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The Feasibility of Remote Brief Mindfulness Training and Impact on Anxiety-Related Attention Bias

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by

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Abstract

Mindfulness is characterized by Kabat-Zinn (2005) as a cultivated attentional practice of moment-to-moment, non-judgmental awareness. Brief mindfulness training (BMT) has been shown to reduce symptoms of anxiety (Howarth et al., 2019) as well as improve the allocation of attentional resources (Norris et al., 2018). It remains unclear, however, whether BMT can remediate specific disruptions in attention associated with anxiety, such as the anxiety-related attention bias (AB) or selected and exaggerated attention to threat. The current study tested the hypothesis that BMT would improve AB and state anxiety compared to a control. Undergraduates aged 18 to 42 (M_{age} = 21.46; N = 135) were randomly assigned to either control or brief mindfulness training (BMT) conditions. Analyses revealed that the BMT significantly improved subjective state mindfulness and state anxiety, but did not influence AB. Additionally, analyses were conducted to explore differences between novices and practitioners (meditation experience). This study provided support for the feasibility of web-based BMT which has implications for therapeutic interventions and increasing accessibility to mental healthcare.

Keywords: mindfulness, attention bias, anxiety, remote intervention

The Feasibility of Remote Brief Mindfulness Training and Impact on Anxiety-Related Attention Bias

Mindfulness has been broadly conceptualized as the non-judgmental, non-reactive awareness of the present moment (Kabat-Zinn, 2005; Bishop, 2004). Within the context of empirically supported interventions, such as mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT), research has found that mindfulness-based interventions (MBIs) are efficacious in reducing anxiety in a range of populations, from youth to adults (Hoffmann et al., 2010; Dunning, et al., 2018; de Abreu Costa et al., 2019; Hoge et al., 2015). The underlying mechanisms of how mindfulness relates to reductions in negative mental health outcomes in anxiety and provides symptom relief are still being explored. Anxiety-related attention bias (AB) is thought to contribute to the maintenance and etiology of anxiety disorders (Roy et al., 2015). According to a neurocognitive approach, deficits in top-down functioning may contribute to poor attentional control in response to affective threat stimuli and ultimately to anxiety-related AB (Pavlov et al., 2011; Packard, et al., 2022). It has been argued that mindfulness training can take on both a top-down and bottom-up approach (Chiesa et al., 2013), and has been associated with greater attentional regulation (Kerr et al., 2013), which may have implications for improving anxiety-related AB.

Mindfulness

The western-scientific conceptualization of mindfulness and mindfulness meditation (MM) have been adapted from Buddhist principles specifically focused on awareness, compassion, equanimity, or the balance of emotions, and clarity. Kabat-Zinn (2011) argues that since these capacities can be honed using intentional attentional practice, they are therefore universal principles and can be adapted and disseminated for secular use. Mindfulness research

has grown exponentially since the early 1980's. Starting in the field of medicine it has branched out into many different areas from neuroscience to education (Kabat-Zinn, 2011). Within the field of psychology, mindfulness has been shown to be associated with greater psychological well-being (Brown & Ryan, 2003). Mindfulness is referred to at times as a dispositional trait or a state that can be cultivated through the practice of MM. Research has focused on MM as a way to improve symptomatology associated with an array of anxiety disorders, including social and generalized anxiety disorders (Miron & Orcutt, 2014; Bamber & Morpeth, 2019). Others have explored trait mindfulness and how it relates to anxiety, depression, and self-compassion (Ostafin et al., 2014; Makadi et al., 2020; Freudenthaler et al., 2017). Trait mindfulness relates to when individuals have an "innate capacity of paying and maintaining attention to present-moment experiences with an open and nonjudgmental attitude" (Tang & Tang, 2020; Brown & Ryan 2003). Mindfulness can be cultivated through consistent meditation practice involving a variety of techniques but typically includes, focused attention (FA) and open monitoring (OM) (Sumantry & Stewart, 2021). Gains in trait mindfulness can occur when a state of mindfulness is induced repeatedly and consistently over time, i.e. MM practice (Kiken et al., 2015).

Mindfulness Meditation and Attention

The conceptualization of mindfulness implies that attentional awareness and control is a critical component of MM practice. Several studies have explored the connection between MM and attentional networks. Specifically, two subtypes of meditation: focused attention (FA), sustaining attention on one object, and open monitoring (OM), staying present while directing attention without becoming too absorbed in thought, are components of MM that relate to attention mechanisms (Sumantry & Stewart, 2021). Components of FA require sustaining attention on a chosen object and also disengaging attention from any distraction (Lutz et al.,

2008). OM requires nonreactive awareness and monitoring of experience (Lutz et al., 2008). Sumantry and Stewart's (2021) meta-analysis examined the relationship between attention and mindfulness in 87 published studies. The authors found that attentional ability was a mechanism behind meditation and mindfulness (Sumantry & Stewart, 2021). For example, meditators were able to longer sustain focus than nonmeditators and inhibit competing, distracting stimuli (Sumantry & Stewart, 2021). Evidence from neuroimaging studies also suggests a relationship between attention and MM involving FA and OM (Fox et al., 2016). FA was specifically associated with activations in areas associated with cognitive control of attention, among other functions, while OM was associated with activations in cognitive control regions involved in the monitoring of attention to internal and external information (Fox et al., 2016).

