Brief Mindfulness Meditation: Can it make a real Difference?

Abstract

Objectives: This study investigated the effects of a brief mindfulness meditation induction on trait mindfulness, and its components, mind-wandering, and negative affect, in comparison to control conditions.

Methods: Fifty-five non-meditators (*M* = 48 years, *SD* = 16 years; 62% female) completed pre- and post-intervention measures of trait mindfulness, negative affect, and both state and trait mind-wandering. Participants were randomly allocated to one of three 15 minute intervention conditions: brief mindfulness meditation (MM) induction, progressive muscle relaxation (PMR; active control), or viewing a Ted Talk video (passive control).

Results: There were non-significant increases in trait mindfulness and its components, non-significant decreases in mind-wandering and negative affect, and the groups did not differ significantly from each other. However, medium and large within-group effect sizes were found for attention and non-judging, respectively with other effect sizes being either small or negligible. Time x condition interaction effect sizes were medium for trait mindfulness, acceptance, and non-judging, and small or negligible for all others.

Conclusions: The 15-minute brief mindfulness meditation induction was insufficient to produce statistically significant changes in trait mindfulness, attention, non-judging, mind-wandering or negative affect. Although the time x condition interaction for acceptance was significant, this relates to increases in the MM group in comparison to decreases in the control conditions, which needs further investigation. The medium within-group effect size for attention suggests that longer mindfulness meditation inductions may result in larger increased levels of attention. Larger samples are recommended for future studies, with longitudinal designs to determine any lasting beneficial impacts.

Keywords Mindfulness, Mind-wandering, SART, Negative Affect

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In a general sense, stress appears a ubiquitous part of daily life for many individuals in Western societies, with psychological distress also being relatively common. High levels of self-reported negative affect (NA) are associated with both stress and psychological distress (Dua 1993). In an attempt to mitigate the psychological effects of such stress, distress, and negative affect in general, many turn to *mindfulness meditation* (MM); that is, meditation practices that encourage the individual to exist in the moment (Hölzel, Lazar, Gard, Schuman-Olivier, Vago and Ott 2011). To cater for the growing number of people seeking to engage in MM, numerous programmes and apps have been developed, with some claiming positive results in as little as five minutes practice per day (Van Dam, Van Vugt, Vago, Schmalzl, Saron et al. 2018). While such *brief* MM may appeal to time-poor, stressed or distressed individuals, this abridged approach appears at odds with the central tenet of MM, which was traditionally conceptualised within Buddhist traditions as training that helps one to increase the wholesome qualities and decrease unwholesome qualities, as well as understanding the impermanent nature of all phenomena (Rapgay and Bystrisky 2009). Specifically, within Buddhist literature, the cultivation of mindfulness is generally depicted as requiring years of rigorous MM practice to gain the wisdom to understand the subtleties of life that cause suffering, thus facilitating their amelioration (Goyal, Singh, Sibinga, Gould, Rowland-Seymour et al. 2014). Hence, cultivating mindfulness, in Buddhist traditions, involves daily MM practice over many years, if not the entire lifetime (Rapgay and Bystrisky 2009).

Despite this apparent discordance between Buddhist and Western manifestations of MM practices, some short MM approaches, for example, the Mindfulness Based Stress Reduction Program (MBSR; Kabat-Zinn, Lipworth and Burney 1985), and the Mindfulness Based Cognitive Therapy (MBCT; Segal, Williams and Teasdale 2018), have proved

effective for pain relief (Cramer, Haller, Lauche and Dobos 2012) and psychological disorders such as depression and anxiety (Chiesa and Serretti 2011), respectively. It is important to note that, while short, these programmes are not necessarily brief. Rather, they are typically completed over an eight week period during which participants engage in daily guided individual and/or group sessions of 30 to 60 minutes duration (Kabat-Zinn 1990). In contrast, brief MM activities have been described as single session inductions lasting less than 20 minutes, and/or less than one week of MM related activities (Heppner and Shirk 2018). Alternately they may be single or multi-session MM interventions lasting two weeks or less (Schumer, Lindsay and Creswell 2018). Nevertheless, numerous researchers have reported beneficial effects of brief MM inductions and interventions on cognition, pro-social behaviours, emotion regulation, pain management, perception of physical health, and health behaviours (see Heppner and Shirk 2018 for a review).

Given that the quantity of MM practice associated with MBIs and, in particular, brief MM inductions and interventions, falls far short of the amount commonly entailed within Buddhist practice traditions, the veracity of findings requires further investigation. Specifically there is a need to verify the accuracy of the central assumption that positive psychological and health outcomes reported to be associated with MBIs and brief MM inductions and interventions are due to participants' engagement in MM, that is that the underpinning mechanism of action is that MM inductions and interventions lead to increases in mindfulness, which is subsequently the cause of reduced psychological distress, increased psychological wellbeing, and improved health outcomes.

Effects of Mindfulness Meditation on Mindfulness and its Components

Some studies, such as that by Zeidan, Gordon, Merchant, and Goolkasian (2010) which found that brief MM of just 20 minutes per day over three days increased the level of trait mindfulness, provide support for the assumption outlined above - that MM increases

mindfulness. However, this finding is challenged by the findings of three key meta-analytic studies. First, in a meta-analysis of 72 studies, Visted, Vollested, Nielsen, and Nielsen (2014) found that MBIs increase self-reported trait mindfulness with a medium effect size (Hedges' g = .53), however, this increase was found to be non-significant when compared with active control conditions and 37 out of 72 studies did not find a significant increase in trait mindfulness from pre-to post-intervention. In the second meta-analysis of 37 randomised control trials (RCTs) by Baer, Gu, Cavanagh, and Strauss (2019), MBIs were found to increase trait mindfulness scores more than active control conditions with a small, pooled effect size (Hedges' g = .19) but the difference between MBIs and control conditions was found to be non-significant when the number and duration of sessions were matched.

