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Brief Mindfulness Meditation Training Reduces Mind Wandering: The Critical Role of Acceptance

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Mindfulness meditation programs, which train individuals to monitor their present-moment experience in an open or accepting way, have been shown to reduce mind wandering on standardized tasks in several studies. Here we test 2 competing accounts for how mindfulness training reduces mind wandering, evaluating whether the attention-monitoring component of mindfulness training alone reduces mind wandering or whether the acceptance training component is necessary for reducing mind wandering. Healthy young adults ($N = 147$) were randomized to either a 3-day brief mindfulness training condition incorporating instruction in both attention monitoring and acceptance, a mindfulness training condition incorporating attention monitoring instruction only, a relaxation training condition, or an active reading-control condition. Participants completed measures of dispositional mindfulness and treatment expectancies before the training session on Day 1 and then completed a 6-min Sustained Attention to Response Task (SART) measuring mind wandering after the training session on Day 3. Acceptance training was important for reducing mind wandering, such that the attention-monitoring plus acceptance mindfulness training condition had the lowest mind wandering relative to the other conditions, including significantly lower mind wandering than the attention-monitoring only mindfulness training condition. In one of the first experimental mindfulness training dismantling studies to-date, we show that training in acceptance is a critical driver of mindfulness-training reductions in mind wandering. This effect suggests that acceptance skills may facilitate emotion regulation on boring and frustrating sustained attention tasks that foster mind wandering, such as the SART.

Keywords: mindfulness, acceptance, mind wandering

Mindfulness meditation training has been linked to a broad range of cognitive, affective, and health outcomes (Brown, Creswell, & Ryan, 2015; Creswell & Lindsay, 2014; Sedlmeier et al., 2012). Some of the most robust findings in the cognitive domain pertain to how mindfulness meditation training can foster on-task, sustained attention and reduce mind wandering (Jha et al., 2015; Morrison, Goolsarran, Rogers, & Jha, 2014; Mrazek, Smallwood, & Schooler, 2012; Mrazek, Franklin, Phillips, Baird, & Schooler, 2013; Slagter et al., 2007; Tang et al., 2007). For example, Mrazek and colleagues (2012) found that a brief mindfulness meditation training decreased mind wandering during a Sustained Attention to Response Task (SART; Mrazek et al., 2012) relative to passive-relaxation and reading-control conditions. The SART is a commonly used sustained attention task known to be associated with mind wandering reported in daily life and mind wandering measured during mindful breathing tasks, including self-caught, task-unrelated thought (Mrazek et al., 2012). During the SART, participants attend for an extended period of time to frequent nontargets and infrequent targets. Participants are instructed to press the spacebar when presented with all numbers excluding the number "3" and to respond to the number "3" by refraining from pressing the spacebar. To successfully complete the task, participants must maintain their attention to these nontargets for a prolonged period of time and must avoid mind wandering. Failures to correctly respond or refrain from responding indicate greater mind wandering.

Although there are now several studies showing that brief mindfulness meditation training reduces mind wandering during the SART (Morrison et al., 2014; Mrazek et al., 2012), the underlying mechanisms driving these effects are not yet known. It is possible

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that mindfulness decreases mind wandering and facilitates sustained attention during the SART by equipping participants with the emotion regulation skills necessary to regulate frustration or boredom experienced during the task. Previous research has shown that mindfulness training improves emotion regulation (Arch & Craske, 2006), an important skill for successful performance on boring or challenging tasks that require regulation of unpleasant emotions (Philippot, Nef, Clauw, de Romree, & Segal, 2012). Indeed, the SART has been linked in multiple studies to affective outcomes, including negative affect (Mrazek et al., 2012; Smallwood et al., 2009).

Mindfulness meditation can take a variety of forms, but core to each form is an experiential, comparatively nondiscursive observation of internal and/or external perceptual stimuli as they unfold in real time. For example, in the attention-monitoring form of mindfulness commonly taught in mindfulness training programs, attention is concentrated upon a stimulus object (e.g., bodily sensations associated with breathing) while meta-awareness, an apprehension of the current state of the mind, serves to monitor or regulate attention to sustain it (Dreyfus, 2011). Some have argued that implicit to such mindful attention is an acceptance or openness to ongoing perceptual occurrences (Anālayo, 2003; Brown & Ryan, 2004). Yet many people who undertake mindfulness training can attest to the challenge of sustaining mindful attention without a regular (or even incessant) wandering of attention, and many forms of mindfulness instruction have explicitly incorporated skill training in fostering an attitude of acceptance and nonjudgment to enable a disengagement from habitual mental discursivity and reactivity, which can disrupt sustained attention (Bishop et al., 2004). Accordingly, one interesting potential consequence is that learning how to be more accepting toward present-moment experience in mindfulness interventions can foster a greater capacity to sustain attention and reduce mind wandering.