Brief Mindfulness Meditation

Considered as part of the "third wave" of cognitive-behavioral therapy, MBSR and MBCT programs cultivate mindfulness over an 8-week period (Fjorback, et al., 2011). While MBSR and MBCT have been shown to be effective in improving health-related outcomes in clinical and non-clinical populations, researchers have turned to examining the effects of brief MM to address the lengthy time commitment required by traditional MBI's (Howarth et al., 2019). Within the literature, there is a range in what is considered brief, studies range in length of a single-session 10-minute meditation (Erisman & Roemer, 2011) to a 15-minute meditation over the course of 7 days (Wu et al., 2019). In Howarth et al.'s (2019) meta-analysis of 85 brief MBIs, it was found that most of the studies reported significant improvements in a variety of health outcomes, such as improvements in cognition, state anxiety, and mood, although many of the studies also reported mixed findings. Findings from previous research illustrate improvements in attention processing and executive attentional control after brief mindfulness

training (BMT) or induction (Norris et al., 2018, Shires et al., 2018). Shires, et al., (2018) reported that a brief 2-minute mindfulness task produced significant changes in self-report and attentional bias outcomes. It was found that participants who had less difficulty disengaging from affective stimuli benefitted more from the mindfulness training, and participants in the mindfulness group reported greater pain tolerance and less distress compared to control groups. Taken together there is evidence to suggest that brief MM has the potential to influence attentional and self-report anxiety outcomes.

Anxiety-Related Attention Bias

Cognitive models suggest that individuals with anxiety have biases in bottom-up processes, such as threat detection, and dysfunction in top-down processes, such as attentional control (Mogg & Bradley, 2016). One cognitive bias associated with dysregulation of attention is anxiety-related attention bias (AB), categorized as selective and exaggerated attention towards or away from threat (Dennis-Tiwary et al., 2019). AB heterogeneity accounts for individual differences in bias with some individuals displaying a bias away from threat, or avoidance of threat-related stimuli, typically associated with fear-related disorders, with others displaying a bias towards threat-related stimuli, typically associated with distress-related disorders (Dennis-Tiwary et al., 2019). AB has been detected in both clinical and non-clinical populations, specifically in those with anxiety disorders or higher levels of trait anxiety (Bar-Haim et al., 2007).

The dot-probe paradigm, a visual reaction time task, is commonly used to measure AB (Bar-Haim et al., 2007). During the task, participants respond as quickly as possible to a probe presented in the position of a previously presented pair of stimuli. The probe is positioned in either the location of threat-related or neutral stimuli. Latencies in response times to stimuli are

considered to be representative of attentional allocation, with faster response times to probes in the location of threat-related stimuli indicating AB toward threat (Bar-Haim et al., 2007). Conversely, avoidance or bias away from threat, is indicated by longer reaction times to a probe in the location of threat-related stimuli compared to a probe replacing neutral stimuli (Cisler & Koster, 2010).

Much of the research on the relationship between AB and mindfulness has focused on depression (Segal, et al., 2002; Holas et al., 2020), chronic pain (Vago & Nakamura, 2011), and alcoholism (Garland, et al., 2012). Little of the research has focused specifically on anxiety-related AB. However, a recent study found that higher trait mindfulness was associated with less anxiety-related AB in individuals with diagnosed social anxiety (Packard et al., 2022). While studies focusing on the relationship between MM and anxiety-related AB are limited, there has been evidence linking mindfulness to other cognitive bias mechanisms related to anxiety, such as negative cognitive bias and interpretation bias (Ford & Shook, 2018; Mayer et al., 2018). For example, negative cognitive bias has been shown to mediate the relationship between trait mindfulness and emotional distress (Ford & Shook, 2018), while less cognitive interpretation bias was associated with greater trait mindfulness and mediated the relationship between mindfulness and depression and lower anxiety symptomatology (Mayer et al., 2018). MM specifically may work to address the dysregulation of attention by strengthening the deficit in top-down, cognitive control processes that are associated with anxiety-related AB.

