trait mindfulness were analyzed. It was hypothesized that participants in the mindful body scan condition would show greater reductions in risk-taking behavior compared to the control group, and that changes in risk-taking would be mediated by changes in state mindfulness but not trait mindfulness. Ultimately, the present study was intended as a preliminary step toward informing future experimental research investigating the immediate effects of mindfulness on risk-taking behavior.

Method

Participants

Participants were enrolled in undergraduate psychology courses at a major university in the southern United States and signed up for the study using the Psychology Department's online research participation management system. A total of 153 undergraduate students participated in this study, and each received partial course credit for participation. An a priori power analysis indicated that, with an estimated effect size of $d = 0.38$ (Wilson et al., 2015), 87 participants were needed in each group to obtain a power of 0.80. The final sample had 76

participants in the body scan meditation group and 77 participants in the mind wandering group. The original goal of 174 participants was not met due to time constraints, yet was deemed close enough to produce at least adequate statistical power. Informed consent and demographic information were obtained from each participant. The study participants were 76.47% female. Participants were also 74.51% white, 16.34% black or African-American, 5.88% Asian, 0.65% American Indian/Alaskan Native, and 2.61% were of other races. Of the total sample, 7.91% of the participants identified as Hispanic. The age of participants ranged from 18 to 60 years, with a mean of 19.87 years. The sample was 45.1% freshmen, 26.14% sophomores, 12.42% juniors, and 16.34% seniors.

Procedure

A trained researcher met with each participant in a one-on-one laboratory setting to describe the study, answer any questions, and obtain informed consent. Following the consenting procedure, participants filled out preliminary questionnaires, including trait and state mindfulness measures (described below), and then began the computer-based analog risk-taking task (described below). Once the participants completed the risk-taking task, they were randomly assigned to either the mindfulness induction condition or the control condition (described below).

To ensure random assignment with roughly equal groups, the researcher made 174 slips of paper beforehand wherein 87 were labeled “control” and the other 87 were labeled “experiment.” When the time came for the participant to be assigned, the researcher selected a random slip of paper from an envelope. The participant then listened to the audio recording based on their condition assignment. The participants in the mindfulness condition listened to a

brief, 10-minute version of the mindful body scan practice. This audio-guided practice instructs listeners to be mindful of certain focal points in the body. The original body scan used in MBSR is 45 minutes long (Kabat-Zinn, 1990). As mentioned above, a shorter version of the body scan practice has been shown to produce immediate psychological effects in other laboratory-based studies (Cropley et al., 2007; Hamilton, Fawson, May, Andrade, & Kavanagh, 2013; Ussher et al., 2014), which is why it was selected for use in the present study. Participants in the control condition listened to a 10-minute mind-wandering audio recording in which they were instructed to think about “whatever comes to mind”. Also mentioned above, research has shown that mind wandering produces no therapeutic effects when used as the control condition in other mindfulness-based laboratory studies (Wilson et al., 2015), which was the reason for selecting it for control purposes in the present study.

The audio recordings used for this study were created by Dr. Marilee Bresciani Ludvik. The mind-wandering audio is the same as used in the study conducted by Wilson et al. (2015). The body scan audio—although not the same audio used in the cited research—was similar in length and recorded by the same person. A copy of the audio recordings used in both conditions is freely available via the first author. Following the experimental induction, the participants filled out the state and trait mindfulness questionnaires again, and then completed the computer-based analog risk-taking task once more. The session ended with further post-experiment questionnaires (e.g., demographics). The entire experiment, including consenting through debriefing, lasted approximately 45 minutes.

