Increased False-Memory Susceptibility Following Mindfulness Meditation

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Abstract

The effect of mindfulness meditation on false-memory susceptibility was examined in three experiments. Because mindfulness meditation encourages judgment-free thoughts and feelings, we predicted that participants in the mindfulness condition would be especially likely to form false memories. In two experiments, participants were randomly assigned to either a mindfulness induction that instructed them to focus attention on their breath or a mind-wandering induction that instructed them to think about whatever came to mind. Overall number of words from the Deese-Roediger-McDermott (DRM) paradigm that were correctly recalled did not differ between conditions. However, participants in the mindfulness condition were significantly more likely to report critical non-studied items than participants in the control condition. In a third experiment, using recognition and a reality-monitoring paradigm, participants had reduced reality-monitoring accuracy after completing the mindfulness induction. These results demonstrate a potential unintended consequence of mindfulness meditation where memories become less reliable.

Keywords: false memories, mindfulness, DRM, source monitoring, reality monitoring, signal-detection theory

The concept of mindfulness is pervasive in both popular culture and academic research. Oprah Winfrey, Deepak Chopra, and Dr. Oz (Oz Blog, 2013) have all extolled the merits of being mindful, and scholarly studies have investigated the benefits of this phenomenon. Mindfulness-based interventions on both physical and psychological disorders have been reported, including reduced pain intensity for patients with chronic pain (Reiner, Tibi, & Lipsitz, 2013), improved psychological well-being (Brown & Ryan, 2003), reduced levels of stress and anxiety (Astin, 1997; Jain et al., 2007; Rosenzweig, Reibel, Greeson, Brainard, & Hojat, 2003; Shapiro, Schwartz, & Bonner, 1998), and decreased depression in older adults (Geschwind, Peeters, Drukker, van Os, & Wichers, 2011). Mindfulness meditation focuses attention on the present moment in an accepting and nonjudgmental manner (Brown & Ryan, 2003; Baer, Smith, & Allen, 2004; Kabat-Zinn, 2013). Each thought, feeling, and sensation is acknowledged and accepted without judgment or evaluation (Kabat-Zinn, 2013; Bishop et al., 2004; Segal, Williams, & Teasdale, 2012; Teasdale, 1999). As Kabat-Zinn (2013) has noted, “the practice involves suspending judgment and just watching *whatever* comes up” (p. 23, emphasis in original).

In contrast to the myriad benefits of being mindful, mindfulness meditation may also increase false-memory susceptibility by affecting the cognitive operations needed to distinguish between internal and external sources of information. According to the source-monitoring framework, false memories occur because of a failure to distinguish the origin of a memory (Johnson, Hashtroudi, & Lindsay, 1993; Lindsay, 2008). When the origin of a memory is misattributed, information from one context is falsely remembered as having been part of a different context. Source-monitoring errors can arise as a consequence of confusing memory sources. Confusion can occur between two external sources as well as between an internally-generated source and an external one (Johnson et al., 1993).

Reality monitoring is the process of discriminating between internally-generated and external memory sources (Johnson & Raye, 1981). Information that people generate themselves is usually associated with cognitive operations (i.e., mental processes involved in the generation of information) that leave a trace and later provide cues that the information was internally generated rather than actually encountered in the external world (Lindsay, 2008; Johnson, Raye, Foley, & Foley, 1981). If focusing mindful attention without judgment results in the suspension of cognitive operations (and the elimination of the trace records those operations would otherwise leave), people would have greater difficulty differentiating internal and external sources of information. That is, mindfulness training might increase the risk for false memories because internally-generated memories would lack the cues that are ordinarily used to help identify them as having been internally generated.

In the first two experiments, we examined the effect of mindfulness meditation on false-memory susceptibility using the Deese-Roediger-McDermott (DRM) paradigm (Roediger & McDermott, 1995). The DRM is the most widely used paradigm to test false memories (Brainerd & Reyna, 2005). The procedure involves presenting lists of closely related words and then testing memory with either recall or recognition. Each list has one word (the critical item) that is a closely related word not on the list. The critical item is strongly activated by the other words on the list, and it can be falsely remembered if people mistake this strong, internal activation for an actual memory of the word. For example, the word list (Roediger, Watson, McDermott, & Gallo, 2001) *garbage, waste,* *can, refuse, sewage, bag, junk, rubbish, sweep, scraps, pile, dump, landfill, debris,* and *litter* can activate the critical item *trash*.

