



Not sensitive, yet less biased: A signal detection theory perspective on mindfulness, attention, and recognition memory

Eyal Rosenstreich ^{a,*}, Lital Ruderman ^b

^a Department of Behavioral Sciences, Peres Academic Center, Rehovot, Israel

^b Section of Comparative Medicine, Yale School of Medicine, New Haven, CT 06510, USA

ARTICLE INFO

Article history:

Received 22 April 2015

Revised 10 April 2016

Accepted 16 May 2016

Keywords:

Mindfulness

Recognition memory

Divided attention

Sensitivity

Response bias

ABSTRACT

The practice of mindfulness has been argued to increase attention control and improve memory performance. However, it was recently suggested that the effect of mindfulness on memory may be due to a shift in response-bias, rather than to an increase in memory-sensitivity. The present study examined the mindfulness-attention-memory triad. Participants filled in the five-facets of mindfulness questionnaire, and completed two recognition blocks; in the first attention was full, whereas in the second attention was divided during the encoding of information. It was found that the facet of non-judging (NJ) moderated the impact of attention on memory, such that responses of high NJ participants were less biased and remained constant even when attention was divided. Facets of mindfulness were not associated with memory sensitivity. These findings suggest that mindfulness may affect memory through decision making processes, rather than through directing attentional resources to the encoding of information.

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1. Introduction

Mindfulness is an ongoing awareness of the present moment, emotions, and state of mind (Kabat-Zinn, 2003). Mindfulness practice was theorized to promote de-automatization, that is, to reduce the extent to which behavior is based upon “non-thinking” (Kang, Gruber, & Gray, 2013). Specifically, Kang et al. suggested that mindfulness affects behavior through four factors: Attention (an increase in attentional control and cognitive flexibility), awareness (which reduces automatic processing), being at the present moment (which promotes de-centering), and non-judgmental acceptance (embracing thoughts and feelings as they are, without attempting to suppress them).

In line with Kang et al.'s (2013) model, the practice of mindfulness has been demonstrated to improve the management of attentional resources (e.g., Morrison, Goolsarran, Rogers, & Jha, 2013; Tang et al., 2007). For example, Jensen, Vangkilde, Frokjaer, and Hasselbalch (2012) compared a mindfulness practice group to control groups which received a non-mindfulness relaxation practice or a financial incentive in various tasks of attention (e.g., to determine whether a target was presented in gray or white, or to find and cross a given target letter within a large set of letters). The results indicated that mindfulness practice was associated with a more stable performance in selective attention tasks, manifested in low reaction time variability and stable error rate across trials (see also Galla, Hale, Shrestha, Loo, & Smalley, 2012; Ruocco & Direkolu, 2013).

* Corresponding author at: Department of Behavioral Sciences, Peres Academic Center, 10 Peres St., Rehovot, Israel.

E-mail address: eyal@pac.ac.il (E. Rosenstreich).

It seems, therefore, that mindfulness may improve the use of attentional resources. The current study further investigated the connection between mindfulness and attentional demands through the scope of memory performance.

Memory performance has been argued to be very sensitive to deficit of attentional resources. In particular, dividing participants' attention during the encoding of words reduced the amount of words recollected in a later memory test (e.g., [Knott & Dewhurst, 2007](#); [Naveh-Benjamin, Craik, Gavrilesu, & Anderson, 2000](#)). It has therefore been suggested recently that memory performance may benefit from mindfulness practice ([Rosenstreich, 2014](#)). That is, mindfulness may improve memory performance by increasing the availability of attentional resources during encoding.

Indeed, studies which examined the effects of mindfulness on memory typically showed that mindfulness was associated with increased memory performance (for a review, see [Rosenstreich, 2014](#)). One study, conducted by [Alberts and Thewissen \(2011\)](#), presented mindfulness trainees and controls with a to-be-remembered list of 30 positive, negative, and neutral words (ten words of each type). After a retention interval, participants were asked to recall as many studied words as they could. It was found that although mindfulness practitioners did not recall more words in general when compared to controls, they recalled significantly fewer negative words (see also [van Vugt, Hitchcock, Shahar, & Britton, 2012](#)). In another study, [Lykins, Baer, and Gottlob \(2012\)](#), presented the California Verbal Learning Test (CVLT) to matched groups of meditators and non-meditators. The CVLT is a common diagnostic memory test, consisting of two study lists with 32 neutral words (16 in each). Each of the lists is presented five times during the study stage. Immediate and delayed memory tests revealed that mindfulness meditators recalled more words than non-meditators. However, this effect diminished when retrieval was cued (i.e., cued-recall test). Because retrieval in free recall tests is typically more difficult than in cued recall test (where the retrieval cues may make memory more accessible) (cf. [Carpenter, Pashler, & Vul, 2006](#)), this finding may indicate that mindfulness improves memory accessibility when a retrieval cue is absent.