Baer et al., also found that MBIs had small but significant effects in relation to the mindfulness components of observing (Hedges g = .24), non-judging (Hedges' g = .14), and non-reactivity (Hedges' g = .23). Similarly, in a meta-analysis of 88 MM RCTs, Quaglia, Brau, Freeman, McDaniel, and Brown (2016) found that MM increased the levels of attention, non-judgment, non-reactivity, and observation components, with moderate effect sizes indicated (Hedges' g of .44, .44, .50, and .47, respectively), with a small effect size reported for describing (Hedges' g = .28). However, when compared to control conditions, there was only a significant difference in relation to attention, and this difference was between the active (Hedges' g = .21) and inactive (Hedges' g = .56) control conditions. Hence, the impact of MM on mindfulness components was not significantly different to the impact of control conditions.

The meta-analytic findings of Visted et al. (2014), Quaglia et al. (2016), and Baer et al. (2019) demonstrate the importance of including both active and passive control conditions within studies designed to evaluate MBIs and brief MM inductions and interventions, and of ensuring that control conditions are matched to the intervention with regard to session

numbers and duration. Concerns have also been raised regarding the possibility of results being affected by participant expectancies, whereby an increase in self-reported mindfulness resulted from by participants expecting to have increased mindfulness after completing the MM intervention or induction (Visted et al. 2014; Sedlmeier, Eberth, Schwartz, Zimmermann, Haarig et al. 2012). It has, thus, been suggested that the inclusion of objective measures of mindfulness may counter the potential impact of these issues (Davidson and Kaszniak 2015). However, difficulties arise with measuring mindfulness, including some of its components, without using self-reports because mindfulness essentially consists of mental activities that are unobservable and are only measurable indirectly. The exception here is the attention (observing) component of mindfulness.

Among mindfulness researchers, there is broad agreement that attention is the central element of mindfulness and MM is conceptualised as essentially attentional training in both Buddhist contexts as well as modern psychology (Carmody 2009). Several studies that used objective measures in their studies have reported an increase in attention following MM interventions when spread over few weeks (e.g. Jha, Krompinger and Baime 2007; Malinowski et al. 2017) down to few days (Zeidan, Johnson, Diamond, David and Goolkasian 2009), although few studies have also investigated the effects of brief MM inductions on attention using objective measures. Notable exceptions include Norris, Creem, Hendler, and Kober (2018) who reported a 10-minute brief MM improved attention measured objectively using a Flanker task (Eriksen and Eriksen 1974) in comparison to a control condition of passively listening to a National Geographic audio tape about giant sequoias. Similarly, Wenk-Sormaz (2005) found that a 20-minute brief MM improved participant performance on a Stroop task (Stroop 1935) compared to control condition participants, who were asked to just rest, and let their minds wander.

In contrast, Larson, Steffen, and Primosch (2013) found no difference between those who participated in a mindful breathing exercise over 14 minutes and those who listened to an audio tape about relaxation and ethical living in relation to their performance on the Eriksen Flanker Task. Similarly, Johnson, Gur, and Currier (2015) did not find a significant difference in performance on sustained attention tasks including the Symbol Digit Modalities Test (SDMT; Smith 1982), the Computer-adaptive adjustable two-back task, and the Trail Making Test, parts A and B (Reitan 1958), between those who participated in a 25 minute MM, a sham MM, or a reading task.

This change in approach, from measuring sustained attention to lapses in sustained attention, is evident in the growing body of research investigating mind-wandering in relation to mindfulness and MM. Mind-wandering, which has been found to be positively associated with depression, anxiety, stress, and negative affect (Killingsworth and Gilbert 2010; Medvedev, Norden, Krägeloh and Siegert 2018; Seli, Beaty, Marty-Dugas and Smilek 2019), has been described as the periodic straying of attention from a task with which one is engaged (Smallwood and Schooler 2006). While self-report questionnaires have often been used to measure mind-wandering, including the Attention Related Cognitive Errors Scale (ARCES; Cheyne, Solman, Carriere and Smilek 2009), the Mindful Attention and Awareness Scale-Lapses Only (MAAS-LO; Carriere, Cheyne and Smilek 2008), and the Mind-Wandering Questionnaire (MWQ; Mrazek, Phillips, Franklin, Broadway and Schooler 2013), some researchers, such as Mrazek, Smallwood and Schooler (2012) have instead used laboratory-based tests of sustained attention to measure mind-wandering objectively.

Mrazek et al. (2012) found that eight minutes of mindful breathing reduced self-reported and SART measured mind-wandering. Similarly, Morrison, Goolsarran, Rogers, and Jha (2014) found that seven hours of mindfulness training improved SART performance as well as self-reported mind-wandering. In contrast, Xu, Purdon, Seli, and Smilek (2017) found

that, when compared with a control group that passively listened to an extract from a book, brief MM of 10 minutes prevented an increase in mind-wandering during an attention task (Metronome Response Task, MRT; Seli, Cheyne and Smilek 2013), but did not reduce it. Similarly, another study by Banks, Welhaf, and Srour (2015) found that, when compared to a group that participated in relaxation training, even a one-week MM practised at home, did not reduce mind-wandering, as measured by thought probes inserted into a working memory task. Banks et al. suggest that the findings of Mrazek et al. (2012) and Morrison et al. (2014) may be due to expectation effects as neither study included an active control group. Furthermore, Banks et al. suggest that the results obtained by Morrison et al., may be due to the longer duration of their intervention, of eight weeks as opposed to one week in Banks et al.'s study. Lastly, Giannandrea et al. (2019) found that MBSR training reduced SART errors, but not self-reported mind-wandering.