Measures

Risk-taking behavior. Level of risk-taking behavior was assessed using the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). In the BART, each participant is presented with a balloon and is instructed to pump up the balloon using a button on the screen. With each pump of the balloon, the participant earns money; however, the balloon will over inflate and explode at a threshold unknown to the participant, which results in a loss of all money earned, and thus each pump of the balloon also increases the risk of popping the balloon and losing money. The participant may choose at any point to cash out and collect the money, but if the balloon explodes, the participant loses all money earned during that trial. Analog risk-taking is therefore measured by the average number of pumps on unexploded balloons, with higher averages indicative of increased risk-taking propensity. The optimal number of pumps per balloon is 64—thus, if each participant pumped each balloon 64 times, they would maximize the amount of money earned for the task. Participants completed 20 trials (i.e., they pumped 20 balloons) of the BART at both pre-test and post-test. In previous studies using the BART, participants were given the exact money that they earned. Due to monetary constraints in the present study, however, participants did not receive this exact financial compensation. Rather, participants were informed at the outset of the task that they would be ranked based on their overall performance, which was evaluated by number of pumps and total money earned, and that the top 25 participants from the study would be entered into a \$20 gift-card drawing, from which there would be three winners. Therefore, participants' performance was incentivized by the possibility of obtaining a larger sum of money, not by the actual amount of money indicated by their BART performance. For the purposes of the present study, the BART was

conceptualized as the dependent outcome variable, as it was hypothesized that the mindful body scan exercise would produce immediate reductions in analog risk-taking behavior.

State mindfulness. The State Mindfulness Scale (SMS; Tanay & Bernstein, 2013) was used to assess the current levels of state mindfulness in participants across conditions. This self-report scale consists of 21 items, has demonstrated good internal reliability (Cronbach's $\alpha = .94$ at both pre- and post-test in the present study), and has been used in several studies to assess state mindfulness in adult samples. When completing the SMS, participants answer questions based on their experiences in the past 10-15 minutes that are suggestive of mindful behavior. Sample items include, "I noticed thoughts come and go" and "I felt aware of what was happening inside of me." Participants respond to each item using a 5-point Likert-type scale (1 = *not at all* to 5 = *very well*). In the present study, the SMS was conceptualized as a dependent process variable, as it was hypothesized that the mindful body scan exercise would produce immediate increases in state mindfulness, and that these changes would be the therapeutic mechanism that mediated reductions in analog risk-taking behavior.

Trait mindfulness. The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was used to assess the level of trait mindfulness in each participant across both conditions. This self-report scale consists of 15 items, has demonstrated good internal reliability (Cronbach's $\alpha = .85$ at pre-test and $.88$ at post-test in the present study), and has been used in numerous studies to assess trait mindfulness in adult samples. When completing the MAAS, participants answer questions based on their average, day-to-day experiences that are suggestive of a lack of mindfulness. Sample items include, "I drive places on 'automatic pilot' and then wonder why I went there" and "I snack without being aware that I'm eating." Participants responded to each

item using a 6-point Likert-type scale (1= *almost always* to 6 = *almost never*). Given that trait mindfulness was not expected to change as a function of the single-use mindful body scan practice, the MAAS was used in the present study as secondary process variable, for the purposes of allowing a manipulation and validity check on the state mindfulness measure.

Data Analyses

Differential changes in analog risk-taking behavior, operationalized by changes in BART scores, between the experimental conditions were examined via analyses of variance (ANOVA). The same analytic approach was also used to analyze changes in state and trait mindfulness. To compliment these analyses, Bayes factors were also conducted to determine the probability of the data fitting under the null hypothesis with the probability of fitting under the alternative hypothesis. Before the primary statistical analyses were run, pre-induction differences on the outcome (BART) and process (SMS and MAAS) variables were examined. If pre-induction differences were identified, then analyses of covariance (ANCOVA) would be run using relevant baseline scores as covariates. Given no pre-induction differences were found, however, primary analyses were conducted using repeated-measures one-way ANOVA. Following the examination of group differences, the relationships between changes in the outcome and process variables was examined by calculating change scores (Time 2 – Time 1) for all variables and conducting bivariate correlations between these scores. Changes score correlations were intended as a preliminary analysis of possible mediation, to explore the relationship between movement in process and outcome variables between time points. If a significant and meaningful relationship would have been observed between state mindfulness and risk-taking propensity, then a path analysis would have been conducted using AMOS to investigate the

potential mediating relations between changes in state and trait mindfulness and changes in risk-taking behavior. However, these additional analyses were ultimately deemed unnecessary, given the results from earlier analyses. All analyses of variance and correlations were conducted using SPSS version 24, while the Bayesian analyses were conducted using JASP Statistics Software (<https://jasp-stats.org/>).