Nevertheless, the findings described above show that in order to fully understand the connection between mindfulness and memory, it is crucial to employ different memory tests. Along with this notion, the present study will focus on a scarcely investigated memory test in the mindfulness literature, recognition memory. The potential contribution of recognition tests in elucidating the mindfulness-memory connection has been demonstrated recently ([Rosenstreich, 2015](#)). A short mindfulness practice increased the correct recognition of studied words, but at the same time also increased the rate of incorrect recognition. That is, although mindfulness practitioners correctly remembered more words than randomized control participants who engaged in a mind-wandering workshop, they were also more prone to memory distortions.

Moreover, the application of a recognition test enables the assessment of two informative measures of memory performance: memory sensitivity and response bias. Derived from Signal Detection Theory (SDT), sensitivity represents the ability to discriminate between studied (hits) and unstudied items (false alarms), whereas response bias represents a participant's tendency to respond "studied" or "unstudied" during a recognition test, regardless of his level of memory performance (for further details, see [Macmillan & Creelman, 2005](#); [Rotello, Masson, & Verde, 2008](#)).

Incorporating the assessment of sensitivity and response bias within a study of mindfulness may deepen our understanding of the mindfulness-memory association. In particular, an improvement in memory performance could be either due to an increase in sensitivity (i.e., improved ability to discriminate between targets and foils), or due to a change in response patterns (i.e., increased tendency to judge target and foils as targets). A recent study employing these two measures revealed that the increased hit rate observed after mindfulness practice was due to response bias rather than increased sensitivity ([Rosenstreich, 2015](#)). That is, whereas control participants tended to favor the "unstudied" response, mindfulness practitioners were less biased and tended to favor both "studied" and "unstudied" responses in a similar proportion. Furthermore, both groups did not differ in their sensitivity.

Nevertheless, two questions remain open following that study ([Rosenstreich, 2015](#)) regarding the connection between mindfulness and memory sensitivity and response bias. First, the study was aimed to investigate the impact of mindfulness practice on false memories, that is, to experimentally provoke memory distortions. It is therefore not clear whether the effect observed on response bias and the null effect observed on sensitivity were a result of the specific experimental design, or rather represent the underlying mechanisms of mindfulness. It remains to be seen what happens in the absence of such a memory distortion.

The second question arises from the way mindfulness was operationalized. As described earlier, mindfulness is theorized as an ongoing awareness of the present moment. This theoretical construct could be either promoted by an intervention (for a review of mindfulness-based interventions, see [Shapiro & Carlson, 2009](#)), or measured as a predisposed trait. Employing a mindfulness intervention, as in [Rosenstreich \(2015\)](#), enables conclusions on causal connections between mindfulness and various variables, while measuring mindfulness as a trait may provide insights regarding the underlying factors of mindfulness. Specifically, the construct of mindfulness was argued to consist of five facets: (1) Non-Reacting: the ability to withhold reaction; (2) Observing: the ability to observe and direct attention; (3) Awareness: the ability to act with awareness; (4) Describing: the ability to describe thoughts and feelings; and (5) Non-Judgment: the ability to act without judging the self and others ([Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006](#)).

It was recently suggested that the facets of awareness and acceptance (non-judgment) play a significant role in attention and memory, respectively ([Ruocco & Direkoglu, 2013](#)). Specifically, Ruocco & Direkoglu showed that the facet of awareness was associated with improved performance in sustained attention tasks, whereas acceptance was associated with improved performance in working memory tasks. Hence, in order to better understand the connection between mindfulness, memory sensitivity, and response bias, mindfulness should not only be induced; rather, facets of mindfulness should first be assessed.

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