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REVIEW

Impacts of Mindfulness Meditation on Episodic Memory: A Review of Recent Studies

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Abstract

Objectives The primary aim of this review was to investigate the specific cognitive and neural effects of mindfulness practices on veridical and false episodic memory and the impact of these effects on memory in clinical populations.

Method A scoping review was conducted to assess and synthesize this recent research, focusing on 26 papers from 2010 to 2024 on the topic of mindfulness and human episodic memory.

Results Overall, findings suggest that mindfulness moderately improves recall and recognition accuracy but may either increase or reduce false memories. Although further research is needed to clarify which individuals benefit most from mindfulness interventions, mindfulness may be beneficial for improving memory in clinical populations, such as patients with depression, but may not be beneficial for memory decline in aging. In addition to these behavioral effects, some research suggests that mindfulness meditation may lead to increases in grey matter concentration and function in the prefrontal cortex and hippocampus and increases in theta oscillatory communication among the frontal-parietal-medial temporal lobe memory network. These results suggest that mindfulness impacts memory by affecting the brain networks related to episodic memory.

Conclusions Although the research reviewed here has shown some promising effects of mindfulness on episodic memory, future research should be done to expand on these findings in behavioral studies, focusing more on standardized meditation lengths and practices. Increased use of brain imaging in studies is also needed to understand the mechanisms underlying these effects on episodic memory.

Preregistration This study is not preregistered.

Keywords Mindfulness meditation · Veridical memory · False memory · Clinical applications

As mindfulness meditation has increased substantially in popularity in the west, so has research related to its effectiveness and mechanisms. For example, the two most popular mindfulness apps, Headspace and Calm, have had over 200 million downloads. In addition, the number of publications on mindfulness has risen dramatically in the last two decades with 2808 publications in 2020, including randomized controlled clinical trials, which has driven an increase in its use in clinical practice (Baminiwatta & Solangaarachchi, 2021; Creswell, 2017; Van Dam et al., 2017; Whitfield et al., 2022). Mindfulness meditation is a broad term that can be defined in a myriad of ways, often resulting in a lack of clarity about which practices are actually being discussed. Mindfulness, meditation, or mindfulness meditation can all refer to spiritual practices originating in Buddhism, a formal secular practice for stress reduction or other benefits, or a general state of awareness (Van Dam et al., 2017). As a state of awareness, mindfulness has been defined by four characteristics: increased sensitivity to the environment, more openness to new information, creation of new categories to structure perception, and increased awareness of other points of view (Levi & Rosenstreich, 2019). Because of these diverse definitions and experiences of mindfulness, research varies widely. Meditation practitioners may be biased in wanting to show the effectiveness of mindfulness, while clinicians may be most concerned with finding effective treatments, no matter what they are. At the same time,

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research takes significant time and many studies to come to a consensus and does not result in straightforward understanding that is favored in wider media coverage (Van Dam et al., 2017).

Recent research has begun to explore the effects of mindfulness meditation on cognition. A recent review paper on general cognitive impacts of meditation found that half of the studies included were from 2017 or later, showing increasing academic interest in mindfulness and cognitive processes (reviewed in Whitfield et al., 2022). Western understandings of mindfulness meditation in popular culture associate it primarily with emotional rather than cognitive processes. Research in mindfulness meditation has shown positive effects on a number of psychological and health outcomes such as reducing stress, depression, generalized anxiety disorder, addictions, attention deficit disorder, and pain disorders (reviewed in Cahn & Polich, 2006; reviewed in Creswell, 2017; reviewed in Holzel et al., 2011a, 2011b; reviewed in Tang et al., 2015; reviewed in Van Dam et al., 2017). Although mindfulness is defined as a state of awareness, in the Buddhist tradition there is a close relationship between mindfulness and memory. In fact, the Sanskrit word *sati* or *smrti* (depending on transliteration) may represent both mindfulness and memory as we understand them in English (Levi & Rosenstreich, 2019). This close relationship between mindfulness and memory suggests that they share cognitive processes. Therefore, in addition to emotion, mindfulness practices may also impact memory.