Mrazek et al. (2012) reported that they could not determine the precise mechanism by which MM reduced mind-wandering. However, other studies have found that MM interventions that incorporated training in both attention and acceptance had a superior effect on SART performance when compared with attention training alone, relaxation training alone or a reading condition (Rahl, Lindsay, Pacilio, Brown and Creswell 2017; Lindsay, Young, Smyth, Brown and Creswell 2018). These findings, therefore, suggest that it may be beneficial to examine the association of not just overall mindfulness but also its components.

Effects of Brief Mindfulness Meditation and Mindfulness on Psychological Distress

The common element of various forms of psychological distress including high levels of stress, depression, and anxiety is negative affect (Dua 1993). Many studies reported beneficial effects of brief MM inductions and interventions on psychological distress, particularly negative affect. For example, Erisman and Roemer (2010) found that those who participated in a 10-minute MM induction had less negative affect compared to those who received 10 minutes of educational information. Arch and Craske (2006) found that after taking part in a 15-minute mindful breathing session, participants reported less negative affect after viewing negatively and neutrally valenced pictures than control condition participants who were instructed to let their mind wander for 15 minutes. Johnson et al. (2015) found that just one session of a 25-minute MM reduced overall distress scores, including tension, confusion, and anger, when compared to a passive book listening control condition, but not in comparison to a sham MM intervention. Vinci, Peltier, Shah, Kinsaul, McVay et al. (2014) found that a 10-minute MM reduced negative affect more than the control condition which involved solving a word puzzle, but not in comparison to a relaxation condition. Thompson and Walsh (2007) found that after a 10-minute MM, both positive affect and negative affect decreased. Lastly, in a meta-analysis of 65 RCTs. Schumer et al. (2018) found that brief MM reduced negative affectivity, with a small effect size (Hedges' g = .21), although this effect size decreased (Hedges' g = .04), after taking publication bias into account.

Not all brief MM interventions have, however, reported beneficial effects. For example, Vinci et al. (2014) found that, among college drinkers, a 10-minute MM intervention did not reduce the urge to drink compared to those in the control group who were engaged in solving word puzzles. Vinci et al. suggested that the mindfulness intervention may have been too brief to produce the predicted changes in drinking.

The Present Study

To summarise, while some studies have found that brief MM increases self-reported trait mindfulness (e.g., Zeidan et al. 2010), and attention (e.g., Norris et al. 2018), and reduces mind-wandering (e.g., Mrazek et al. 2012) and negative affect (e.g., Erisman and Roemer 2010), it may be too brief to increase levels of acceptance and non-judging because attention needs to be stabilised first (Lutz, Slagter, Dunne and Davidson 2008; Malinowski et al. 2017). As a result, brief MM may not increase overall trait mindfulness scores because most multicomponent scales measure trait mindfulness by combining the scores of all trait mindfulness components. This possibility requires investigation.

Similarly, while Mrazek et al. (2012) reported that eight minutes of mindful breathing reduced minds-wandering, this finding was not supported in studies by Banks et al. (2015) and Xu et al. (2017). Therefore, there is a need to further investigate the impact of brief MM on mind-wandering. Lastly, considering that even the MBIs which generally last about eight weeks do not seem to be consistently superior to comparable interventions in reducing psychological distress, it remains unclear at this point if brief MM inductions and interventions can reduce negative affect and if so, whether it would be superior to comparable interventions.

Given this lack of consensus in the literature, the current study aimed to increase clarity by evaluating the impact of a brief MM induction on levels of self-reported mindfulness and its components, as well as self-reported and objectively measured mind-wandering, and negative affect, all in comparison to both active (progressive muscle relaxation; PMR) and passive (viewing a Ted Talk) control conditions with matched session duration. The active control condition was a progressive muscle relaxation (PMR) activity, while the passive control condition involved participants viewing a Ted Talk.. Based on current literature which, although sometimes contradictory, largely suggests that brief MM

inductions and interventions are not capable of producing effects beyond those of expectation (that is, placebo), the following three hypothesis were proposed:

1. that no significant difference would be found between the brief MM induction condition and the active (PMR) and passive (Ted Talk) control conditions in relation to self-reported changes in levels of mindfulness or its components (attention, acceptance, non-judging);
2. that no significant difference would be found between brief MM induction condition and the active and passive control conditions in relation to changes in self-reported and objectively measured mind-wandering;
3. that no significant difference would be found between the brief MM induction condition and the active and passive control conditions in relation to self-reported changes in levels of positive and negative affect.

Method

Participants

Using G*Power 3.1.9.7 (Faul, Erdfelder, Lang and Buchner 2007), a minimum of 42 participants was identified as being required to conduct the study, with a medium effect size of .25, an alpha level of .05 and power of .80. A subset of 65 participants from a larger study participated in the interventions, of which 55 completed all measures. The participants, recruited by Qualtrics® from the USA, Australia and India, had no experience or less than one year's experience in meditation and comprised of 34 (62%) females and 21 (38%) males, ranging in age from 21-76 years (M = 47.95 years, SD = 15.97). Overall, 60% of participants had completed an undergraduate degree and 58% were employed.