Here we tested two accounts to explain how mindfulness training may affect mind wandering. The first account is that training in attention monitoring could be sufficient to reduce mind wandering, as the capacity to sustain attention might foster on-task attention (Chiesa & Malinowski, 2011; Malinowski, 2013). The second account, the attention-monitoring plus acceptance account, posits that acceptance training is a critical mechanism in mindfulness-training effects on reducing mind wandering. Specifically, attentionally demanding tasks can induce boredom, frustration, and other unpleasant emotions that may interfere with task performance, whereas acceptance may facilitate greater emotion regulation that buffers the distracting effects of these negative emotions and facilitates on-task attention and performance (Lindsay & Creswell, 2015; Teper & Inzlicht, 2013). Indeed, several studies suggest that greater acceptance is associated with improved cognitive performance on tasks involving simultaneous attention and affect regulation, such as the Stroop task (Anicha, Ode, Moeller, & Robinson, 2012; Moore & Malinowski, 2009; Teper & Inzlicht, 2013). Furthermore, this attention-monitoring plus acceptance account builds from previous research showing that negative emotions prospectively drive greater mind wandering (Franklin et al., 2013; Killingsworth & Gilbert, 2010).

In this study, we dismantled mindfulness training into two primary instructional components of attention monitoring and acceptance to better understand whether attention monitoring alone drives improvements on an attention task (the SART), or whether the attitude of acceptance toward monitored experiences further enhances performance on the SART. Participants were randomly assigned to training in conditions of mindfulness training in attention monitoring only, mindfulness training in attention monitoring and acceptance, relaxation training, or an active reading-control. Attention-monitoring only training instructed participants to monitor the ongoing sensations of breathing and to note thoughts, emotions, and sensations that spontaneously arise in the mind and body before bringing attention back to the breath. After receiving training on attending to their breath, participants then learned to monitor their body sensations, thoughts, and emotions. The attention-monitoring plus acceptance mindfulness training condition incorporated these instructions as well as instructions for adopting an accepting, nonjudgmental attitude toward ongoing experience. Specifically, participants were taught to monitor their experiences with acceptance and nonjudgment, remaining detached and nonreactive when noticing that their minds wandered, or when observing difficult emotions or uncomfortable body sensations. After receiving 3 days of 20-min trainings in each condition, participants completed the SART, performance on which served as the behavioral index of mind wandering for this study.

Method

Participants

Eligible participants were those who were between the ages of 18 and 30 years, in good mental and physical health, meditation novices (no prior meditation experience), and not taking any form of oral contraceptive for purposes of controlling for factors that may impact measurement of biological stress reactivity on Day 4 (to be reported on in future papers). We enrolled 147 (74 male) participants from the Carnegie Mellon University and University of Pittsburgh campus communities and randomly assigned them to one of four conditions, using a 2:2:2:1 allocation sequence: a four-session attention-monitoring-only mindfulness-training program ($n = 41$), a four-session attention-monitoring-plus-acceptance mindfulness-training program ($n = 41$), a four-session relaxation-training program ($n = 38$), or four sessions of listening to neutral reading material in a reading-control condition ($n = 22$; see the Training Conditions section). We excluded five participants from study analyses, two for reporting being outside of the required age range after enrollment in the study, one for prior meditation experience, and two for equipment failure resulting in missing SART data. Analyses were thus conducted on $N = 142$ participants. The average age of our final sample was 21 years old ($SD = 3.25$). The ethnic breakdown was 27% Caucasian, 31% Asian, 22% Asian American, 9% African American, 4% Latino/Hispanic, 6% Mixed, and 1% Other. All study procedures were approved by the Institutional Review Board at Carnegie Mellon University and data was collected between August, 2013 and July 2014.