Mindfulness meditation has been shown to improve attention and executive function, which depends on attention (Bailey et al., 2023; Bajestani et al., 2024; Chiesa et al., 2011; Creswell, 2017; Eberth & Sedlmeier, 2012; Holzel et al., 2011a, 2011b; reviewed in Lutz et al., 2008; Sedlmeier et al., 2012; Sharma et al., 2023; Tang et al., 2015). For example, a brief, 4-day, mindfulness meditation training improved performance on attention and executive function tasks (symbol digit modality, verbal fluency, and n-back) (Zeidan et al., 2010), and studies have shown promising impacts of mindfulness on improving working memory, particularly in challenging environments where losses in working memory are common (Jha et al., 2010). Episodic memory encoding and retrieval are complex cognitive functions that involve many automatic and controlled processes (attention and executive function). For example, encoding involves attending to relevant information and organizing that information, and retrieval involves the specification of a retrieval cue, searching the long-term store of information with that cue, reactivation of the stored information, selecting appropriate representations, interference resolution, memory suppression, and monitoring the reactivated information to make a memory decision. Although many studies have shown effects of mindfulness meditation on attention and executive function, which should contribute to better episodic memory, few studies have focused on establishing how attentional improvements with mindfulness may or may not translate to episodic memory improvements (Jha et al., 2010; Rosenstreich & Ruderman, 2016).

Current research is increasingly examining the behavioral effects of mindfulness meditation on episodic memory, but the neural effects of mindfulness meditation on episodic memory remain comparatively understudied. Episodic memory involves the interaction of frontal, parietal, and medial temporal lobe regions (Spaniol et al., 2009). Recent research has begun to examine how these distributed regions coordinate activity. Neural oscillations play an important role in communication among neurons within a network. Theta (4–8 Hz) oscillations are thought to play an important role in the communication among neurons in the frontal-parietal-medial temporal lobe network involved in episodic memory. In positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) studies, mindfulness meditation has been related to structural and functional differences in brain networks related to episodic memory (Fox et al., 2014, 2016; Tomasino et al., 2012). Mindfulness meditation experts have increased grey matter in the prefrontal cortex (Kang et al., 2013; Lazar et al., 2005; Luders et al., 2009, 2013a, 2013b) and hippocampus (Holzel et al., 2008; Luders et al., 2009, 2013a, 2013b), increased connectivity in the temporal component of the superior longitudinal fasciculus (Luders et al., 2011), and mindfulness meditation training leads to increased hippocampal volume (Holzel et al., 2011a, 2011b; Luders et al., 2013a, 2013b). In addition to structural changes, mindfulness meditation is related to activity in the prefrontal cortex (reviewed in Cahn & Polich, 2006; Lazar et al., 2000; Sperduti et al., 2012; reviewed in Tang et al., 2012; Tomasino & Fabbro, 2016; reviewed in Zeidan, 2015) and hippocampus (Engstrom et al., 2010; Lazar et al., 2000; Lou et al., 1999). In electroencephalography (EEG) studies, mindfulness meditation is related to increases in theta oscillations (Aftanas & Golosheikin, 2003; Brandmeyer & Delorme, 2018; reviewed in Cahn & Polich, 2006; reviewed in Delmonte, 1984; reviewed in Fell et al., 2010; Kubota et al., 2001; reviewed in Lee et al., 2018; reviewed in Lomas et al., 2015; Lou et al., 1999; Tang et al., 2009). Therefore, mindfulness practices may impact memory by affecting brain networks related to episodic memory.

Due to the relative novelty of studying the impacts and mechanisms of mindfulness meditation in general, there are significant issues in the field with consistency and quality of methodology (Tang et al., 2015; Van Dam et al., 2017). As previously discussed, one major issue is defining what mindfulness or meditation are. While it is likely that self-reported meditation would be different than a 12-min meditation induction in a lab, there are no methodological standards for defining mindfulness (Alberts & Thewissen,

2011; Lekhak et al., 2020; Van Dam et al., 2017). Many studies use cross-sectional designs with relatively small sample sizes, and there are few longitudinal studies with well-matched control groups and active control conditions. Mindfulness meditation length and practices (e.g., focused attention, open monitoring, and mindfulness-based stress reduction (MBSR)) as well as memory paradigms vary, and the construct of mindfulness is often measured with subjective self-reports. These issues of consistency and quality of methodology make it difficult to interpret the results and draw strong conclusions from this research to guide mindfulness interventions.