Individual Differences Related to Past Meditation Experience

Lastly, there is evidence to suggest that there may be differences in attention and brain function between experienced meditation practitioners and novices (Hodgins & Adair, 2010; Tang et al., 2015; Kurth et al., 2015). For example, it was found that long term, experienced

meditators displayed greater gray matter left-hemispheric asymmetry in the superior parietal lobe, associated with attention processing involving task preparation and task switching, compared to controls (Kurth, et al., 2015). Additionally, it has been reported that meditators compared to non-meditators display significantly higher levels of mindfulness on self-report measures, although results are mixed (Bergomi et al., 2015). Higher self-reported trait mindfulness is related to lower anxiety symptoms (Carpenter et al., 2019). While previous single-session meditation studies have specifically recruited meditation naïve participants (Zeiden et al., 2010, Johnson et al., 2015), others have not (Garland et al., 2017; Strohmaier et al., 2022). Exploring the relationship between individual meditation experience and BMT may provide insight in differential effects for meditators compared to novices.

The Present Study

Studies examining the relationship between anxiety-related AB and mindfulness are limited. Additionally, many therapeutic interventions are being adapted for digital implementation, e.g., internet-based cognitive behavioral therapy, and have been found to be effective, but there is limited research focusing specifically on internet-based mindfulness training (Stefanopoulou, et al., 2019). The present study aimed to evaluate the effectiveness of a single-session, remote brief mindfulness training (BMT) on anxiety-related AB. To further investigate the feasibility of internet-based mindfulness training, our study was delivered remotely using web-based platforms. We hypothesized that individuals in the BMT compared to the control condition would report significant improvements in mindfulness, state anxiety, and AB. The implication of efficacious digital based interventions is that they may be more convenient and less costly for the individual, and more easily distributed by healthcare providers, ultimately leading to greater mental healthcare accessibility. Lastly, we will explore the

associations between participants with meditation experience versus novices and whether they differed on key study measures, specifically examining if those with experience showed reduced anxiety, AB, and higher trait mindfulness.

Method

Participants

The sample consisted of 135 participants recruited from an Introduction to Psychology course at Hunter College, The City University of New York (CUNY – Hunter). Participants ranged in age from 18 to 42 (M = 21.46, SD = 4.87). There were 82 females (60.7%), 51 males (37.8%), and 2 responded as Other (1.5%). Self-reported ethnicity and race were as follows: 23% Hispanic, 34.8% Asian, 34.8% White, 17% Black/African American, 10.4% identified as more than one race, 2.2% American Indian/Alaska Native, and .7% Native Hawaiian/Pacific Islander. There were 31 self-identified practitioners, defined as individuals with previous meditation experience, and 104 self-identified novices, defined as individuals with no prior meditation experience. Participants were self-selected and compensated with 3 credits for their time in the 2.5 hour-long study.

Materials

Participants completed the study remotely via web-based platforms. Measures were administered utilizing Qualtrics survey software. The anxiety-related attention bias (AB) measure, a five-minute online dot probe task, was administered independently of Qualtrics on an external website. The audio scripts (Appendix A) were delivered by embedding YouTube videos into Qualtrics.

Anxiety Measures

Beck Anxiety Inventory (BAI). The 21-item measure was used to measure the presence of physical and cognitive symptoms of anxiety. Participants rate statements regarding symptoms in the past week on a scale of 0 (Not at all) to 3 (Severely – it bothered me a lot), e.g. "Nervous; Unsteady". Higher scores indicate greater anxiety (range 0-63). Scores are grouped as low anxiety (0-21), moderate anxiety (22-35), and potentially concerning levels of anxiety (>=36) (Beck et al., 1988). Internal consistency coefficient alpha ranging from 0.90 to 0.94 and has been tested in both clinical and non-clinical samples (Julian, 2014).

State-Trait Anxiety Inventory - State (STAI-S). The 20-item measure was used to assess state, or current, anxiety. Participants rate statements on a scale of 1 (not at all) to 4 (very much so), e.g., "I am tense; I feel calm". Higher scores indicate greater state anxiety (Spielberger et al., 1983). Internal consistency coefficient alpha ranging from 0.86 to 0.95 (Julian, 2014).

Depression and Anxiety Stress Scales – 21 Items (DASS-21). Used to assess depression, anxiety, and stress on 3 subscales and as a unidimensional factor. Participants rate statements about the past week on a scale of 0 (did not apply to me at all) to 3 (applied to me very much so, most of the time), e.g. "I was worried about situations in which I might panic and make a fool of myself". Higher scores indicate greater depression, anxiety, and stress (Lovibond & Lovibond, 1995). Cronbach's alpha for each subscale was reported as 0.94 for Depression, 0.87 for Anxiety, and 0.91 for Stress, reflecting high internal consistency (Antony et al., 1998).