Procedure

Participants were recruited for a study investigating attention training and performance ability. At the baseline session, participants completed a measure of dispositional mindfulness, were randomly assigned to a study condition, completed the first of four 20-min training sessions, and then completed a measure of training

expectancy (see the Measures section). Training sessions were delivered on consecutive days by prerecorded audio files via computer and headphones. To ensure experimenter blinding to training condition, an independent research-staff member created a prerandomized set of labeled audio files for each participant. Experimenters monitored participants during each training session and reminded them to actively engage in the training if they appeared to be sleeping or distracted. After completing the third training session, participants completed the SART (see Measures). Finally, participants returned on the 4th consecutive day to complete a final training session, questionnaires, and the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993), and then were debriefed on the primary study aims. Participants were compensated a total of $60 for full participation in the 4 days of study activities. This report describes the SART results; other reports to follow will describe other results.

Training conditions. Each training condition consisted of four 20-min sessions audio recorded by the same female voice. In all active treatment conditions, instructions were matched for word count, length of silent periods, and training expectancies for performance on upcoming tasks. All participants were told that the attention training was designed to prepare them for upcoming tasks. Participants randomly assigned to the active reading-control condition received minimal training expectancies pertaining to upcoming tasks.

In the mindfulness conditions, participants were asked to maintain an upright seated posture. Participants in the relaxation condition were instructed to find a comfortable position and do whatever they needed to relax. Participants in the control condition were given no posture instruction and instead were told to let their minds and bodies be at ease. Mindfulness instructions in this study map onto other mindfulness trainings with similar attention-monitoring, thought-labeling, and body-scanning practices. The scripts for all study conditions are available upon request.

The attention-monitoring only training condition. The attention-monitoring only mindfulness training condition consisted of meditation training that included training sustained attention to breathing sensations, body sensations, thoughts and emotions, as well as a meta-awareness of cognitive, emotional, and physical events (e.g., "You can notice when your mind wanders off using the label 'distracted,' and then return to monitoring your breathing"). Unspoken labeling of such events (e.g., thinking, feeling) helped to foster concentration upon the attentional object (e.g., breath sensations). No instructions designed to foster acceptance of ongoing experience were included.

The attention-monitoring plus acceptance training condition. The attention-monitoring plus acceptance mindfulness training condition consisted of similar instructions to those for the attention-monitoring-only training condition, plus instructions to attend to breathing sensations, other bodily sensations, emotions, and thoughts with an accepting and nonjudgmental attitude toward those experiences (e.g., "Most importantly, there is no need in this practice to judge yourself negatively, because becoming distracted is just part of the practice of training your attention").

The relaxation training condition. The guided relaxation-training condition consisted of different forms of guided relaxation-imagery exercises, including walking along a beach, through a forest, and through an imagined space (e.g., "You are entering into your imagination as if entering into a pleasant, inviting world").

The reading-control condition. The reading-control condition contained excerpts from neutral articles on geography, culture, and the environment (e.g., "The trigger for this ecological shift—found nowhere else—is the onset of the *khareef,* the southwesterly monsoon"). Participants were instructed to allow themselves to be "absorbed by the narratives" of the articles. The purpose of this control condition was to match the demands experienced in the 20-min training periods for the active treatment condition, and it provided a relative baseline group for assessments of mind wandering.

Measures

Dispositional mindfulness. On Day 1, prior to completing the first training session, participants completed the 15-item Mindful Attention Awareness Scale (Brown & Ryan, 2003). The Mindful Attention Awareness Scale (MAAS) asks participants to report their attentiveness to and awareness of present moment experience using items such as, "I find it difficult to stay focused on what's happening in the present." Participants make ratings on a scale from 1 (*Almost Never*) to 6 (*Almost Always*). Individual items were reverse-scored, then averaged to create a composite dispositional mindfulness score, with higher scores reflecting higher dispositional mindfulness (Cronbach's $\alpha = .81$).

Training expectancy. Immediately after the training session on Day 1, participants were asked to indicate how much they believe, in that moment, the training they received is beneficial to them. Four items from the Credibility/Expectancy Questionnaire (Devilly & Borkovec, 2000; study $\alpha = .91$) measured belief in the relevance and effectiveness of the training on a scale of 1 (*not at all*) to 9 (*very much*) (e.g., "At this point how much do you feel that attention training will help your cognitive performance at the end of the study?"). Responses to the four items were averaged to produce composite training expectancy scores for Day 1. Higher scores indicate greater belief in the efficacy and relevance of the training for upcoming task performance.