Multiple subject populations and methods have been used to study mindfulness and episodic memory. Historically, many meditation studies were cross-sectional studies (observational studies conducted at one time); however, there are increasingly more longitudinal studies that follow practitioners over longer periods of time (Tang et al., 2015). Many of these had small sample sizes, limiting the statistical power to find effects (Tang et al., 2015). An important factor in studying the impact of mindfulness meditation on episodic memory is the experience level of the subject. The most common methods include comparing beginner and expert meditators on a variety of tests and tasks (also sometimes longitudinal), longitudinal studies observing a group of beginner meditators through a multi-week program, or one-time short mindfulness inductions. Although there have been multiple studies comparing beginner and expert meditators, these studies do not account for prior differences between the groups. Therefore, it is important to carefully match the groups on demographic variables or perform longitudinal studies to ensure robust and unbiased results. The hypothesis is that comparative studies would show differences between beginners and experts and that mindfulness meditation training or mindfulness inductions would have a significant impact on beginner meditators.

There are a variety of meditation lengths and meditation practices. In addition, the memory paradigms used vary widely across studies and include recognition memory, free recall, and false memory (Deese-Roediger-McDermott Paradigm, DRM). Although there are some validated measures of mindfulness that have become common in the literature, such as the Five Facet Mindfulness Questionnaire (FFMQ), other studies are based only on self-report. Finally, as highlighted in this review, most studies have only examined the behavioral effects of mindfulness on episodic memory. In order to understand neural mechanisms underlying the effects of mindfulness on episodic memory, it is important to record both behavior and brain activity using neuroimaging techniques such as fMRI and EEG.

The primary aim of conducting this review was to investigate the specific cognitive and neural effects of mindfulness practices on veridical and false episodic memory and the impact of these effects on memory in clinical populations. This scoping review paper focused on the behavioral evidence and limited neural evidence showing the impact of mindfulness in both beginner and expert meditators. Reviewing the behavioral and neural evidence is important for understanding how mindfulness impacts episodic memory. The behavioral research tells us which types and processes of memory are affected by mindfulness, and the neural evidence tells us how mindfulness affects the brain networks involved in episodic memory, which may lead to more effective mindfulness-based interventions for memory improvement. To date, little work has been done to understand the neural correlates of these effects. Therefore, the current review will also act as a call for researchers to further study the neural mechanisms underlying the effect of mindfulness meditation on episodic memory.

Method

This review paper was designed as a scoping review in order to assess the present state of knowledge about mindfulness and human episodic memory. The goal of conducting this scoping review was to synthesize recent findings and determine knowledge gaps in the relatively small body of work that exists. To ensure that the scoping review included all of the relevant papers, a hybrid search strategy was employed, combining database search with citation search. Therefore, while some of the papers included in this literature review were not directly found using the search terms described below, they appeared in the citations of papers in the results. Particular focus was placed on findings published in the *Mindfulness* journal.

The initial database searches were conducted in PubMed and Google Scholar. Since the earliest papers on mindfulness and episodic memory were published around 2010, the scope of the search was from 2010 through mid-2024 (Alberts & Thewissen, 2011). The search terms in the literature search were "mindfulness" combined with the Boolean operator AND with "episodic memory," "false memory," and "memory." The search terms "episodic memory" and "false memory" were chosen as they most effectively reflected the literature review's focus on long-term memory, including false memory. The general search for "mindfulness and memory" was included to ensure that multi-pronged studies containing findings about different memory processes would not be missed. In PubMed, "mindfulness and episodic memory" yielded 92 results, "mindfulness and false memory" yielded 22 results, and "mindfulness and memory" yielded 963 results. In Google Scholar, "mindfulness and episodic memory" yielded 11 results, "mindfulness and false memory" yielded 21 results, and "mindfulness and memory" yielded 328 results.

Inclusion criteria for this scoping review were as follows: (1) publication date of 2010 through mid-2024, (2) focus on the impact of mindfulness on long-term memory, (3) at least one of the memory search terms and the "mindfulness" search term present in the title or abstract of the paper, and (4) published in a peer-reviewed journal. The literature search was conducted with a publication date range of 2010–2024, ensuring that all papers fit that criteria. Further inclusion criteria were applied manually by at least one of the authors. Papers with either a central focus on or focused section on the impact of mindfulness meditation on long-term memory were included, meaning that papers exclusively focused on working memory or autobiographical memory were omitted. At least one of the search terms "episodic memory," "false memory," or "memory" (including plurals) in addition to "mindfulness" also had to be present in the title or abstract of the paper for inclusion. Finally, all papers included were published in peer-reviewed journals, excluding unpublished theses, conference proceedings, and scientific posters. In total, 26 papers were found to meet all inclusion criteria and were included in this scoping review. The small number of papers showed that studying mindfulness and episodic memory is a newer and understudied topic.