In the third experiment, we used a reality-monitoring paradigm and extended the research to recognition memory. If increases in false memories after mindfulness training are due to reduced reality-monitoring abilities, participants would have reduced abilities to discriminate between words actually studied and words internally activated during study but not actually presented.

Experiment 1

Method

Participants

One hundred fifty-three (37 male, 116 female) undergraduate students (*M* = 20.7 years; *SD* = 2.4) at the University of California, San Diego participated in this experiment for course credit. The data-collection stopping rule was to recruit as many participants as possible before the end of the quarter.

Materials and Procedure

Participants sat in individual sound-attenuated rooms and were randomly assigned to receive either a 15-minute mindfulness induction or a 15-minute mind-wandering induction. In the mindfulness induction, participants listened to a guided focused-breathing exercise recorded by Marilee Bresciani Ludvik at the Rushing to Yoga Foundation. This mindfulness induction was based on a script by Arch and Craske (2006) that had been adapted from work by Kabat-Zinn (1990). It instructed participants to focus attention on their breath without judgment. The mind-wandering induction, also recorded by Marilee Bresciani Ludvik, instructed participants to think about whatever came to mind. Mind wandering has been used as a control condition in other mindfulness experiments to represent a neutral, mental state (e.g., Hafenbrack, Kinias, & Barsade, 2014; Kiken & Shook, 2011).

All participants were then shown the DRM word list for the critical item *trash* (Roediger et al. 2001). Each word was presented in the center of the computer screen for 1.5 seconds. After all fifteen words were presented, participants immediately typed as many words as they could remember.

Results

Participants who received the mindfulness induction were significantly more likely to falsely remember seeing the word *trash* (39%, 95% CI = [29.15%, 49.46%]) than participants completing the mind-wandering induction (20%, 95% CI = [12.37%, 31.35%]), $z = 2.48$, $p = 0.014$, Cohen's $d = 0.50$, 95% CI = [0.18, 0.82]. Mean proportion of correctly recalled words did not significantly differ between the mindfulness condition (7.02, 95% CI = [6.68, 7.37]) and mind-wandering condition (6.75, 95% CI = [6.35, 7.15]), $t(152) = 1.02$, $p > 0.250$. The average order in which the critical item was reported did not significantly differ between the mindfulness condition (6.3) and mind-wandering condition (6.1), $t(45) = 0.2$, $p > 0.250$ Average number of other intrusions falsely recalled did not significantly differ between the mindfulness condition (0.34) and mind-wandering condition (0.29), $t(152) = 0.45$, $p > 0.250$.

Experiment 2

Method

Participants

One hundred forty (40 male, 100 female) undergraduate students ($M = 21.5$ years;

SD = 4.3) at the University of California, San Diego participated in this experiment for course credit. Using our effect size from Experiment 1, we estimated that 128 participants were needed in order to have 80% power to detect a statistically significant difference. The data-collection stopping rule was to recruit as many participants as possible before the end of the quarter with at least 128 participants.

Materials and Procedure

Participants sat in individual sound-attenuated rooms. Six (pre-induction) DRM word lists from Roediger et al. (2001) (critical items: *mountain*, *music*, *thief*, *doctor*, *cold*, *needle*) were presented in random order. Each word was presented in the center of the computer screen for 1.5 seconds. After viewing each list, participants immediately typed as many words as they could remember.

After the six lists were completed, the computer randomly assigned participants to receive either the mindfulness induction or the mind-wandering induction. These inductions were the same as in Experiment 1. Following the inductions, all participants completed a different set of six (post-induction) DRM word lists also from Roediger et al. (2001) (critical items: *lamp*, *trash*, *slow*, *wish*, *foot*, *window*) presented in random order.[1] Each word was presented in the center of the computer screen for 1.5 seconds. Again, after viewing each list, participants immediately typed as many words as they could remember.

[1] These lists were not counterbalanced between the pre-induction and post-induction sections (which is not ideal for the within-subject comparisons) because the pre-induction lists were originally included to serve as covariates in the analysis of the post-induction word lists.