Perseverative Thinking Questionnaire (PTQ). A 15-item self-report measure used to assess repetitive negative thinking associated with anxiety and depression in clinical and non-clinical populations. Participants rate statements on a scale of 0 (negative) to 4 (almost always), e.g., "I get stuck on certain issues and can't move on". Higher scores indicate greater repetitive

negative thinking. Internal consistency coefficient alphas for all subscales range from 0.83 to 0.94 (Ehring et al., 2011).

Mindfulness Measures

Five Facet Mindfulness Questionnaire – 15-Item (FFMQ-15). Used to assess 5-facets (Observing, Describing, Acting with Awareness, Non-Judging, Non-Reactivity) of trait-like mindfulness at baseline. Participants rated 15 statements, 3 items per facet, on a scale of 1 (never or very rarely true) to 5 (very often or always true), e.g. "When I have distressing thoughts or images I just notice them and let them go." Higher scores represent greater trait-like mindfulness (Baer et al., 2008). Gu et al. (2016) found the factor structure of the FFMQ-15 to be consistent with the 39-item FFMQ and support the use of the FFMQ-15 when briefer measures are needed.

Meditation History Questionnaire (MHQ). The 5-item survey was administered to assess participants' prior experience with meditation, i.e. frequency and length (Victorson, n.d.).

Mindful Attention Awareness Scale (MAAS). Used to assess trait-like mindfulness as a unidimensional factor. Participants rate 15 statements about their everyday experience on a scale of 1 (almost always) to 6 (almost never), e.g., "I could be experiencing some emotion and not be conscious of it until some time later". Higher scores represent greater mindfulness in everyday life (Brown & Ryan, 2003). Internal consistency coefficient alpha is 0.89 (MacKillop & Anderson, 2007).

Mindfulness Practice Quality (PQ-M). Used to assess mindfulness practice quality directly following the audio session, whether participants engaged with the BMT as intended. Mindfulness practice quality is defined as participants' receptiveness and present moment attention during the meditation session. Participants rate six statements related to practice quality on a scale of 0-100%. Higher scores indicate greater practice quality (Del Re et al., 2012).

Toronto Mindfulness Scale (TMS). Used to assess two different aspects of state-like mindfulness (Curiosity and Decentering) following the audio session. Participants rated 13 statements describing their experience on a scale of 0 (Not at All) to 4 (Very Much), e.g., "I was more concerned with being open to my experiences than controlling or changing them". Higher scores represent higher levels of curiosity and de-centering. Internal consistency coefficient alpha is 0.95 (Lau, 2006).

Attention Measures

Dot Probe Attention Task. Measures how long attention is drawn to specific types of stimuli (MacLeod et al., 1986). The current study used faces as emotionally-relevant stimuli to measure attention toward or away from social threat. The task produced three scores of AB: Threat-Bias (TB), Disengagement, and Vigilance. The Dot Probe Attention Task has been found to successfully detect threat-related bias in anxious and trait anxious populations (Bar-Haim et al., 2007).

Engagement Questionnaires (EQ). A 3-item engagement questionnaire was administered after the training session and each dot probe task. Participants rate statements on a scale 1 (Not Engaged at All) to 7 (Extremely Engaged), e.g. "How engaged were you with this task?".

Additional Measures

Additional measures were administered but were not included in this report. Measures of attentional control and mood were not analyzed: Analog Mood Scale (Brenner, 2000), Positive and Negative Affect Schedule (Magyar-Moe, 2009), Emotional Attentional Control Scale (Barry, et al., 2013) and Attentional Control Scale (Derryberry & Reed, 2002). Additionally, the

Coronavirus Anxiety Scale (Lee, 2020), was administered but not analyzed due to many participants completing the survey after the height of the COVID-19 pandemic.

Audio Scripts

The audio recordings were delivered via an embedded YouTube video in Qualtrics. The video controls were disabled to prevent fast-forwarding, rewinding, pausing, and redirecting to the external YouTube website. Both audio sessions were recorded by the same research coordinator. The BMT script was adapted from Johnson's et al. (2015) study investigating cognitive bias and mindfulness. Bell tolls were added to remind participants to bring their awareness back to the present. Breath counts were included for individuals new to breathwork to provide additional guidance during the meditation. The control script was a National Geographic about sequoia trees (Quammen, 2012). The article was read twice back-to-back to match the word count and length of the BMT audio. The control script was adapted from Norris et al.'s (2018) study investigating brief mindfulness meditation and attention.

Procedure

The current study employed a mixed, randomized, and experimental design. Institutional review board approval was obtained before recruitment, starting in November 2020, and data collection stopped in August 2021. All identifiable data was kept in password-protected files on password-protected servers or web accounts to ensure confidentiality. Qualtrics online survey software (Qualtrics, Provo, UT, USA) was utilized to deliver the study and to collect data. Participants were recruited from CUNY-Hunter's Psychology 100 course via SONA recruitment software. Self-selected students received an email with study information, including a password-protected file containing participant identification, a survey link, and instructions.