This scoping review is divided into sections based on the research areas identified in the literature review. The first section focuses on veridical memory, both with novice and experienced practitioners. The second section focuses on false memory, where a relatively larger body of work exists. Finally, the last section focuses on clinical applications, both for mental health populations and elderly populations. Table 1 provides details of the episodic memory paradigm, mindfulness strategy, results, and conclusions for each study reviewed below.

Results

Veridical Memory

Mindfulness meditation has been shown to affect veridical memory (Basso et al., 2019; Brown et al., 2016; Lloyd et al., 2016; Lueke & Lueke, 2019; Lykins & Baer, 2012; Nyhus et al., 2019; Shemesh et al., 2023). The following section provides a comprehensive review of studies using various memory paradigms and comparing beginner and expert meditators, beginner meditators after a multi-week program, or after a one-time short mindfulness induction.

A few comparative studies that compared beginner and expert meditators and controlled additional demographic variables, such as age, showed better free recall and recognition memory for expert meditators (Lykins & Baer, 2012; Shemesh et al., 2023). One study carefully matched non-meditators and meditators on a wide variety of demographic variables, including age, education, and mental disorders (Lykins & Baer, 2012). While meditators scored higher on one measure of long-term memory, long-delay free recall, they did not score higher on long-delay cued recall or working memory. It is possible that the lack of differences between the non-meditator control and meditator groups could be due to how well they were demographically matched. Another comparative study matched non-meditators and meditators on age alone and found significant differences in both mindfulness traits and memory (Shemesh et al., 2023). Meditators reported higher trait mindfulness and lower anxiety, higher autobiographical vividness and specificity, and enhanced performance in a picture recognition test. No difference between the meditator and control groups was observed in a narrative memory test.

Longitudinal studies that trained novices on mindfulness meditation over the course of 4–8 weeks also showed beneficial effects on memory (Basso et al., 2019; Nyhus et al., 2019). In one longitudinal study, beginner meditators were asked to either listen to 13-min podcast segments or 13-min meditations. After four weeks, no significant effects were found; however, after eight weeks, the subjects improved their recognition memory performance, as tested using the hippocampal-dependent Mnemonic Similarity Task (Basso et al., 2019). Because the hippocampus is associated with episodic memory, and previous research has reported greater gray matter concentration in the hippocampus and parahippocampal cortex for long-term meditators, this finding suggests that 4–8 weeks is enough time for a meditation practice to cause changes in the brain. In another longitudinal study on beginner meditators that lasted only four weeks, we found positive impacts on episodic memory. We also found that theta power, previously associated with episodic memory and meditative states, increased following mindfulness meditation training (Nyhus et al., 2019). Specifically, the left parietal channels and the right frontal channels, which are areas associated with episodic memory, showed increases in theta oscillatory power in the meditation group but not in the waitlist control group.

Finally, induction studies typically administer memory tests following a single mindfulness induction, usually with beginner meditators. In some cases, these inductions are extremely short—down to just three minutes (Lloyd et al., 2016). Even this 3-min mindfulness induction led to improved memory test performance when it was done before the encoding of word lists. Another study replicated the finding that a brief mindfulness induction improved memory through recognition and free-recall tests (Brown et al., 2016). Importantly, both of these studies were conducted with beginner meditators, suggesting that even a very short mindfulness session could have positive impacts on memory. Another mindfulness induction study found that ten minutes of mindfulness reduced encoding errors when the induction