Sustained Attention to Response Task. The SART is a 6-min, computerized mind-wandering task (Mrazek et al., 2012) in which participants are instructed to press the spacebar in response to frequent nontargets (i.e., Go trials; all numbers except the number "3") and to refrain from pressing the spacebar in response to infrequent targets i.e., NoGo trials; the number 3). Participants were presented with 34 NoGo trials and 281 Go trials, for a total of 315 trials. Participants were provided with a limited response time of 250 ms, with an interstimulus interval of 900 ms (see Figure 1). Participants were not provided with any feedback after the training or task trials. Mind wandering is measured during the SART when lapses of attention occur and participants fail to respond correctly on task trials (either correctly pressing the spacebar in response to seeing a number other than 3 on the screen, or correctly refraining from pressing the spacebar in response to seeing the number 3 on the screen). Sustained attention discrimination rate (discrimination) was our measure of mind wandering and is calculated as the hit rate (i.e., number of correct presses in response to frequent nontargets) minus the SART error rate (i.e., number of incorrect presses in response to infrequent targets). We report training-condition differences in discrimination (i.e., overall

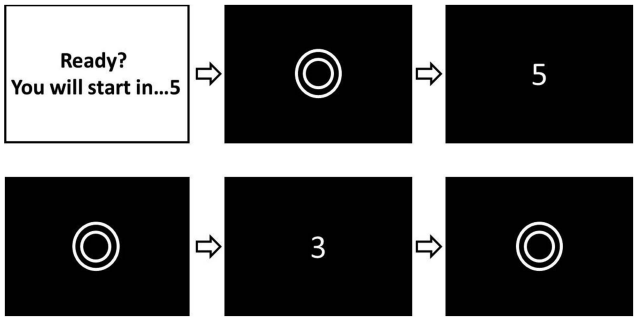

Figure 1. An example of a frequent Go trial followed by an infrequent NoGo trial in the sustained-attention response task.

attention calculated from hit rate minus false-alarm rate) during the SART.

Statistical Data Analysis

All analyses were conducted with IBM-SPSS 21 software. Preliminary analyses included one-way analyses of variance (ANOVA) or χ^2 tests evaluating success of randomization of age, gender, ethnicity, and trait mindfulness. One-way analyses of covariance (ANCOVA), controlling for age, were implemented to test for condition differences in treatment expectancies and SART performance, gender effects on SART performance, as well as effects of the interaction between gender and condition on SART performance. Secondary analyses tested for dispositional mindfulness relationships with SART performance using linear regression, as well as multiple regression analyses testing for condition and dispositional mindfulness interactions on SART performance. In analyses that included dispositional mindfulness, mean-centered MAAS scores were used. Three dummy coded variables were created for multiple regression analyses, one for each active training condition, using the reading control condition as the reference group.

Results

Preliminary Analyses

There were no baseline condition differences in gender, $\chi^2(3) = 1.74$, $p = .63$, race/ethnic composition, $\chi^2(18) = 10.30$, $p = .92$, or dispositional MAAS mindfulness, $F(3) = .74$, $p = .53$, indicating successful randomization. There was a significant condition difference in age, $F(3) = 2.69$, $p = .049$, so age was included as a covariate in all study analyses. As expected, there was a marginally significant (bordering on statistical significance) condition difference for Day 1 treatment expectancy controlling for age, $F(3) = 2.66$, $p = .05$, such that all three active treatment conditions had higher treatment expectancies (attention-monitoring only: $M = 6.32$, $SE = .26$; attention-monitoring plus acceptance: $M = 5.75$, $SE = .26$; relaxation: $M = 5.91$, $SE = .28$) relative to the active reading-control condition ($M = 5.05$, $SE = .36$). Collapsing across study conditions, one-way ANCOVAs revealed no gender differences on the SART when controlling for age: discrimination, $F(1) = .05$, $p = .82$; and no Gender × Condition interactions on the SART when controlling for age: discrimination, $F(3) = .62$, $p = .61$.