All participants were informed that the purpose of the study was to examine contextual influences on cognitive skills, including attention, concentration, and emotion regulation. Additionally, participants were provided with a disclaimer that the full intent of the study would be provided in a debriefing after completion. Participants consented at the start of the survey. Participants were required to enter their identification information before completing the standard demographics questionnaire, BAI, DASS-21, FFMQ-15, MAAS, PTQ, and STAI-S. Then, participants clicked a link to an external website delivering the online dot probe task. After the pre-training dot probe task, participants returned to Qualtrics to complete an engagement questionnaire and a second STAI-S. Next, participants were randomly assigned to either control or BMT conditions. All participants were instructed to find a quiet area, where they could sit undisturbed for a duration of approximately 25-minutes. Once participants were ready to begin, an embedded, blank Youtube video began playing automatically. After the audio session, participants completed a second EQ and third STAI-S. Then, participants completed a post-training dot probe task. Participants finished the last EQ and fourth STAI-S and were thanked for their participation. Upon completion of the study, participants were compensated with 3 credits towards the Psychology 100 course and received a debriefing email.

Online Dot Probe Task

Participants were directed to an external website delivering the online dot probe task. Participants were required to enter an ID and session number to establish whether task completion was pre- or post-audio session. A 5-minute timer was used to prevent participants from skipping the dot probe task. A password presented at the end of the task was required to continue the study in Qualtrics.

Results

Participants

A total of 261 participants signed up to participate and 115 of those participants were excluded for not finishing the survey. Participants who submitted the study in less than 40 minutes were excluded due to the infeasibility of completing all critical components. A single participant was excluded due to duplication of identification information, the first completed study data was kept and the duplicate was deleted. An additional 19 participants who attempted the dot probe task were excluded due to incomplete data. Lastly, 17 participants did not attempt to complete the dot probe. See Figure 1 for participant flow information. The remaining 135 participants were randomly assigned via Qualtrics to either a Control or BMT condition. Out of 135 participants, 73.3% completed the AB task.

Baseline Measures

Table 1 displays baseline AB (Threat Bias, Disengagement, Vigilance), trait anxiety (BAI, DASS-21), and state anxiety (STAI-S) for the BMT and Control conditions. Correlations between anxiety and AB measures are displayed in Table 2.

Meditation Experience Exploratory Analyses

A chi-square test of independence was performed to explore the association between Meditation Experience (Practitioner versus Novice) and Condition (BMT versus Control). The relation between these variables was not significant, X^2 (1, N = 135) = 1.59, p = .208, indicating that Meditation Experience and Condition were not related. To explore whether Practitioners (n = 31) compared to Novices (n = 104) would report greater mindfulness, decreased AB, and lower trait anxiety, t-tests were conducted. Practitioners (M = 10.35, SD = 3.36) reported significantly higher scores on the FFMQ-15 Observing subscale, versus Novices (M = 9.07, SD = 3.09),

t(133)= -1.99, *p* = .048. Practitioners (*M* = 11.00, *SD* = 2.93) also reported significantly higher scores on the FFMQ-15 Describe subscale compared to Novices (*M* = 8.70, *SD* = 3.06), *t*(133)= -3.70, *p* < .001. Practitioners did not score significantly higher than Novices on the rest of the FFMQ-15 subscales or on the MAAS. Differences between Practitioners and Novices on the baseline trait anxiety measures also did not reach significance. A significant difference did emerge between Practitioners (*M* = 39.65, *SD* = 11.15) and Novices (*M* = 44.46, *SD* = 9.97) for pre-training state anxiety, *t*(133) = 2.16, *p* = .033, but not for post-training.

Taken together, the exploratory hypothesis that Practitioners would report greater trait mindfulness and less anxiety was only partially supported, with Practitioners scoring higher on some sub facets of mindfulness but not others and not reporting lower trait anxiety at baseline than Novices.

Lastly, to explore the hypothesis that Practitioners would score higher than Novices on mindfulness measures following the training session, t-tests were conducted but did not reach significance. The exploratory hypothesis that Practitioners would report greater mindfulness compared to Novices following the BMT was also not supported.

To explore how meditation experience may influence AB scores, t-tests were run for pre-training and post-training AB measures. At pre-training, there was a significant difference between Practitioners (*M* = -10.86, *SD* = 27.35) and Novices (*M* = 6.93, *SD* = 32.88) on Vigilance scores, *t(*133) = 2.40, *p* = .018. Practitioners displayed less Vigilance than Novices at baseline. No other tests were significant for any other AB measures and therefore the exploratory hypothesis regarding improved AB scores in Practitioners compared to Novices was not supported.