Participants were randomised into three condition groups, *Mindfulness Meditation Group* (MMG), *Progressive Muscle Relaxation Group* (PMRG), and the control *Ted Talk Group* (TTG). The MMG consisted of 21 participants of whom 13 (62%) were female, and 8

(38%) were male, ranging in age from 24 to 75 years (*M* = 47.19 years, *SD* = 15.47). The PMRG consisted of 15 participants of whom 8 (54%) were female, and 7 (46%) were male, ranging in age from 21 to 73 years (*M* = 42.07 years, *SD* = 17.27). The TTG consisted of 19 participants of whom 13 (68%) were female, and 6 (32%) were male, ranging in age from 30 to 76 years (*M* = 53.42 years, *SD* = 14.37). Demographic details are displayed in Table 1

<<Insert Table 1 about here>>

Materials

Participants completed pre- and post-intervention measures via an anonymous online questionnaire hosted by Qualtrics® which consisted of demographic items (e.g., age, sex, education, and employment), and scales measuring baseline trait mindfulness, trait mind-wandering, and negative affect. Participants also completed the SART pre and post completion of one of the interventions associated with the three conditions: brief MMG, PMRG or TTG. Details of the measures and intervention materials used in the study are as follows:

The Carolina Empirically Derived Mindfulness Inventory (CEDMI; Coffey, Hartman and Fredrickson 2010) is a 22-item scale that measures trait mindfulness. Respondents are asked to indicate on a 5-point scale how true each item is of them (from 1 = *never or very rarely true* to 5 = *very often or always true*). The scale yields a total mindfulness score along with scores for three subscales: attention (8 items), acceptance (6 items), and non-judging (8 items). All scores range from 1-5 with higher scores indicating higher levels of mindfulness or the named components. Good internal consistency reliability has been reported for the full scale and the subscales (attention: α = .74; acceptance: α =. 90; non-judging: α = .87; trait mindfulness total score: α =. 88; Coffey et al. 2010), which are similar to the ones found in the current study (attention: α =. 91; acceptance: α =. 95; non-judging: α = .94; trait mindfulness total score: α =. 83).

The Mind Wandering Questionnaire (MWQ; Mrazek et al. 2013) is a 5-item scale that measures trait mind-wandering. Respondents are asked to indicate on a 6-point scale how true each item is of them (from 1 = *almost never* to 6 = *almost always*). Scores range from 1-6 with higher scores indicating higher levels of mind wandering. Good internal consistency reliability has been reported for the scale (α = .85 Mrazek et al. 2013), which are similar to the ones found in the current study for (α =. 90).

The Positive and Negative Affective Schedule (PANAS; Watson, Clark and Tellegen 1988) is a 20-item scale of which ten measure positive affect and ten negative affect. Each item is a word that describes different emotions or feelings. Respondents are asked to indicate on a 5-point scale to what extent they experienced an emotion or feeling at that moment (from 1 = *very slightly or not at all* to 5 = *extremely*). Scores for both positive and negative affect range from 10 to 50 with higher scores indicating the levels of the affect being measured. Good internal consistency reliability has been reported for both scales, positive affect (α = .89) and negative affect (α = 85) (Watson et al. 1988). These are similar to the internal reliability coefficients obtained in this study, positive affect (α = .93) and negative affect (α = 85).

Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley and Yiend 1997) is an objective albeit indirect measure of sustained attention and mind-wandering (Smallwood, Davies, Heim, Finnigan, Sudberry et al. 2004). In this test, participants are presented a single digit between 1 and 9 in the middle of a computer screen in varying font sizes. Participants are asked to respond by pressing the space bar if any digit other than 3 (GO targets) is presented and withhold from responding if digit 3 (NO-GO targets) is presented. The nine digits are presented at a steady rate in five font sizes, 25 times each, totalling 225 trials. Each digit appears on the screen for 250ms with an inter-stimulus interval of 900ms during which a mask appears on the screen. The total duration of the

experiment is approximately 4 minutes. A practice session that includes 18 trials with the NO-GO targets presented twice precedes the experiment.

SART offers many outcome variables as a measure of mind-wandering. For this study, *commission errors* (CEs; pressing the space bar when the digit 3 appears), *omission errors* (OEs; failing to press the space bar when a digit other than 3 appears), and *response time coefficient of variability* (RT_CV; standard deviation around correct responses to GO targets divided by the corresponding mean reaction times), were included as markers of mind-wandering. While CEs are considered markers of significant lapses of attention, OEs and RT_CV indicate minimal disruption of attention (Mrazek et al. 2012; Cheyne et al. 2009). SART has been used by many researchers as a tool for indexing mind-wandering (Morrison et al. 2014) and has good test-retest reliability (Robertson et al. 1997). Robertson et al. (1997) initially confirmed the external validity of the SART using the Cognitive Failures Questionnaire (CFQ, Broadbent, Cooper, FitzGerald and Parkes 1982). Smilek, Carriere, and Cheyne (2010) reconfirmed SART's external validity by using the ARCES and the MASS-LO.

Interventions: Brief MM induction (MMG). MMG participants were guided through a 15-minute mindful body scan meditation which involved paying attention sequentially to different parts of the body while ignoring any distracting thoughts that arose. This method is adapted from the U Ba Khin method that was developed by Sayagi U Ba Khin, a well-known Burmese meditation master (Anālayo 2006). Guided instructions were delivered by the first author (LHS) who is an experienced practitioner and teacher of mindfulness meditation. This brief MM was chosen because body scan is generally the first step in MM, both in the Buddhist traditions as well as the MBIs such as MBSR.