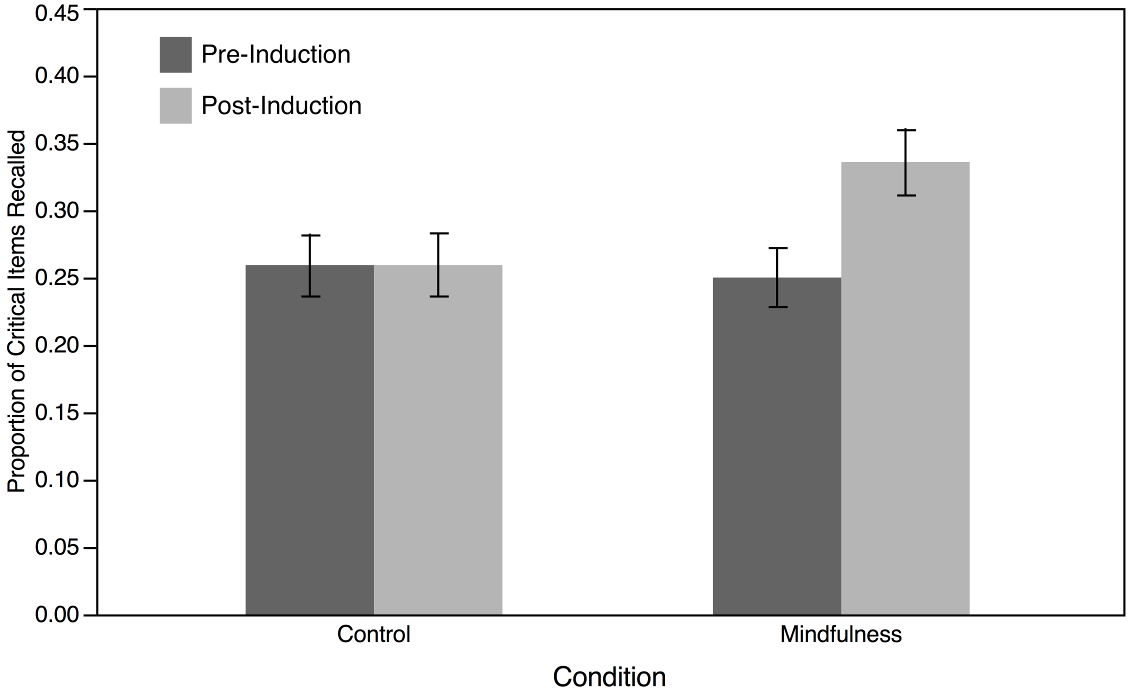

Fig. 1. Average proportion of critical items falsely recalled on the pre-induction and post-induction word lists in the mind-wandering (control) and mindfulness conditions. Error bars represent standard error.

Results

In the within-subjects comparison, participants were significantly more likely to falsely recall the critical items after the mindfulness induction than before the induction, $t(67) = 2.75$, $p = 0.008$, Cohen's $d = 0.33$, 95% CI = [0.09, 0.58]. Participants in the mind-wandering (control) condition showed no difference in critical item recall on the pre-induction and post-induction lists, $t(71) < 0.001$, $p > 0.250$, Cohen's $d = 0.00$, 95% CI = [0, 0]. The same results were also found in the between-subjects comparison. Participants who received the mindfulness induction were significantly more likely to falsely recall the critical item ($M = 0.34$, 95% CI = [0.29, 0.38]) than participants completing the mind-wandering induction ($M = 0.26$, 95% CI = [0.21, 0.31]), $t(138) = 2.27$, $p = 0.025$, Cohen's $d = 0.38$, 95% CI = [0.05, 0.72]. This difference remained significant when controlling for participants' baseline levels of false-memory susceptibility and memory performance using the average pre-induction critical item recall and proportion correct, $F(1, 136) = 5.78$, $p = 0.018$. When performing a 2 x 2 ANOVA, there was a significant interaction between condition (mindfulness vs. mind-wandering) and pre/post, $F(1, 138) = 4.22$, $p = 0.042$. Figure 1 shows the average proportion of critical items falsely recalled on the pre-induction and post-induction word lists.