Primary Analyses

Evidence from SART outcomes supports the attention-monitoring plus acceptance account; participants in this condition showed the lowest mind wandering relative to the other three conditions (attention-monitoring only, relaxation, control). Specifically, a one-way ANCOVA (controlling for age) revealed a significant condition difference in mind wandering as measured by discrimination, or the number of correct presses in response to frequent nontargets minus the number of incorrect presses in response to infrequent targets, $F(3) = 3.41$, $p = .02$; see Table 1 and Figure 2. In follow-up pairwise comparisons, there were significant differences between attention-monitoring plus acceptance and attention-monitoring only ($M_{diff} = 6.21$, $SE = 2.78$, $p = .03$) as well as between attention-monitoring plus acceptance and reading-control ($M_{diff} = 9.84$, $SE = 3.31$, $p = .003$). The difference between attention-monitoring plus acceptance mindfulness training and relaxation training was in the expected direction but nonsignificant ($M_{diff} = 3.74$, $SE = 2.85$, $p = .19$).

Secondary Analyses

There is some question in the literature whether baseline dispositional mindfulness (as measured by the MAAS) is associated with mind wandering during the SART (Cheyne, Carriere, & Smilek, 2006). We found no significant association in regression analyses controlling for age relating baseline dispositional mindfulness with discrimination, $\beta = .10$, $t(2) = 1.22$, $p = .23$. It is also possible that baseline dispositional mindfulness moderated subsequent mindfulness-training condition effects on discrimination (Creswell, Pacilio, Lindsay, & Brown, 2014), but no dispositional mindfulness main effect was found, $\beta = .07$, $t(8) = .36$, $p = .72$ and no significant dispositional Mindfulness × Training Condition interactions were observed (all $ps > .42$) in multiple regression analyses (see Table 2).

Discussion

The findings of this study are consistent with existing evidence showing that mindfulness training reduces mind wandering on the SART and also extends previous work by showing that the acceptance component in mindfulness training is an important component for these effects. Using a randomized controlled design, we showed that brief attention-monitoring plus acceptance mindfulness training significantly reduced mind wandering compared with a structurally equivalent attention-monitoring only mindful-

Table 1
Study-Condition Effects on Discrimination During the SART Task, Controlling for Age

Study condition	Mean	Standard error
Monitor and accept	267.264	1.959
Monitor only	261.050	1.959
Relaxation	263.520	2.040
Reading control	257.425	2.695

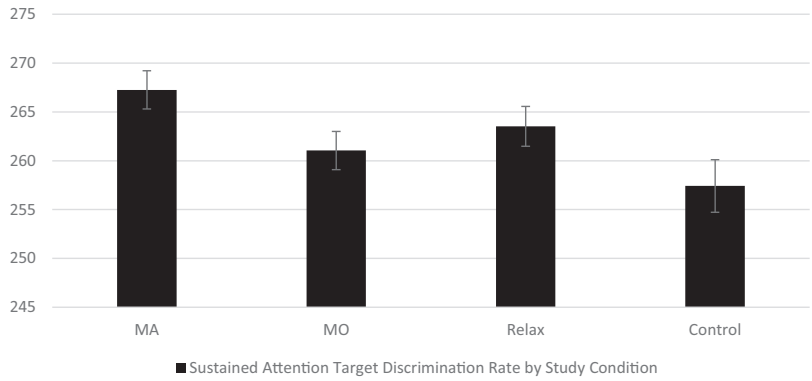

Figure 2. A one-way ANCOVA (controlling for age) revealed a significant condition difference in mind wandering as measured by discrimination.

ness training program. Our experimental approach provided support for the attention-monitoring plus acceptance account that posits that the acceptance component of mindfulness training is critical for improving mind wandering (Lindsay & Creswell, 2015), and contributes new evidence to the body of literature exploring active ingredients in mindfulness training (Anicha et al., 2012; Chiesa & Malinowski, 2011; Franklin et al., 2013; Lindsay & Creswell, 2015; Malinowski, 2013; Moore & Malinowski, 2009; Teper & Inzlicht, 2013). Evidence from this study suggests that learning how to be more accepting toward present-moment experiences in mindfulness interventions fosters a greater capacity to reduce mind wandering and that the acceptance component of mindfulness may be important in mindfulness-training programs geared toward improving attention outcomes.