Active Control Condition: Progressive Muscle Relaxation (PMRG). Participants in the active control condition were guided through a process that involved sequentially

tensing and relaxing different parts of the body. The instructions were based on Bernstein and Borkovec's (1973) progressive relaxation training, and took 15 minutes for the participants to complete. Guided instructions were delivered by the first author (LHS). PMR was selected as an active control condition because, like body-scan MM used in this study, it guides the participants to focus on different parts of the body to produce a state of relaxation and calmness (Jain, Shapiro, Swanick, Roesch, Mills et al. 2007). PMR differs from MM, however, in that there are no explicit instructions to disengage from the thoughts that arise from moment to moment. Moreover, Banks et al. (2015) have suggested that relaxation training generates similar levels of participant expectancies as MM.

Passive Control Condition: Ted Talk Video (TTG). The 15 minute Ted Talk video was of Paul Hessburg discussing the impact of deforestation on wild fires, which was initially presented in May 2017 in the USA and was accessed via YouTube (https://www.ted.com/talks/paul_hessburg_why_wildfires_have_gotten_worse_and_what_we_can_do_about_it). This Ted Talk video was chosen because it was of the same length as the other two interventions and was not related in any way to MM or PMR.

Procedure

The study received approval from the Human Research Ethics Committee of the University of New England (approval number: HE 19-168). On accessing the study's online questionnaire, participants were required to read the information statement for participants and to indicate their consent before being able to proceed further with the study.

After completing demographic items and pre-intervention measures in the questionnaire participants were automatically redirected to another site to complete the SART. It took participants approximately 30 minutes to complete the pre-intervention measures including the SART. Participants were then randomly assigned to one of the three conditions (MMG, PMRG or TTG), which involved participants completing the associated intervention

or control activity. All three activities were embedded in the questionnaire and lasted approximately 15 minutes. After completion of either audio or video activities, participants were able to complete the post-intervention questionnaire measures and SART. It took participants approximately 35 minutes complete this final part of the study. All participants were compensated for their time by via Qualtrics.

Data Analyses

A one-way of analysis of variance (ANOVA) was conducted to examine the differences between the groups in terms of age while a chi-square test was used to examine differences in sex, followed by a correlational analyses to investigate the relationship between all the variables of interest. These analyses were followed by a series of mixed between-within subjects ANOVAs to investigate the impact of the brief MM induction, in comparison to the PMR, and TT control conditions on self-reported mind-wandering, SART errors, and negative affect across two time periods (T1: pre-intervention, and T2: post-intervention). Data analysis was conducted using IBM SPSS version 27 (IBM Corporation, 2020).

Results

A one-way analyses of variance (ANOVA) confirmed that there was no significant difference between the three conditions in terms of age: F (2, 52) = 2.58, p = .12, η_p^2 = .08 (medium effect size). Similarly, a chi-square test indicated no significant difference relating to sex χ^2 (2, n = 55) = .81, p = .67, Cramer's V = .12 (small effect size) (see Table 1). Additional one-way ANOVAs demonstrated that the groups did not differ significantly on any of the variables pre-intervention (see Table 2). The lack of difference between the groups indicated successful randomisation.

<< Insert Table 2 about here>>

Table 3 presents the correlations between all variables for all participants at T1.

<< Insert Table 3 about here>>

A series of mixed between-within subjects ANOVAs were then conducted to compare brief MM, PMR and TT conditions in terms of their impact on trait mindfulness and its components, along with self-reported and objective markers of mind-wandering, and positive and negative affect between T1 to T2. The main and interaction effects of time and group on all outcomes are presented in Table 4, and the percentage of change in group mean scores of the variables is presented in Figures 1,2, and 3.

<< Insert Figures 1, 2, and 3, and Table 4 about here>>

TM and its components

The results of the two-way mixed ANOVAs indicated that there were no significant main effects of time or condition, and while time x condition interaction for trait mindfulness, attention, and non-judging scores was non-significant, it was significant for acceptance (see Table 4). However, a medium effect was indicated for the main effect of time on attention scores ($\eta_p^2 = .06$), with mean scores for all three groups increasing between T1 and T2 (see Table 4 and Figure 1). A large effect size was indicated for the main effect of time on non-judging scores ($\eta_p^2 = .14$) with scores of all three groups decreasing from T1 to T2 (see Table 4 and Figure 1). Time x condition interaction effect sizes for trait mindfulness and non-judging were medium ($\eta_p^2 = .10$ and .06, respectively).The mean scores of trait mindfulness decreased from T1 to T2 marginally in the PMR condition (2%) and substantially in the TT (8%) condition, while they increased marginally (2%) in the MM condition. In contrast whereas non-judging scores decreased from T1 to T2 in all three groups, MMG (4%), PMRG (7%), and TTG (15.4%). The time x condition interaction effect size for acceptance was significant with its mean scores decreasing in both PMR and TT conditions (3% and 4.7 %, respectively) while they increased (5.4%) in the MM condition.(see Figure1). The interaction effect size for attention was negligible.

Mind-wandering

The results of the two-way mixed ANOVAs indicated that there were no significant main effects of time or condition, and no significant time x condition interactions for trait mind-wandering or the SART outcome measures (see Table 4). The effect sizes were either small or non-existent for all variables for the main effects of time and group, and also for time x condition interaction (see Table 4). While the trait mind-wandering scores decreased from T1 to T2 in the MM group, they increased in both control conditions. Similarly, while the SART outcomes, CEs and RT_CV scores decreased from T1 to T2 in all three conditions, the OEs scores increased in both control conditions (see Figure 2).