Participants receiving the mindfulness induction did not significantly differ from participants receiving the mind-wandering induction in average proportion of words correctly recalled (mindfulness: $M = 0.46$, 95% CI = [0.44, 0.49] vs. mind-wandering: $M = 0.45$, 95% CI = [0.43, 0.48]), $t(138) = 0.66$, $p > 0.250$, Cohen's d = 0.11, 95% CI = [-0.22, 0.44]. Proportion correct was not significantly different even after controlling for both correct identifications and critical item recall on the pre-induction lists, $F(1, 136) = 1.66$, $p = 0.2$. Participants in the two conditions did not significantly differ in critical item recall ($p > 0.250$) or correct recall ($p > 0.250$) on the DRM lists completed before receiving the audio inductions. The average order in which the critical item was reported did not significantly differ between the mindfulness condition (5.7) and mind-wandering condition (5.2), $t(119) = 1.6$, $p = 0.11$ or change after completing the mindfulness induction (5.4 for pre- and 5.7 for post-induction), $t(50) = 0.55$, $p > 0.250$. Average number of other intrusions falsely recalled did not significantly differ between the mindfulness condition (0.22) and mind-wandering condition (0.18), $t(138) = 0.96$, $p > 0.250$ or change after completing the mindfulness induction (0.22 in both pre and post), $t(67) = 0$, $p > 0.250$.

Discussion

These results provide evidence that false-memory susceptibility increases after completing mindfulness training. As opposed to Experiment 1, the pre/post design of this experiment also provides evidence that the change in false-memory susceptibility is due to mindfulness training increasing susceptibility rather than the mind-wandering induction reducing false-memory susceptibility. In the next experiment, we extend this work to a reality-monitoring paradigm (Brainerd & Reyna, 2005) to better identify why false memories increase after mindfulness meditation training.

Experiment 3

Method

Participants

Two hundred fifteen (59 male, 156 female) undergraduate students (*M* = 20.3 years; *SD* = 2.9) at the University of California, San Diego participated in this experiment for course credit. Using our effect size from the within-subjects comparison in Experiment 2, we estimated that 75 participants were needed in order to have 80% power to detect a statistically significant difference. The data-collection stopping rule was to recruit as many participants as possible before the end of the quarter with at least 75 participants.

Materials and Procedure

Two hundred pairs of strongly associated words (e.g., *foot-shoe*, *sediment-fossil*) were constructed using databases of word associations (Palermo & Jenkins, 1964; Rotmistrov, 2014). One hundred word pairs were randomly selected for the pre-induction study/test phase. The remaining one hundred word pairs were then used for the post-induction study/test phase.

Participants sat in individual sound-attenuated rooms. During the pre-induction study phase, one word from each pair was randomly selected and presented in the center of the computer screen for 1.5 seconds. The order of the 100 presented words was randomized. After all 100 words were presented to participants, the pre-induction test phase immediately began. One word from each pair was randomly selected for the test phase and presented in the center of the computer screen. This procedure gave each word an equal probability of being a target or a lure. Participants were asked to identify the word as "old" (had appeared on word list) or "new" (had not appeared on word list) and to indicate their level of confidence.

All participants then listened to the 15-minute mindfulness induction used in the first two experiments. After completing the mindfulness induction, participants began the post-induction study phase followed immediately by the post-induction test phase. This procedure was identical to the pre-induction study/test phase.

Results

We compared how well participants were able to discriminate between externally-presented (old or target) items and internally-generated (new or lure) items using d' (Macmillan & Creelman, 2005). Accuracy was significantly higher for the word lists studied and tested prior to the mindfulness induction than the word lists studied and tested after the mindfulness induction (d': $M = 1.60$, $SD = 0.71$ vs. $M = 1.42$, $SD = 0.65$), $t(214) = 4.08$, $p < 0.001$, Cohen's $d = 0.28$, 95% CI = [0.14, 0.41]. Hit rate and false-alarm rate had a significant interaction with condition, $F(1, 214) = 20.94$, $p < 0.001$. The false-alarm rate significantly increased after participants completed the mindfulness induction ($M = 0.20$, $SD = 0.15$ vs. $M = 0.25$, $SD = 0.18$), $t(214) = 4.49$, $p < 0.001$, Cohen's $d = 0.31$, 95% CI = [0.17, 0.44], but the hit rate did not significantly change ($M = 0.72$, $SD = 0.15$ vs. $M = 0.71$, $SD = 0.16$), $t(214) = 1.55$, $p = 0.123$, Cohen's $d = 0.11$, 95% CI = [-0.03, 0.24]. Because null hypothesis significance testing cannot provide evidence in favor of the null, we also calculated the JZS Bayes factor for the nonsignificant change in the hit rate (Rouder, Speckman, Sun, Morey, and Iverson, 2009). This method gives 5.65:1 odds in favor of the null hypothesis.