Table 1 Studies on the effects of mindfulness meditation on episodic memory

Authors and year	Memory paradigm	Mindfulness strategy	Sample size (*n*)	Control group	Results	Conclusions
Alberts & Thewissen, 2011	Affective word recall	Focused attention (breathing)	(38)	Randomized group, no mindfulness intervention	Mindfulness group subjects (12-min mindfulness intervention) recalled a significantly lower proportion of negative words after 20 min compared to controls.	Since forgetting negative events is associated with long term well-being, mindfulness could have positive impacts on subjective well-being.
Ayache et al., 2022	False memory (DRM paradigm) and recognition memory	Focused attention (breathing)	(34)	Randomized group (but matched on cognitive and emotional variables), listening to a story	Mindfulness (15-min mindfulness intervention) had no effect on false memories for pictorial memory in a virtual environment; mindfulness did increase memory sensitivity, and dispositional mindfulness also had an effect.	False memories observed in DRM studies may be a result of semantic memory as they are not observed with pictorial memory.
Baranski & Was, 2017	False memory (DRM paradigm)	Focused attention (breathing)	Experiment 1 (202), Experiment 2 (75)	Experiment 1 randomized groups of mind wandering with and without DRM warning, Experiment 2 randomized groups of mind wandering and word search puzzles	In Experiment 1, mindfulness induction did not increase false alarms on critical items, and warning subjects of false memories reduced false alarms; in Experiment 2, mindfulness induction resulted in fewer critical item false alarms.	Mindfulness decreases false memories.
Basso et al., 2019	Recognition memory (Mnemonic Similarity Task)	8 weeks of daily Journey Meditation (including both focused attention and open awareness)	Beginner meditators (76) (34 dropped out)	8 weeks of daily podcast listening	Beginner meditators' recognition memory performance improved after 8 weeks of Journey Meditation program.	4 weeks is not enough time to see any changes in memory, but 8 weeks is sufficient.
Bitton et al., 2023	False memory (DRM paradigm)	Focused attention (breathing) and open monitoring	(34)	No control group	Focused attention and open monitoring mindfulness meditation styles both increased false memory recall.	Focused attention and open monitoring mindfulness increases false memories.

Table 1 (continued)

Authors and year	Memory paradigm	Mindfulness strategy	Sample size (*n*)	Control group	Results	Conclusions
Brown et al., 2016	Recognition memory (Remember-Know paradigm) and free recall	Focused attention	Experiment 1 (143), Experiment 2 (93), and Experiment 3 (57)	Experiment 1 only trait mindfulness, Experiment two audio recordings on planning for the future and human thought & perception, Experiment 3 distraction audio (focused attention covered by background noise) or no-task (waiting)	In Experiment 1, self-reported mindful state without meditation stimulus (but not self-reported trait mindfulness) predicted better Remember-Know task recognition; in Experiment 2 and Experiment 3, brief mindfulness training improved Remember-Know task performance and free-recall performance.	Mindfulness-related attentional improvements impact memory encoding, and therefore episodic memory.
Calvillo et al., 2018	False memory (DRM paradigm)	Open awareness and focused attention (breathing)	(228)	35 multiplication problems	Mindfulness after encoding reduced false recognition of critical lures and made subjects less likely to deem a test item as old.	Mindfulness after encoding protects against false memories.
Joss et al., 2024	Recognition memory (Mnemonic Similarity Task)	Adapted 8-week MBSR program	(39)	Randomized group, stress management education	Subjects in an 8-week mindfulness-based intervention among ACE survivors led to improved pattern separation capability and changes of the right hippocampus and right subiculum.	Mindfulness improves episodic memory and increases hippocampal volume with clinical applications for ACE survivors.
Lekhak et al., 2020	Word recall	Survey question—"Do you ever meditate"	Older adults (1,135)	No control group	Meditation did not have a significant effect on episodic memory in word recall test, while prayer did.	Meditation does not affect memory in older adults, but only collected meditation data once, subjects may not have been meditating enough to see an impact.
Lloyd et al., 2016	False memory and word/non-word recognition	Focused attention (breathing)	Subjects across four sub-experiments (369)	Randomized group, segment of neutral documentary about the history of radio	3-min mindfulness before retrieval, but not encoding, improves memory test performance and reduces false alarms for lures.	Positive impact of mindfulness on memory is likely due to retrieval processes, not encoding; there may be different mechanisms for recognition memory and recall.

Table 1 (continued)