Results

Descriptive statistics were examined for the overall sample and each experimental condition at both time points (see Table 1). All study variables were relatively normally distributed and characterized by adequate internal consistency at Time 1 and Time 2. ANOVA were run to determine any pre-induction differences on both outcome and process variables. There were no significant differences found between conditions on state mindfulness, $F(1, 151) = 2.43, p = .12$, trait mindfulness, $F(1, 151) = .11, p = .75$, or BART scores, $F(1, 151) = .81, p = .37$ at Time 1, and thus ANCOVA was deemed unnecessary. Bivariate correlations were also run for all study variables at each time point to explore the directionality and magnitude of relationships both pre- and post- induction (see Table 2). A small, positive correlation between MAAS scores and SMS scores was observed at both pre-test ($r = .34$) and post-test (also $r = .34$), whereas a small, negative correlation was observed between pre-test BART scores and post-test SMS scores ($r = -.18$). Findings for all other correlations were negligible (see Table 2).

A series of repeated-measures one-way ANOVA were run using Time 1 and Time 2 scores from the BART, SMS, and MAAS. Group sizes were roughly equal for each analysis, with 76 participants in the mindful body scan condition and 77 participants in the mind wandering condition. Several univariate outliers were detected after converting the dependent variables

into z-scores; however, these scores were not excluded from the analyses because they were likely indicative of credible response patterns. Levene's test of error variances was non-significant and Box's test of covariance matrices was also non-significant, suggesting both homogeneity of variance and covariance. The assumption of linearity was met as there were no curvilinear relationships detected.

For the outcome dependent variable, ANOVA findings indicated that there was no significant interaction of BART score and condition over time, $F(1, 151) = 0.09, p = .77, \eta_p^2 = .001$. There was, however, a significant main effect of time characterized by a small effect size, $F(1, 151) = 7.65, p < .01, \eta_p^2 = .05$, suggesting both groups' risk-taking behavior increased slightly from pre-test to post-test (see Figure 1). Given the lack of interaction effects, no post-hoc comparisons were conducted. However, comparing the effect of time to the null hypothesis, the calculated Bayes factor (null/alternative) indicated that the data are 1/4.42 in favor of the alternative hypothesis—meaning that the data are 4.42 times more likely to occur in a model that includes time than in a model that does not include time. Comparing the effect of time by condition to just the main effects, the calculated Bayes factor (interaction/main effects) indicated that the data are 0.19/1 in favor of the model with only the main effects—meaning that the data are 5.26 times more likely to occur in a model that only includes main effects than in a model that also includes the interaction. Thus, the Bayesian analysis provides further evidence against the presence of an interaction effect.

For the process dependent variables, ANOVA findings showed no significant interaction of SMS score and condition over time, $F(1, 151) = 1.31, p = .25, \eta_p^2 = .009$. However, there was a significant main effect of time characterized by a large effect size, $F(1, 151) = 25.15, p < .01$,

$\eta_p^2 = .14$. These data were further examined using Bayesian analyses. Comparing the effect of time to the null hypothesis, the calculated Bayes factor (null/alternative) indicated that the data are 1/8416.46 in favor of the alternative hypothesis—meaning the data are over 8000 times more likely to occur in a model that includes time than in a model that does not include time. Comparing the effect of time by condition to just the main effects, the calculated Bayes factor (interaction/main effects) indicated that the data are 0.31/1 in favor of the model with only the main effects—meaning that the data are 3.23 times more likely to occur in a model that only includes main effects than in a model that also includes the interaction. Similarly, there was no significant interaction of MAAS score and condition over time, $F(1, 151) = .50, p = .48, \eta_p^2 = .003$, yet there was a significant main effect of time characterized by a large effect size, $F(1, 151) = 47.06, p < .01, \eta_p^2 = .24$. Again, these data were examined using Bayesian analyses. Comparing the effect of time to the null hypothesis, the calculated Bayes factor (null/alternative) indicated that the data are $1/5.037 \times 10^7$ in favor of the alternative hypothesis—meaning that the data are over 50 million times more likely to occur in a model that includes time than in a model that does not include time. Comparing the effect of time by condition to just the main effects, the calculated Bayes factor (interaction/main effects) indicated that the data are 0.22/1 in favor of the model with only the main effects—meaning that the data are 4.55 times more likely to occur in a model that only includes main effects than in a model that also includes the interaction. Taken together, these findings suggest both groups' mindfulness scores substantially changed over time, with trait mindfulness decreasing and state mindfulness increasing, but that this change was not a product of condition.