One interesting question for future research is to investigate how acceptance training impacts sustained attention and mind wandering outcomes. One possibility is that acceptance acts as an emotion-regulation strategy (Dan-Glauser & Gross, 2015), and improves the regulation of negative affect experienced during boring and frustrating tasks like the SART (Teper, Segal, & Inzlicht, 2013). Acceptance may also lead to the use of other emotion-regulatory strategies, including decentering (Bernstein et al., 2015; Bieling et al., 2012; Hoge et al., 2015). Indeed, a number of studies show that mindfulness training is effective at improving emotion regulation and research has also shown that the SART is linked to affective outcomes, including negative affect (Mrazek et al., 2012; Smallwood et al., 2009), so we posit that acceptance may be a critical skill for these effects of mindfulness on emotion-related outcomes (Lindsay & Creswell, 2015). Acceptance, the embracing of present experience without judgment or attempts to change the experience (Hayes, Luoma, Bond, Masuda, & Lillis, 2006), has been linked to positive outcomes in previous studies of acceptance–commitment therapy (ACT) and emotion-regulation therapy (ERT), including effects on emotion outcomes (Arch et al., 2012; Bond & Bunce, 2003; Forman et al., 2007; Fresco et al., 2013). The orientation of acceptance is theorized to allow one to attend to negative affective states from a nonreactive perspective (Bieling et al., 2012), which may foster better task performance than an emotionally reactive or judgmental state; and indeed, previous findings suggest that greater negative affect is associated with more SART errors (Mrazek et al., 2012). A capacity to accept emotional responses as natural and to allow them to arise and pass in the background (rather than getting caught up or engaged in them) while directing attention to a task, may minimize attentional lapses and enhance task performance.

Table 2
Condition by Dispositional Mindfulness Interaction Effects on Discrimination, Controlling for Age

Variables	*B*	*SE*	β	*t*	*p*
Constant	230.391	7.424		31.035	.00
Age	1.234	.337	.299	3.658	.00
Mean-centered MAAS	1.532	4.234	.073	.362	.718
Monitor + Accept × MAAS	4.158	5.257	.106	.791	.43
Monitor Only × MAAS	.181	5.172	.005	.035	.972
Relaxation × MAAS	−.108	5.262	−.003	−.02	.984

Note. MAAS = Mindful Attention Awareness Scale.

We did not observe a significant effect of baseline dispositional mindfulness (or an interaction between trained mindfulness and dispositional mindfulness) on SART performance. Higher basic dispositional mindfulness has been found to enhance mindfulness training effects in some previous research (Creswell et al., 2014; Shapiro et al., 2011) but studies are still few and the boundary conditions for such moderated effects are unknown. One unexpected finding, which we found interesting, was that relaxation training was effective (above and beyond the attention-monitoring only mindfulness training condition) at reducing mind wandering, showing comparable effects to attention-monitoring plus acceptance mindfulness training. Results from recent studies comparing mindfulness and relaxation training interventions are mixed, with some evidence that mindfulness meditation training and relaxation training show comparable beneficial effects on inattention, distress, and positive mood states (Jain et al., 2007; Schooler et al., 2014), and other findings showing that mindfulness training may differentially improve attention and self-regulation, as well as reduce distraction and rumination more effectively than relaxation training (Droit-Volet, Fanget, & Dambrun, 2015; Jain et al., 2007; Tang et al., 2007). Our study findings, along with findings from previous studies, support the potentially important role of the relaxation response on attention-related outcomes (Droit-Volet et al., 2015; Lazar et al., 2000). The mechanisms facilitating similar

effects of the attention-monitoring plus acceptance mindfulness training program and a relaxation training program are unknown, although embodied cognition theories suggest the possibility that inducing relaxed body states might affect emotional responses (Niedenthal, 2007). If both forms of training foster emotion regulation, both may promote equanimity and acceptance toward emotions that arise during the SART (Hayes-Skelton, Usmani, Lee, Roemer, & Orsillo, 2012; Hayes-Skelton, Roemer, Orsillo, & Borkovec, 2013), with consequent benefits for task performance.

There are some limitations to this study. First, we did not incorporate an acceptance-only condition and are therefore not able to make inferences that acceptance without training in attention monitoring improves mind wandering (Lindsay & Creswell, 2015). Second, we did not measure negative affect during the SART, so although we posited that attention-monitoring plus acceptance mindfulness training buffered negative affective responses to the SART (Creswell & Lindsay, 2014), this prediction needs to be empirically tested in future studies, for example through the inclusion of affect measures during and after the SART.

Conclusion

This study provides one of the first dismantling tests of mindfulness training components (attention and acceptance) for attention-related outcomes. Our study tested two basic mechanisms of mindfulness training and found that there are beneficial effects of acceptance training on behavioral measures of mind-wandering performance outcomes.

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