Authors and year	Memory paradigm	Mindfulness strategy	Sample size (*n*)	Control group	Results	Conclusions
Lueke & Lueke, 2019	Word recall	Focused attention (breathing and bodily sensations)	Experiment 1 (85), Experiment 2 (57)	Audio tape describing an English countryside	In Experiment 1, significantly more encoding errors for controls than mindfulness group, and mindfulness did not affect selective attention or attention switching; in Experiment 2, no difference between mindfulness group and controls.	Mindfulness must be present during learning process to enhance encoding; trait mindfulness in long-term practitioners could have a similar effect.
Lykins & Baer, 2012	Free and cued recall	Two sessions/week for at least the past six months of mindfulness, insight, or Vipassana meditation	Experienced meditators (33) and controls (33)	Demographically matched non-meditators	Experienced meditators scored higher on long-delay free recall and two measures of short-term memory, but not long-delay cued recall, working memory, or total learning.	Lack of robust differences in memory may have been due to careful demographic matching, but did not ask meditators how they meditate or to enter a mindful state.
Meeks et al., 2019	False memory (DRM paradigm)	Focused attention (breathing)	(123)	Mind wandering – instructions to sit and think about whatever came to mind	Mindfulness group subjects (12-min mindfulness intervention) with negative mood context recalled fewer negative lures compared to controls.	Mindfulness meditation decreases false memories; but only in the context of negative mood and negative lures.
Namias & Huff, 2024	Dual-list recall	Trait mindfulness and focused attention (body scan)	Experiment 1 (150), Experiment 2 (46 experimental and 45 controls)	Randomized group, audio tape describing painting	Mindfulness trait and 5- minute induction had no effect on attention or memory.	Lack of effects may be due to short duration, longer-term practice is necessary to see improvement on memory.
Nyhus et al., 2019	Word recognition	Modified 4-week MBSR program, focused attention (breathing)	(40)	Randomized group, wait list	Subjects in a 4-week mindfulness course had higher FFMQ scores, greater source discrimination, and increased theta power in left parietal and right frontal channels.	4 weeks of mindfulness training increases source memory and theta oscillations.

Table 1 (continued)

Authors and year	Memory paradigm	Mindfulness strategy	Sample size (*n*)	Control group	Results	Conclusions
Qi et al., 2018	False memory	8-week mindfulness program, including focused attention (breathing and body scans)	(48)	Randomized group, 8-week socioemotional learning program	Mindfulness group had reduced accuracy at retrieval and more non-specific errors in incorrect responses than controls when asked to recall target event.	Mindfulness affects decision-making process during retrieval, not at encoding.
Requier et al., 2023	Free recall	Trait mindfulness, deconstructive meditative capacity	(134)	Randomized groups of non-native language learning and no intervention	No correlation between trait meditation capacity and episodic memory.	Trait meditation capacity does not impact episodic memory; but mindfulness programs were not studied.
Roberts-Wolfe et al., 2012	Affective word recall	12-week mindfulness meditation laboratory course	(58)	Self-selected group, 12-week courses in religious/East Asian studies or music	Subjects in a 12-week mindfulness course had greater increases in positive word recall and well-being measures compared to controls.	Mindfulness affects emotional information processing.
Rosenstreich & Ruderman, 2016	Recognition (Remember-Know-Guess) and signal detection	Facets of mindfulness only	(68)	Block of full attention recognition and distracted recognition with tone classification task	FFMQ generally not correlated with memory performance, except higher non-judgment decreased false alarms of unstudied words.	Mindfulness decreases response bias, with no impact on sensitivity, and may have more to do with retrieval than encoding.
Rosenstreich & Ruderman, 2017	Recognition (Remember-Know paradigm)	Focused attention (breathing, body scan and mindful eating) and open awareness	Experiment 1 (42), Experiment 2 (48), and Experiment 3 (68)	Experiment 1 non-meditators, Experiment 2 randomized group sham mindfulness (mind wandering instructions), Experiment 3 dispositional mindfulness only	In Experiment 1, mindfulness group subjects had increased hits with higher fluency, controls had increased hits and false alarms with higher fluency; in Experiment 2, mindfulness increased familiarity of neutral words using Remember-Know procedure; in Experiment 3, observing positively predicted rates of familiarity.	Mindfulness reduces false alarms by promoting metacognitive memory.

Table 1 (continued)