Considering the presence of main effects for time and the lack of interaction effects observed via ANOVA, change scores (Time 1–Time 2) for both the outcome (BART) and process (SMS and MAAS) variables were calculated and bivariate correlations were run using the overall sample. The intention of this analysis was to evaluate the association of changes in the process and outcome variables over time for all participants, as the ANOVA and Bayesian findings indicated meaningful pre–post changes across both conditions. Results from these correlations indicated a small but significant association between the change in state mindfulness (SMS Δ) and the change in risk-taking behavior (BART Δ ; $r = .18, p = .03$), which was in contrast to a lack of significant correlation between these scores at either time point (see Table 2). The correlation between change in state mindfulness (SMS Δ) and change in trait mindfulness (MAAS Δ) was statistically negligible ($r = -.06, p = .46$), as was the correlation between change in trait mindfulness (MAAS Δ) and change in risk-taking behavior (BART Δ ; $r = .04, p = .63$), which was similar to the correlations observed at both time points (see Table 2). Taken together, these findings provide marginal evidence to suggest that changes in state mindfulness, but not trait mindfulness, are related to changes in risk-taking behavior across conditions, albeit in the opposite direction as expected. Given the lack of interaction effects noted earlier as well as the marginal relationships observed via correlations in change scores, further analyses testing the potential mediating role of changes in state mindfulness on changes in risk-taking behavior were deemed unnecessary.

Discussion

The purpose of this study was to examine the effect of the mindful body scan practice on risk-taking behavior in a lab setting. Risk-taking behavior is a key component of several

psychological disorders, and several mindfulness-based interventions have been shown to successfully reduce this type of behavior. Previous studies in this line of research involve practicing mindfulness over time (e.g., one three-hour class per week for 8 weeks, with daily practice), whereas this study aimed to understand the potential immediate effects of the mindful body scan practice on an analog risk-taking task. Previous studies also primarily used self-monitoring or behavior rating scale methods as outcome measures of risk-taking, whereas the present study used a computer-administered, performance-based behavioral measure (i.e., BART). Participants completed pre-test measures of state and trait mindfulness and the BART paradigm, were randomly assigned to listen to the mindful body scan audio or a mind wandering audio (control), and then completed post-test versions of the BART and mindfulness measures. It was hypothesized that participants in the mindful body scan condition would show greater reductions in risk-taking behavior compared to the control group, and that changes in risk-taking would be mediated by changes in state mindfulness but not trait mindfulness. However, findings generally failed to support these hypotheses.

Results from repeated-measures one-way ANOVA demonstrated that there was no effect of condition on participants' BART scores, and this was further supported by the resulting Bayes factor. Both groups had significantly increased BART scores at post-test—indicating gains in risk-taking propensity—however, there was no interaction effect, which suggests this change was not attributable to the unique elements of the mindful body scan exercise. It may be that participants became more skilled at completing the task to maximize payout; however, the participants' average scores were far from the optimal number of 64 pumps. Furthermore, results indicated that participants in the mindful body scan condition did not experience an

increase in state mindfulness over and above those in the mind wandering (control) condition, yet a large main effect of increased state mindfulness was observed across groups, which was further supported by the resulting Bayes factor. This suggests that the mindful body scan audio used in this study did not uniquely influence state levels of mindfulness, and thus observed changes in state mindfulness must be accounted for by some other factor beyond those that are distinctive to the body scan practice itself. That said, there was a small, significant positive correlation between the change ($T2 - T1$) in state mindfulness and the change ($T2 - T1$) in risk-taking behavior for the total sample. This finding is notable, given there was no initial correlation between levels of state or trait mindfulness and performance on the BART. There was also no interaction effect observed for condition and trait mindfulness as well as no correlation observed between changes in trait mindfulness and changes in risk-taking propensity, which was expected. Thus, although the experimental hypothesis regarding between-group differences in risk-taking changes was not supported, marginal support was evidenced for the relationship between changes in state mindfulness and changes in risk-taking behavior. Yet this relationship was contrary to our hypothesis, as increases in state mindfulness were actually slightly associated with increases in risk-taking.