Positive and Negative Affect

The results of the two-way mixed ANOVAs indicated that there were no significant main effects of time or condition, and no significant time x condition interactions for both positive and negative affect (see Table 4). While the effect sizes were either small or non-existent for main effect of time for both positive and negative affect, the effect size for the main effect of condition was medium for positive affect ($\eta_p^2 = .06$) with the scores decreasing between T1and T2 for the PMR group but increasing for the MM and TT groups (see Figure 3). The time x condition interaction effects for both positive and negative affect were small.

Discussion

As hypothesised, there were no significant time, condition, or time x condition interaction effects found in relation to levels of trait mindfulness, attention or non-judging but the time x condition interaction effect for acceptance was significant. However, the main effect of time on attention was found to have a medium effect size, reflecting the increase in attention scores from T1 to T2 for all groups, while for non-judging, the main effect of time was found to have a large effect size, reflecting a decrease in non-judging scores from T1 to T2 for all groups. Therefore, while the first hypothesis was technically supported, there is a

need to consider the implications associated with these medium and large effect sizes. Furthermore, while the time x condition interaction was significant for acceptance, the effect sizes of time x condition interaction for trait mindfulness, acceptance and non-judging were medium.

Similarly, there was no main effect of time or group in relation to self-reported and SART measured mind-wandering, nor in relation to positive and negative affect, thereby supporting the second and third hypotheses. Although the main effect of time on trait mind-wandering, CEs and RT_CV were small, their scores decreased in the MM group. While the main effect of time on positive effect was non-existent, it was small for negative affect with its scores decreasing in all three groups. The effect sizes for the time x condition interaction for trait mind-wandering and the SART outcome variables were small.

The finding that the brief MM induction increased attention, albeit non-significantly, is consistent with other studies which employed brief MM inductions ranging from five minutes (Friese et al. 2012) to 10 minutes (Norris et al. 2018) and 20 minutes (Wenk-Sormaz 2005). The current study also supports other studies which found that attention levels increased after longer sessions of MM ranging from four days (Zeidan, Johnson et al. 2010) to eight weeks (Jha et al. 2007). The effect size in the current study was, however, medium compared to the large effect size in Zeidan, Johnson et al.'s (2010) study. This may suggest that longer practice of MM leads to larger increases in attention which is consistent with the suggestion by Lutz et al. (2008).

Nevertheless, it is important to note that the amount of increase in attention reported by the brief MM induction group participants did not differ significantly from that reported by the active or passive control group participants. Hence, all groups reported a similar increase in attention levels from T1 to T2. This is consistent with the results of both Larson et al. (2013), and Johnson et al. (2015), Banks et al. (2015), and Xu et al. (2017). Similarly,

Johnson et al. (2015) did not find significant differences between MM induction and control conditions in their impact on cognitive tasks. They surmised that the reason for this could be the demanding nature of cognitive tasks they used and suggested that less demanding tasks such as SART might be more responsive to MM type interventions. The current study did employ SART but still did not find any significant difference between the effects of different interventions. In a similar vein, to investigate mind-wandering Giannandrea et al. (2019) suggested using self-report questionnaires specific to trait mind-wandering which this study used (MWQ) but still did not find a significant impact of MM on self-reported mind-wandering. Therefore, the likely reason for the lack of MM impact on trait mind-wandering and the SART variables may be the brevity of MM intervention rather than the cognitive tasks used or the choice of the measurement instrument. However, future studies could examine whether the nature of cognitive tasks or measurement instruments make a difference in the impact of brief MM interventions on mind-wandering.

Conversely, the current study's findings that brief MM did not significantly increase the levels of either trait mindfulness or acceptance contradict a number of studies, including Baer et al. (2019), Visted et al. (2014), and Zeidan, Gordon et al. (2010). Looking at the results more deeply, particularly at the changes from T1 to T2 in the levels of trait mindfulness, acceptance and non-judging, it appears that the brief MM intervention did have greater impact than the control conditions. Specifically, both trait mindfulness and its acceptance component increased in the MM group, but they decreased for the PMR group and TT groups. Further, while the levels of non-judging decreased in all three groups, the decrease was greater in the TT group than for the MM and PMR groups. The increase in trait mindfulness scores from T1 to T2 in the MM group is consistent with Zeidan, Gordon et al. (2010) who found that MM increased mindfulness more than control conditions. The increase in trait mindfulness in the MM groups is also consistent with two meta-analytic findings by

Visted et al. (2014) and Baer et al. (2019). The increase in acceptance levels in the MM group in the present study is consistent with Baer et al. (2019) who found in a meta-analysis that acceptance scores increased significantly from pre to post intervention in the MM group when compared with control groups with the increase becoming non-significant when session times were matched for MM and the control groups. Hence, when the medium and large effect sizes are considered, this study's results are consistent with the findings of Baer et al. (2019), Visted et al. (2014), and Zeidan, Gordon et al. (2010) studies. It may be that the current study lacked the statistical power to detect an effect. Alternatively, the variance between the results of the present study and the comparable studies referred to above, may reflect the length of MM intervention studied. While in Zeidan, Gordon et al.'s study the MM was over three days, Visted et al. (2014) and Baer et al.'s (2019) studies related to MBIs which generally lasted eight weeks. In contrast, the interventions in the current study lasted just 15 minutes. Lastly, the current study findings are consistent with Malinowski et al. (2015), who found that even eight weeks of MM increased the levels of only attention but not trait mindfulness or its components, acceptance and non-judging. However, as noted above, in the current study, non-judging levels decreased from T1 to T2 in the present study, indicating that the participants became more judgmental over the duration of the study. This may have been due to the increasing demands and the attendant strain associated with the study completion, including participants completing the same self-report questionnaires and demanding cognitive tasks twice. The largest decrease in non-judging scores was evident for the Ted Talk group. It is possible that this could have been related to the content of the presentation, which was about how indiscriminate deforestation has resulted in increase in wild-fires resulting in destruction of flora and fauna.