Feasibility Assessment: Impact on Subjective Mindfulness

The BMT versus Control group scored significantly higher post-intervention on both subscales of the TMS, Curiosity, $t(133) = 2.33$, $p = .022$, and Decentering, $t(133) = 2.41$, $p = .017$. The BMT group also scored significantly higher than the Control group on the PQ-M indicating better practice quality, $t(133) = 2.30$, $p = .023$. Lastly, the BMT group scored higher than the Control group on the engagement questionnaire (EQ), $t(133) = 3.10$, $p = .002$. These results support the hypothesis that BMT would increase subjective state mindfulness compared to a Control condition. The significant findings from the EQ and PQ-M confirm that the mindfulness training was more effective than the control audio. Table 3 displays mean, standard deviation, and range for pre- and post-training trait and state mindfulness measures.

Anxiety-Related Attention Bias

We tested the hypothesis that participants in the BMT condition would report a greater reduction in AB compared to the control condition at post-training. A mixed-design analysis of variance (ANOVA) with Condition (BMT versus Control) as the between-subject factor and Time (Pre versus Post) as a within-subject factor was conducted to compare the effects of Time and Condition on anxiety-related AB. There was no significant main effect of Time or Condition on threat bias, vigilance or disengagement scores. Counter to predictions, no significant interactions between Time and Condition on any of the AB measures were found.

State Anxiety

To test the hypothesis that the BMT group would report lower state anxiety compared to the Control group following the training session, a mixed ANOVA was run to examine the effect of Condition and Time on state anxiety using pre- and post-training STAI-State scores. The results of the mixed ANOVA yielded a significant interaction between Time and Condition, $F(1,$

133) = 10.79, p = .001, η_p^2 = .075 (Table 3). Further Bonferroni adjusted post hoc analyses revealed a significant difference between the BMT and Control condition following the training, such that, as predicted, at post-training those in the BMT group (M = 35.63, SE = 1.25) had significantly lower STAI scores than those in the Control group (M = 41.04, SE = 1.20), F(1, 133) = 9.73, p = .002, η_p^2 = .068 (Figure 2).

Discussion

The present study aimed to assess the feasibility of delivering a remote BMT to examine the effects on AB, state anxiety, and mindfulness. We compared the effects of a single-session 25-minute MM to a control condition. It was hypothesized that individuals in the BMT group compared to the control group would report improvements in AB, reduced state anxiety, and increased state mindfulness. Additionally, we assessed whether meditation experience would impact the outcome of the BMT on novices versus practitioners. It was hypothesized that practitioners versus novices would display greater improvements in AB and state mindfulness following the BMT. These hypotheses were partially supported and discussed below.

The main finding of this study is that the BMT group reported greater reductions in state anxiety post-training than those in the control group, which is consistent with previous research (Zeiden et al., 2010). Our results suggest that a remotely delivered single session BMT is effective at reducing state anxiety compared to a control condition. Interestingly, there was a main effect of time (subsumed under the significant interaction) on state anxiety. Thus, in line with prior studies (e.g., Zeiden et al., 2010), the control condition (listening to National Geographic) served as a relaxing activity and reduced negative affect. While our control condition audio was replicated from Norris et al.'s (2018) study, there is research suggesting the anxiolytic effects of nature-based guided imagery (Nguyen & Brymer, 2018) and the relationship

between lower anxiety levels and nature relatedness, or personal connection to nature (Martyn & Brymer, 2014). Despite the overall reduction in state anxiety in both groups, the BMT group reported lower state anxiety post-training than Controls, indicating that the BMT had a significantly greater influence on state anxiety.

As predicted, the BMT group versus the control group reported higher levels of state mindfulness following the training, confirming previous studies showing that even brief mindfulness training can have a positive impact on state mindfulness (Howarth et al., 2019). This is particularly important confirmatory information in the context of the present, fully remote study because it demonstrates that online-based BMTs are feasible, cost-effective, and potentially effective.

There were no significant differences found between the BMT and Control group on AB measures. Although there are studies reporting the significant effects of BMT on AB (e.g., Wu et al., 2019), results are mixed (e.g., Howarth et al., 2019). Methodological design may have had an impact. For example, the single-session mindfulness training may be too brief to influence AB scores measured via the dot probe. Gill et al.'s (2020) meta-analysis examining single session mindfulness inductions and cognitive outcomes found only significant small effects on Higher-order function, but surprisingly no effects on attentional or executive functioning. More substantive MM training may be required to influence AB via attentional networks, as evidenced by the significant findings in studies assessing longer forms of MM, such as MBSR or MBCT (Vago & Nakamura, 2011; Holas et al., 2020). Additionally, more reliable measures of AB, such as event-related potentials (ERPs), were not obtainable due to the current study's remote design. There is a debate about the reliability of dot probe measures of AB, and therefore other

measures of AB, such as ERPs, may be more reliable and better able to capture individual differences and changes in AB (Carlson & Fang, 2020).