Limitations and Future Directions

There are a few noteworthy limitations of the current study. First, the mindful body scan audio did not make participants significantly more mindful than the mind wandering audio. It is therefore possible that this audio—which is a shortened version of the regular 45-minute body scan—was not long enough to effect a meaningful change in level of mindfulness. The body scan audio used for the current study was 11 minutes long, and thus future studies might

explore how the length of mindfulness-based exercises differently effects state mindfulness scores. Previous research looking at the effect of mindfulness exercises on state mindfulness has primarily examined the influence of multiple sessions over time (Hadash, Segev, Tanay, Goldstein, & Bernstein, 2016; Shoham, Goldstein, Oren, Spivak, & Bernstein, 2017; Tanay & Bernstein, 2015). The lengths of these mindfulness-based practices are similar to those used in popular therapies, such as MBSR and MBCT, that are the mainstay of clinical interventions (Khouri et al., 2013a). Furthermore, there is a possibility that the measure of state mindfulness used in the present study (SMS) may not be particularly sensitive to change, and therefore potential changes in state levels of mindfulness may have gone undetected. Previous studies using the SMS have looked at how scores change over time, but not within a single laboratory session (Hadash et al., 2016; Shoham et al., 2017; Tanay & Bernstein, 2015). Thus, further research could examine how responses to the SMS change depending on the type of audio one is listening to (i.e., mind wandering, relaxation, mindfulness-based meditation) and how quickly such changes can be observed. Finally, it is also possible that the participants were not genuinely engaged with the particulars of the audio-based exercises. Participants were told to “follow along with the relaxation audio”—however, it may have been necessary to give them more explicit directions to facilitate effective engagement with the audio recording (e.g., telling them to close their eyes or look down at their hands, or relax their posture). Further research might therefore examine how priming a mindfulness-based audio impacts its therapeutic effectiveness.

Given the findings and limitations of the present study, we suggest that future studies are needed to investigate the relationship between mindfulness and risk-taking behavior using

alternate methods. Previous research has shown that higher levels of mindfulness are related to reduced risk-taking behaviors, such as smoking, binge-eating, and alcohol use (Black et al., 2012; Copley et al., 2007; Reynolds et al., 2015). Several treatment studies have also shown that mindfulness-based interventions reduce risk-taking behavior (Hendrickson & Rasumussen, 2013; Panos et al., 2014). Yet findings from the present study suggest that changes in risk-taking were not attributable to the unique elements of the mindful body scan, and that there was actually a small positive association between changes in state mindfulness and changes in risk-taking across conditions. Future research is therefore warranted to better understand this phenomenon. As discussed above, experimental research regarding the immediate effects of mindfulness-based practices and risk-taking propensity is lacking, and empirical probes are needed to determine which components of mindful practices are the most salient in affecting risk-taking behavior. Given this study employed the use of just one mindfulness-based exercise (i.e., mindful body scan), it is possible that other practices (e.g., mindful breathing or mindful eating) may yield differential immediate effects. It is not currently known which unique mindfulness-based practices affect risk-taking—or whether it is a combination of several practices. It is also possible that it is not the content of the practices themselves but rather the implementation parameters along which the content is delivered (e.g., dosage and training of treatment provider) that moderate effectiveness (Klingbeil et al., 2017b). The current lack of rigorous component analyses in the mindfulness literature preclude the knowledge of how exactly mindfulness-based interventions work to reduce certain problem behaviors (Levin, Hildebrandt, Lillis, & Hayes, 2012; Roemer & Orsillo, 2003), yet this scientific

knowledge is sorely needed to optimize the use of mindfulness for practical purposes (Renshaw, 2017).

Interestingly, this study found that the mindful body scan audio and the mind wandering audio did not differentially affect state mindfulness or risk-taking propensity. Previous studies, however, found that mind wandering produced no therapeutic effects, while a mindfulness-based meditation did show immediate expected effects (Wilson et al., 2015). It is noteworthy that the previous research comparing these two exercises did not use the SMS or any measure of state mindfulness. The SMS consists of 21 items and, thus, it is possible that reading multiple questions primed the participants to be more mindful than they would have otherwise been while attending to the subsequent audio exercise, no matter the content (i.e., body scan vs. mind wandering). In order to investigate this potential unintended priming effect of the SMS, another study would need to be conducted wherein one-third of participants are randomly assigned to a passive control group and do not listen to any audio recording. Given the passive control condition would still complete the same measures at pre-test and post-test, analyses could be conducted to determine if increases in state mindfulness and increases in risk-taking were a function of measurement-only or audio-recording manipulation.