Authors and year	Memory paradigm	Mindfulness strategy	Sample size (*n*)	Control group	Results	Conclusions
Shemesh et al., 2023	Recognition memory, narrative memory	Vipassana meditation	Experienced meditators (25) and controls (23)	Age-matched meditation naïve individuals	Meditators reported higher trait mindfulness and autobiographical vividness and specificity, no difference in narrative memory test, enhanced performance in picture recognition test, and decreased false alarm rate in picture recognition compared to controls.	Long-term mindfulness practitioners may have enhanced long-term memories due to enhanced rejection of misinformation.
Sherman & Grange, 2020	False memory (DRM paradigm)	Not specified	(387)	Paper-based join the dot puzzles	Subjects in 15-min mindfulness and mind wandering groups did not differ in their correct or false recall or recognition; these inductions activated overlapping states of mind.	Mindfulness may increase false memories, but mind-wandering may not be a good control.
van Vugt et al., 2012	Affective word recall	8 weeks of MBCT	Depression patients in partial or full remission (52)	Randomized group, wait list	Subjects in an 8-week MBCT program were less likely to pause during negative word recall, showing a lower likelihood of getting stuck in negative mental context.	MBCT reduces depression symptoms through reducing rumination and negative memory.
Wendt et al., 2021	False memory (DRM paradigm)	Focused attention (body scan)	(120)	Two randomized groups, mind wandering induction and sham mindfulness induction	Body scan mindfulness group subjects (15-min intervention) had decreased delayed (24 h later) correct and false recognition, but there was no effect on immediate recall.	Different types of mindfulness may lead to different false recognition outcomes.
Wilson et al., 2015	False memory (DRM paradigm)	Focused attention (breathing)	Experiment 1 (153), Experiment 2 (140), and Experiment 3 (215)	Mind wandering induction	Mindfulness group subjects in all Experiments were significantly more likely to have false memories of words after the induction.	Mindfulness increases false memory susceptibility due to a reduction in source monitoring.

Table 1 (continued)

Authors and year	Memory paradigm	Mindfulness strategy	Sample size (*n*)	Control group	Results	Conclusions
Yeh & Lu, 2017	False memory (DRM paradigm)	Trait mindfulness	60	No control group	Negative and positive correlation between trait mindfulness depending on encoding/retrieval language.	Mindfulness increases false memory due to activation of semantic information and decreases false memory due to improvement in source monitoring.

happened prior to encoding only (Lueke & Lueke, 2019). Although the control group had significantly more encoding errors than the mindfulness group, selective attention and attention switching were both unaffected. Therefore, it seems that attention may not always explain improvements in memory performance. However, regardless of the methods employed, comparative, longitudinal, or short induction, all of these studies show that mindfulness leads to an improvement in memory. Although mindfulness meditation has generally been shown to have positive effects on veridical memory, a recent study showed no relationship between trait mindfulness or an effect of mindfulness induction on episodic memory (Namias & Huff, 2024).

False Memory

An important element of episodic memory which has been fairly well studied is false memory. False memories may be distorted true memories or completely fabricated. Most of these studies employ the DRM paradigm, which allows for creating conditions for false memories in a lab setting (Roediger & McDermott, 1995). The DRM paradigm consists of showing subjects a list of words which are all linked to a related "target word" and then a recognition test that includes the original words, new unrelated words, and the target word. False memory is measured by how often subjects say that they recognize that the target word was previously presented. In the context of mindfulness studies, false memories are a unique way to learn more about how mindfulness impacts the cognitive mechanisms of memory (Levi & Rosenstreich, 2019). If mindfulness practice only impacts semantic processing, more false memories are likely to occur; conversely, if mindfulness practice impacts higher-order metacognitive memory control, it would more likely reduce false memories. This is because semantic memory may not be as consciously controlled as higher-order metacognitive processes (Rosenstreich & Ruderman, 2017; Yeh & Lu, 2017). In addition to the DRM paradigm, another common procedure is the "Remember-Know-Guess" or "Remember-Know" procedure, where familiarity can be separated from recollection of words in a list and false alarms (Rosenstreich & Ruderman, 2016).

Studies using the DRM paradigm have shown conflicting results on the effect of mindfulness induction on false memories (Baranski & Was, 2017; Bitton et al., 2023; Calvillo et al., 2018; Meeks et al., 2019; Sherman & Grange, 2020; Wendt et al., 2021; Wilson et al., 2015). One study using the DRM paradigm to study false memories showed that subjects in a mindfulness induction group were significantly more likely to have false memories of target words after an induction (Wilson et al., 2015). This finding was consistent across three different sub-experiments. The authors interpreted their finding in terms of the source-monitoring