Similarly, the present study's findings that neither trait mind-wandering nor the SART measures of mind-wandering, CEs, OEs and RT_CV decreased significantly from T1 to T2,

and there were no significant interaction effects, contradicts Mrazek et al. (2012). Nevertheless, it is evident that brief MM intervention resulted in slightly decreased level of trait mind-wandering from T1 to T2, in comparison to the increased levels reported by the PMR and TT groups, with small effect indicated for time x condition interaction. Similar small effects were indicated in relation to the interactions for the SART variables, whereby the MM group improved their performance on all indices, indicating decreased mind-wandering, in contrast to the PMR and TT groups where the performance varied. Hence, while non-significant and associated with small effects, the trend of the results is in concordance with Mrazek et al.'s (2012) findings. It is possible that there may be a fundamental difference between the mindful breathing used by Mrazek et al. and the body scan meditation used in the current study. Colgan, Christopher, Michael and Wahbeh (2015) reported that the mechanisms of action of mindful breathing and body scan differ from each other, in that the body scan meditation focuses on the body and sensations within the body as compared to mindful breathing which focusses on the physical sensations associated with the breathing. It has also been suggested that mindful breathing calms the body and mind (Wielgosz, Schuyler, Lutz and Davidson 2016), which might have resulted in the Mrazek et al.'s study participants performing better on the SART in comparison to the control groups. An alternate explanation suggested by the brief MM induction group improving their performance (although non-significantly) on the mind-wandering measures is that MM is dose dependent with genuinely brief interventions, such as used in the current study and promoted by various MM apps, not being sufficient to result in significant changes in mindful attention. If this is the case, it would be in keeping with Buddhist traditions that emphasise the need for regular MM practice over many years, if not the entire lifetime (Rapgay and Bystrisky 2009).

Finally, this study's finding that the impact of brief MM on negative affect was not significantly different to the passive and active control conditions is consistent with Vinci et al. (2014) who found that brief MM was not significantly different to relaxation in reducing negative affect in problematic college drinkers. While Vinci et al. suggested that brief MM was insufficient to reduce negative affect, this could be justifiably criticised as only relevant to that specific sample. The current study extends this, demonstrating that the same effect can be found in a general population sample. Although not a primary focus, this study also found that neither brief MM nor the control conditions significantly changed the levels of positive affect from T1 to T2.

Study limitations include that, while G*Power calculations suggested that the sample size was adequate for the analysis undertaken, the fact that medium and large effect were associated with non-significant findings indicates that a larger sample size was required. Additionally, it is possible that a longer MM induction duration or a multi-session intervention, may have resulted in larger (and statistically significant) effects on the outcome variables of interest. Another potential limitation of the study is that a measure of trait mindfulness was used rather than a measure of state mindfulness, which may have been more sensitive to any intervention-induced changes in mindfulness variables.

This study is an important one because it helps to clarify further the relationship between brief MM, trait mindfulness and its components, mind-wandering, and negative affect. In the light of burgeoning research on mindfulness, it is necessary, as suggested by Johnson et al. (2015), to guard against making exaggerated claims about the beneficial effects of brief mindfulness interventions. The study shows that trait mindfulness is negatively associated with trait mind-wandering and SART measured mind-wandering and negative affect, which aligns with the existing literature (e.g., Mrazek et al. 2012). However, it does not appear that brief MM significantly increases the levels of trait mindfulness and its

components or decreases self-reported and indirectly measured mind-wandering and negative affect. It has to be noted that the time x condition interaction effect for acceptance was significant, although this is due to decrease in acceptance reported by control groups at T2, in comparison to the slight increase reported by the MM group, rather than an indication of the brief MM induction leading to a large increase in acceptance. This decrease in acceptance for the control groups requires further investigation.

Considering these results it seems likely that higher doses of mindfulness interventions, such as longer MM sessions completed regularly, are probably needed to obtain effects that are not only statistically significant but also clinically useful, particularly in reducing mind-wandering and negative affect. Mrazek et al. suggested that there are no other known interventions that can reduce mind-wandering but MM seems to hold promise; this study's findings would suggest that brief MM inductions do not have this outcome. Future research should investigate the impacts of differing session lengths, frequencies of practice, and types of MM activities to determine the properties such interventions require to result in meaningful increases in mindfulness and reductions in mind-wandering and negative affect. Longitudinal studies could then determine the lasting benefits of such interventions, so as to better inform the practices of people seeking to use mindfulness to manage the stress, distress and negative affect that they experience in daily life.