Participants also had a significantly more liberal response bias (i.e., more of the distribution exceeded the criterion line) after completing the mindfulness induction (c: $M = 0.15$, $SD = 0.40$ vs. $M = 0.085$, $SD = 0.47$), $t(214) = 2.61$, $p = 0.0097$, Cohen's $d = 0.18$, 95% CI = [0.04, 0.31]. However, it is important to note that a change in measured bias does not entail a change in participants' decision strategy (Wixted & Stretch, 2000).

Discussion

The results of Experiment 3 are consistent with the results from Experiments 1 and 2 and provide additional evidence that mindfulness training increased false-memory susceptibility. Experiment 3 also extends the findings to recognition memory and to a reality-monitoring paradigm and supports the idea that the increase in false memories is due to a reduction in reality-monitoring accuracy. Each word on the study list strongly activates its paired associate word. Participants are less accurate at discriminating between associated words (internally generated) and words actually studied (external memory source) after completing the mindfulness induction.

General Discussion

Our research adds to and connects the literature on mindfulness meditation and false memories. While the preponderance of research on mindfulness has focused on the beneficial aspects of this phenomenon (Chiesa, Calati, & Serretti, 2011), our study examines a potential adverse effect. When meditators embrace judgment-free awareness and acceptance, their reality-monitoring accuracy may be impaired, increasing their susceptibility to false memories.

Information encountered in the external world is expected to leave a trace record that contains more sensory detail than information that is internally generated, and this difference in sensory content is one factor that facilitates the discrimination between internally and externally generated information. In addition to this factor, Johnson et al. (1981) also noted the importance of a second factor, namely, cognitive operations associated with the internal generation of information at the time of encoding. At retrieval, a trace record of those cognitive operations ordinarily helps to identify internally-generated information as having been internally generated. However, the nonjudgmental aspect of mindfulness meditation may be expected to reduce this important cue. The essential idea of mindfulness meditation is to avoid performing cognitive operations on (and to instead observe without reaction or judgment) whatever comes to mind. The elimination of cognitive operations would therefore have the effect of also eliminating a trace record of cognitive operations that might otherwise help to discriminate between internally and externally generated information on a later memory test. The end result would be a decreased ability to discriminate between sources of information (Johnson & Raye, 1981), thereby increasing susceptibility to the DRM false memory effect.

This argument can be illustrated using a simple signal-detection model of a task in which the participant's goal is to discriminate between internally-generated ("new") and externally-presented ("old") information (as in Experiment 3). The x-axis in the model shown in Figure 2 ranges from strong evidence that a test item was internally generated (at the far left) to strong evidence that the test item was externally presented (at the far right). The distribution of evidence values for internally-generated items in the control condition (solid green distribution) falls farther to the left than the distribution of evidence values for externally-presented items (solid red distribution). The difference between the two distributions is *d′*.

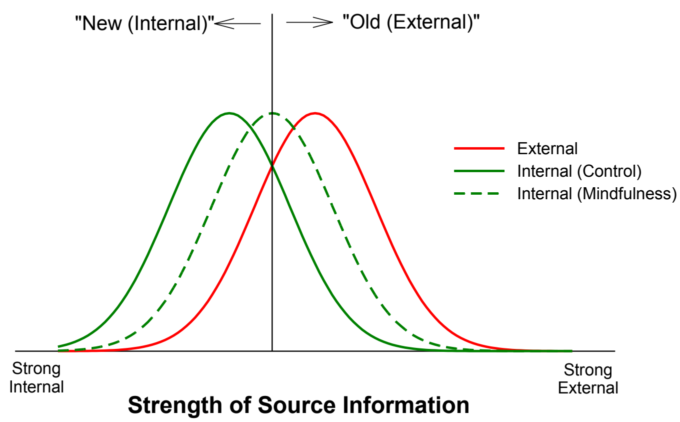

Fig. 2. Signal-detection model representing how mindfulness meditation influences the distributions of source information for internally-generated and externally-presented items. According to this model, mindfulness meditation reduces the ability to discriminate between internally-generated and externally-presented memories by shifting the distribution of internally-generated items to the right without influencing the distribution of externally-presented items.