Limitations

There are several limitations to the present study. First, due to its remote nature, we were not able to employ the use of more reliable measures of AB, such as ERPs or eye-tracking, which are more sensitive to changes in AB over the course of assessment (Dennis et al., 2019). Additionally, we only explored the traditional AB measures of TB, Vigilance, and Disengagement. Future research could analyze trial level bias scores as a more dynamic measure of AB, accounting better for trial-by-trial level variability that has been found to occur over time (Zvielli et al., 2014).

Additionally, a high level of data was lost due to non-completion. While managing the present study, we noticed that additional survey controls were needed to ensure participants completed all tasks, particularly the dot-probe. Another limitation of the current study is that we relied on participant honesty as we were unable to monitor the 25-minute audio sessions. We cannot be certain that all participants participated in the BMT or Control condition, nor could we control for competing distractions in the participants' environments that may have affected the quality of the BMT. Future studies should closely monitor participant progress and put procedures in place to prevent participants' ability to skip tasks. Furthermore, to control for environmental factors, the BMT could be implemented in a controlled environment to eliminate competing distractions and ensure participation in the BMT or Control conditions.

Regarding the sample, participants were recruited college students enrolled in an entry-level psychology course from an urban university. In Bar-Haim et al.'s (2007) meta-analysis, AB "was not observed in non-anxious individuals". Due to the available participant pool, we did not

screen for clinically or sub-clinically anxious participants which might have resulted in fewer participants who displayed anxiety-related AB. It may be beneficial to screen for trait anxious individuals to further explore the relationship between anxiety-related AB and BMT. Although our sample was racially and ethnically diverse, future studies should recruit samples from non-university settings to increase generalizability. In regard to meditation experience, our exploratory analyses did not reveal any association between groups and meditation experience. Future studies may seek to recruit meditation naïve participants to account for meditation experience as a potential moderating variable. That said, it may be relevant to continue exploring how individual differences, such as meditation experience, relate to BMT outcomes.

Taken together, the findings from the current study provide support to the literature examining the efficacy of BMT, with improvements shown in state anxiety and state mindfulness. Additionally, the web-delivered nature of the study adds support to literature investigating the feasibility of digitally delivered interventions. While there were no significant improvements in anxiety-related AB, further research should be conducted with more reliable measures of AB to fully assess the relationship between BMT and anxiety-related AB.

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Appendix

Table 1

Descriptive Statistics for Baseline Anxiety and AB Measures.

Baseline Measures	Active				Control			
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range
1. BAI	65	17.22	12.57	0 - 47	70	18.31	14.29	0 - 58
2. STAI	65	44.20	12.01	20 - 77	70	44.54	12.56	22 - 73
3. DASS21	65	17.68	14.18	0 - 56	70	19.67	16.23	0 - 59
4. DASS21 Depression	65	6.00	5.77	0 - 21	70	7.01	6.63	0 - 21
5. DASS21 Anxiety	65	4.94	4.14	0 - 16	70	4.99	5.05	0 - 17
6. DASS21 Stress	65	6.74	5.22	0 - 19	70	7.64	5.67	0 - 21
7. Threat Bias	44	-7.78	33.01	-97.28 - 73.71	55	6.98	30.81	-56.20 - 87.69
8. Vigilance	44	-4.14	34.41	-81.16 - 76.71	55	8.03	29.95	-52.29 - 76.71
9. Disengagement	44	-4.61	30.49	-83.9 - 81.52	55	-2.77	29.68	-83.90 - 62.38

Note. BAI = Beck Anxiety Inventory; STAI-S = State Trait Anxiety Inventory - State; DASS21 = Depression Anxiety and Stress Scale – 21 item version.

No significant differences were found between active and control conditions on baseline measures.

Table 2

Correlations between Baseline Anxiety and Attention Bias Measures.

Baseline Measures	1	2	3	4	5	6	7	8	9
1. BAI	—								
2. STAI-S	.54**	—							
3. DASS21	.81**	.60**	—						
4. DASS21 Depression	.70**	.56**	.94**	—					
5. DASS21 Anxiety	.84**	.56**	.92**	.77**	—				
6. DASS21 Stress	.73**	.55**	.94**	.82**	.82**	—			
7. Threat Bias	-.08	.01	-.09	-.10	-.08	-.08	—		
8. Vigilance	-.17	.06	-.15	-.13	-.13	-.17	.62**	—	
9. Disengagement	.13	-.06	.07	.04	.06	.11	.30**	-.52**	—

Note. BAI = Beck Anxiety Inventory; STAI-S = State Trait Anxiety Inventory - State; DASS21 = Depression Anxiety and Stress Scale – 21 item version.

** indicates $p < .01$.

Table 3
Descriptive Statistics for Pre and Post Mindfulness and State Anxiety Measures.