Conflict of interest

The authors declare that they have no conflict of interest

Ethical standards

The manuscript does not contain clinical studies or patient data

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Table 1. Demographic characteristics of the study participants

	MMG *N* = 21	PMRG *N* = 15	TTG *N* = 19	*F*	χ^2	*p*
Age	*M* = 47.19 *SD* = 15.47	*M* = 42.07 *SD* = 17.27	*M* = 53.42 *SD* = 14.37	2.58		.115
Sex					.81	.667
Male	8 (38%)	7 (47%)	6 (32%)			
Female	13 (62%)	8 (53%)	13 (68%)			
Education						
Year 12 or less	11 (52%)	4 (27%)	7 (37%)			
Undergraduate or above	10 (48%)	11 (73%0	12 (63%)			
Employment						
Employed	13 (62%)	9 (60%)	10 (53%)			
Not working	7 (33%)	5 (33%)	9 (47%)			
Student	1 (5%)	1 (7%)	-			

Note: MMG = mindfulness meditation group, PMRG = progressive muscle relaxation group, and TTG= Ted talk group

Table 2 Descriptive statistics for all variables at pre-intervention (T1)

	MM group *n* = 21		PMR group *n* = 15		TT group *n* = 19		*F*	*p*	η_p^2
	M	*SD*	*M*	*SD*	*M*	*SD*			
TM	3.49	0.60	3.42	0.53	3.76	0.54	1.76	.182	0.06
Attention	3.47	0.93	3.15	1.05	3.36	1.14	0.42	.661	0.02
Acceptance	3.54	1.28	3.88	1.23	4.18	0.99	1.50	.232	0.05
Non-judging	3.48	1.09	3.37	1.35	3.84	1.02	0.83	.440	0.03
TMW	3.33	1.24	3.05	1.31	2.94	1.24	0.52	.596	0.02
CEs	11.33	6.04	11.93	6.17	10.00	6.77	0.43	.654	0.02
OEs	27.43	44.05	20.60	31.18	23.42	47.26	0.12	.888	0.00
RT_CV	0.32	0.12	0.31	0.09	0.26	0.07	1.90	.160	0.06
PA	31.33	9.22	34.60	8.37	27.89	10.46	2.12	.130	0.08
NA	18.19	12.00	17.73	9.42	18.00	10.70	0.01	.992	2.95

** $p < .001$, *$p < .05$ (2-tailed). *Note:* TM = Trait mindfulness, TMW = Trait Mind-wandering, CE = Commission errors, OEs = Omission errors, RT_CV = Coefficient of response time variability, PA = Positive affect, and NA = Negative affect

Table 3. Pearson correlations between the pre-intervention (T1) scores of key variables

	Variable	1	2	3	4	5	6	7	8	9	10
1	TM	-									
2	Attention	.00	-								
3	Acceptance	.77**	-.46**	-							
4	Non-judging	.77**	-.54**	.68**	-						
5	TMW	-.61**	.34*	-.64**	-.64**	-					
6	CE	-.09	.09	-.12	-11	.03	-				
7	OE	-.26	.23	-.30*	-.33*	.27*	.12	-			
8	RT_CV	.11	-.08	.14	.12	-.04	.21	.05	-		
9	PA	-.23	.57**	-.44**	-.47**	.12	.31*	.19	-.04	-	
10	NA	-.62**	.36**	-.60**	-.70**	.60**	.08	.47**	-.06	.33*	-

** $p < .001$, *$p < .05$ (2-tailed). *Note:* TM = Trait mindfulness, TMW = Trait mind-wandering, CE = Commission errors, OE = Omission errors, RT_CV = Coefficient of response time variability, PA = Positive affect, and NA = Negative affect

Table 4. Descriptive statistics for all variables post-intervention (T2)

	MM Group *n* = 21		PMR Group *n* = 15		TT Group *n* = 21		Within subjects effects		η_p^2	Between subjects effects		η_p^2	Time x Group Interaction		η_p^2
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*		*F*	*p*		*F*	*p*	
TM	3.57	0.49	3.35	0.53	3.46	0.70	2.26	.139	0.04	0.76	.473	0.03	2.97	.060	0.10
Attention	3.66	0.74	3.30	0.97	3.50	1.12	3.29	.075	0.06	0.59	.560	0.02	0.04	.964	0.00
Acceptance	3.72	1.08	3.74	1.11	3.69	1.17	1.71	.197	0.03	0.42	.660	0.02	3.31	.044	0.11
Non-judging	3.35	1.14	3.12	1.31	3.25	1.24	8.38	.006	0.14	0.32	.731	0.01	1.65	.202	0.06
TMW	3.26	1.11	3.28	1.19	3.32	1.41	2.25	.139	0.04	0.11	.898	0.00	1.44	.246	0.05
CEs	10.43	6.01	9.40	5.59	9.84	6.34	2.80	.100	0.05	0.16	.855	0.00	0.88	.422	0.03
OEs	18.24	43.92	22.00	42.72	26.00	50.05	0.20	.654	0.00	0.03	.972	0.00	1.04	.362	0.04
RT_CV	0.26	0.11	0.28	0.11	0.26	0.13	2.35	.132	0.04	0.88	.420	0.03	0.74	.481	0.03
PA	32.48	11.08	34.00	10.04	29.05	11.98	0.38	.541	0.00	1.54	.223	0.06	0.37	.696	0.01
NA	15.67	8.26	17.13	9.71	17.63	9.80	1.01	.321	0.02	0.05	.954	0.00	0.38	.686	0.01

** $p < .001$, *$p < .05$ (2-tailed). *Note:* TM = Trait mindfulness, TMW = Trait Mind-wandering, CE = Commission errors, OEs = Omission errors, RT_CV = Coefficient of response time variability, PA = Positive affect, and NA = Negative affect