As noted above, both the sensory content of the memory trace (more detailed for externally-presented items) and the record of cognitive operations associated with the generation of internally-generated items facilitate this discrimination. Thus, for example, a test item that falls to the far left (a strong evidence trace for internal generation) might be associated with limited sensory content as well as a trace record of cognitive operations associated with the internal generation of that item. However, in the mindfulness condition, this second factor (a trace record of cognitive operations) is largely reduced, thereby shifting the distribution associated with internally-generated items (dashed green distribution) to the right, increasing the false-alarm rate (i.e., the proportion of the distribution that falls above the decision criterion). A test item that falls to the far right, by contrast, might be associated with considerable sensory content and would also have no trace record of cognitive operations associated with internal generation (because the item was externally presented). Mindfulness, which selectively reduces cognitive operations, would therefore not change the representation of externally-presented items, so the same external distribution would apply in both the control and mindfulness conditions. If the decision criterion remains fixed across conditions, this increase in the false-alarm rate would not be accompanied by a change in the hit rate associated with externally-generated items. Thus, the selective change in the false-alarm rate would affect measured bias (more liberal in the mindfulness condition) even though the decision criterion remained unchanged.

Measured bias reflects the distance of the criterion from the point of intersection for the target and lure distributions. As can be observed in Figure 2, the point of intersection for the internal and external distributions in the mindfulness condition is farther to the right than the point of intersection for the internal and external distributions in the control condition. This means that the relative position of the criterion line (which is indicated by the vertical line in the center of the figure) is farther to the left of where the internal and external distributions intersect in the mindfulness condition than in the control condition. This change in the relative location of the criterion line is why measured bias (c) changes between conditions even though, in this model, the absolute location of the criterion line stays the same. Thus, this model predicts that measured bias should be more liberal for the mindfulness condition because of this change in the relative location of the decision criterion (resulting from an increase in the mean of the internal distribution in that condition). This simple model explains all of the results observed in Experiment 3.

A simple criterion shift model (where the distributions remain in the same locations but the criterion line changes) cannot fully account for the Experiment 3 results because not only did measured bias change between conditions, d′ values also changed between conditions. The lower d′ value in the mindfulness condition means that the internal and external distributions moved in a manner that resulted in greater overlap between the two distributions. A simple criterion shift model can only explain the change in measured bias; it cannot explain the change in d′ values observed between conditions.

Another possible model assumes the effect occurs at retrieval rather than during encoding. It can explain the change in d′ values but cannot readily explain all of the Experiment 3 results. According to this retrieval-based interpretation, one might assume that participants in the mindfulness condition respond on the basis of familiarity without engaging in recollection of source information (whereas control participants also engage in recollection of source information). In the absence of recollection, the internal distribution in the mindfulness condition would be to the right (in the external direction) of the internal distribution in the control condition because recollection would not count as evidence against familiar-but-imagined items having appeared on the list. By contrast, the external distribution in the mindfulness condition would be to the left (in the internal direction) of the external distribution in the control condition because recollection would not add evidence in favor of target items having appeared on the list. Thus, d′ values would be lower for the mindfulness condition, consistent with our results. However, the simplest version of this account would predict a difference in both hit and false-alarm rates across conditions with no effect on measured bias, whereas we observed a selective effect on the false-alarm rate and a clear effect on measured bias.

Mindfulness meditation appears to reduce reality-monitoring accuracy. By embracing judgment-free awareness and acceptance, meditators can have greater difficulty differentiating internal and external sources of information. As a result, the same aspects of mindfulness that create countless benefits can also have the unintended negative consequence of increasing false-memory susceptibility.

Author Contributions

The initial study concept came from B. M. Wilson and was developed by all authors. B. M. Wilson analyzed the data, and L. Mickes contributed to the data analysis. B. M. Wilson drafted the manuscript, and L. Mickes, S. Stolarz-Fantino, and E. Fantino edited it. All authors approved the final version of the manuscript for submission.

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