Additional research is also needed to further understand whether mindfulness-based practices can be effectively implemented via automated treatment delivery technologies, as opposed to in-person instructors. Although many scholars in this area recommend having an experienced teacher—who also practices mindfulness—to implement mindfulness-based practices (e.g., Kabat-Zinn, 1990), this assumption has yet to be experimentally examined. This study employed the use of a brief, pre-recorded audio and found that it had no differential

impact on risk-taking behavior compared to an active control condition. It may be that more practice with the help of a teacher is needed to effectively influence propensity for risk-taking via mindfulness. However, previous research has shown that mindfulness-based practices can be effective without others' involvement (Fish, Brimson, & Lynch, 2016) or with very minimal involvement (Klingbeil et al., 2017b). Further research is therefore needed to parse out the parameters related to efficiently implement mindfulness-based practices and maximize their effectiveness (Roemer & Orsillo, 2003), and this is likely best accomplished via laboratory settings that offer strong control over manipulations in intervention and measurement parameters. Finally, given the BART paradigm is only one measure for assessing risk-taking behavior, it is possible that the null findings observed herein are measure dependent. To rule out this possibility, future studies could probe the immediate effects of mindfulness on risk-taking behavior using both the BART and other common risk-taking measures, such as self-report behavioral rating scales (e.g., Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005).

Compliance with Ethical Standards

Conflict of interest: The authors declare no conflict of interest.

Funding: No funding was received to support the present research.

Ethical approval: All procedures involving human participants in this study were conducted in accordance with the ethical standards of the authors' institutional research committee at Louisiana State University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained for all individual participants included in the study.

Author Contributions

SU: designed and implemented the experiment, analyzed the data, as well as wrote up the majority of the manuscript. TR: aided in the design of the study, interpretation of the analyses, and made edits to the manuscript.

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Table 1

Descriptive Statistics for All Study Variables

	Pre-test			Post-test		
	<i>M (SD)</i>	Skew.	Kurt.	<i>M (SD)</i>	Skew.	Kurt.
Overall Sample						
MAAS	3.69 (.72)	0.42	0.3	3.48 (.79)	0.49	0.23
SMS	3.12 (.82)	0.003	-0.55	3.45 (.78)	-0.41	-0.45
BART	36.70 (14.22)	0.12	0.004	38.97 (13.24)	0.15	0.04
Mindfulness Condition						
MAAS	3.67 (.67)	0.65	1.19	3.49 (.73)	0.55	0.65
SMS	3.23 (.83)	-0.12	-0.59	3.63 (.74)	-0.49	-0.05
BART	35.66 (14.06)	0.07	-0.39	38.17 (12.71)	-0.02	0.13
Control Condition						
MAAS	3.71 (.77)	0.24	-0.2	3.48 (.85)	0.46	-0.04
SMS	3.02 (.79)	0.11	-0.36	3.28 (.78)	-0.34	-0.75
BART	37.74 (14.40)	0.23	0.38	39.77 (13.78)	0.25	-0.05

Note. MAAS = Mindful Attention Awareness Scale; SMS = State Mindfulness Scale; BART = Balloon Analogue Risk Task (i.e., number of pumps).

Table 2

Bivariate Correlations for All Study Variables at Both Time Points

	Pre-test			Post-test		
	MAAS	SMS	BART	MAAS	SMS	BART
Pre-test						
MAAS	1	.34**	-0.06	.88**	0.09	-0.03
SMS		1	-0.08	.34**	.48**	-0.11
BART			1	-0.04	-0.18*	0.73**
Post-test						
MAAS				1	0.09	0.01
SMS					1	-0.08
BART						1

Note. MAAS = Mindful Attention Awareness Scale; SMS = State Mindfulness Scale; BART = Balloon Analogue Risk Task (i.e., number of pumps).

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

Figure 1

Profile Plot of Time Main Effect

Note. Error bars represent standard errors.