Measures	BMT (n = 65)			Control (n = 70)		
	M	*SD*	Range	*M*	*SD*	Range
Pre-training measures						
FFMQ Observing	8.98	3.24	3 - 15	9.71	3.11	3 - 15
FFMQ Describe	9.55	3.12	3 - 15	8.93	3.21	3 - 15
FFMQ Awareness	10.35	2.47	5 - 15	10.19	2.6	4 - 15
FFMQ Non-Judging	10.48	3.32	3 - 15	9.6	3.35	3 - 15
FFMQ Non-Reactivity	8.49	2.71	3 - 15	8.56	2.9	3 - 15
MAAS	3.69	1.15	1 - 6	3.93	0.99	1 - 5.93
PTQ	23.42	12.16	0 - 42	26.43	11.69	0 - 42
STAI-S Time 1	43.00*	11.82	20 - 73	43.69*	10.34	24 - 64
Post-training measures						
TMS Curiosity	12.03*	5.71	0 - 24	9.61*	6.32	0 - 23
TMS Decentering	12.57*	6.17	0 - 28	10.11*	5.68	0 - 23
PQM	44.82*	22.03	0 - 100	36.83*	18.21	0 - 86.67
EQ	12.89**	5.11	3 - 21	10.23**	4.88	3 - 20
STAI-S 2	35.63*	9.92	20 - 67	41.04*	10.22	22 - 62

Note. FFMQ = Five Facet Mindfulness Questionnaire; MAAS = Mindful Attention and Awareness Scale; PTQ = Perseverative Thinking Questionnaire; TMS = Toronto Mindfulness Scale; EQ = Engagement Questionnaire; STAI-State = State-Trait Anxiety Scale – State.

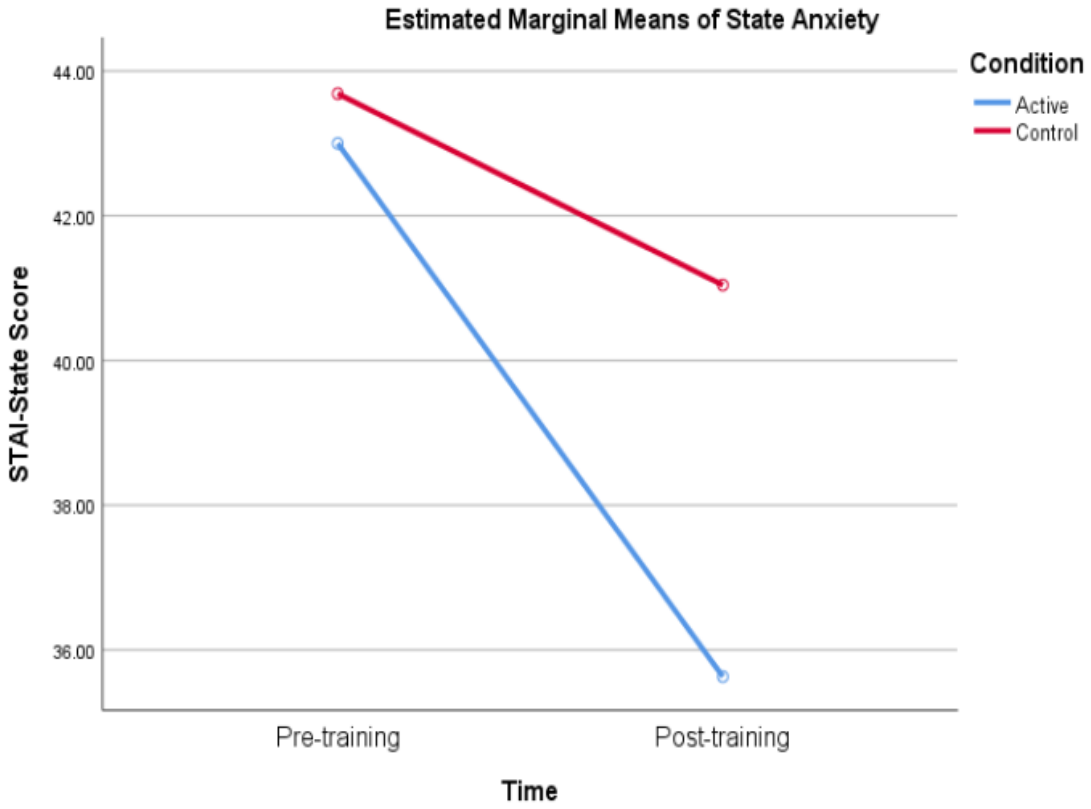
Asterisk indicates T-tests and mixed ANOVA are significant.

* indicates $p < .05$.

** indicates $p < .01$.

Figure 2

State anxiety scores pre- and post-training.



Note. Active (BMT) group displayed less state anxiety than control group at post-training.