framework; false memories of target words resulted from failing to distinguish between internal and external sources of a memory. Another study replicated this finding, using both focused attention and open monitoring mindfulness meditation styles (Bitton et al., 2023). However, the positive impacts of mindfulness on attention, which is important for source-monitoring, suggest that mindfulness should lead to improvements in source-monitoring and decreased false memories. The mind-wandering state used as a control in the Wilson et al. (2015) study was challenged by a study that found that mindfulness and mind-wandering activate overlapping states of mind (Sherman & Grange, 2020). In addition, four other studies were also unable to replicate Wilson et al.'s (2015) finding (Baranski & Was, 2017; Calvillo et al., 2018; Meeks et al., 2019; Wendt et al., 2021). Using a body scan mindfulness intervention, one study found that meditation reduced delayed correct and false recognition (24 h later) but did not impact immediate recall (Wendt et al., 2021). In another study, mindfulness induction resulted in fewer false target word recalls, suggesting that mindfulness decreases false memories (Baranski & Was, 2017). A reduction of false memories was also found in the context of negative mood and lure words, and was again interpreted in terms of the source-monitoring framework (Meeks et al., 2019). They found that a mindfulness induction after encoding reduced false recognition of target words; in addition, subjects were less likely to deem a test item as old. Signal detection analyses showed that a mindfulness intervention after encoding decreased a liberal response bias, which decreased false memories.

Additional studies on false memories have also shown conflicting results (Ayache et al., 2022; Lloyd et al., 2016; Qi et al., 2018; Rosenstreich & Ruderman, 2016, 2017). A study on adolescents who participated in an 8-week mindfulness program found increased false alarms (Qi et al., 2018). In an interview after a "target event," the mindfulness group had reduced accuracy at retrieval and more nonspecific errors in incorrect responses than the control group. In addition, a study on pictorial memories using a virtual environment found no impact of mindfulness on false memories, although mindfulness did increase memory sensitivity (Ayache et al., 2022). However, two studies found that both trait mindfulness and mindfulness induction reduced false alarms (Rosenstreich & Ruderman, 2016, 2017). Notably, even brief mindfulness inductions of just 3 min before retrieval have been found to reduce false alarms for lure words (Lloyd et al., 2016). These results suggest that the mindfulness state affects the decision-making process during retrieval, rather than at encoding. Therefore, it is still unclear what impact mindfulness meditation has on false memories. By extension, it is also unclear whether mindfulness impacts lower-level semantic processing or higher-order metacognitive processes or both. One study found that trait mindfulness is related to both increased and decreased false memories, suggesting that mindfulness both activates semantic information and improves source monitoring (Yeh & Lu, 2017).

Clinical Applications

Mindfulness meditation practices are commonly prescribed for depression, anxiety, and other mental health conditions, as it is well-known that mindfulness can have a positive impact on subjective well-being (Alberts & Thewissen, 2011; Roberts-Wolfe et al., 2012). Meditation has also been found to decrease rumination in patients with underlying depression (van Vugt et al., 2012). Clinicians are often more focused on effectiveness than mechanisms (Van Dam et al., 2017). However, understanding the mechanisms for clinically effective mindfulness treatments may lead to new applications, especially as it relates to memory.

Patients with depression often show an impairment in episodic memory. Impairment in episodic memory in patients with depression can usually be split into two categories. First, depression is often linked with a decrease in memory specificity; memories tend to be overgeneralized and overly negative. In addition, there is often an increase in negative attention bias, and negative memories are recalled better than positive ones. However, forgetting some negative events is associated with long-term well-being (Alberts & Thewissen, 2011). One neural correlate of depression is "hypofrontality," where the prefrontal cortex lacks sufficient activation, causing damage to the hippocampus (Roberts-Wolfe et al., 2012; van Vugt et al., 2012). This hippocampal damage is likely what leads to the negative memory bias and impaired episodic and autobiographical memory seen in patients with depression (van Vugt et al., 2012).

One possible mechanism for improvement in well-being and mental health symptoms due to mindfulness is changes in memory processes. One study found that a 12-min mindfulness intervention resulted in remembering a significantly lower proportion of negative words in a post-induction verbal learning test (Alberts & Thewissen, 2011). This finding has been replicated in similar studies. An 8-week mindfulness-based cognitive therapy (MBCT) program also found that subjects with recurrent depression were less likely to pause during negative word recall, showing that they were less likely to get stuck in a negative mental context (van Vugt et al., 2012). An 8-week mindfulness-based intervention program for adverse childhood experience (ACE) survivors also resulted in improvements in episodic memory, and benefits for hippocampal volumes observed via MRI (Joss et al., 2024).

In addition to depression, there has been an interest in clinical applications of mindfulness for memory loss in older adults. Age-related cognitive impairment usually first

negatively affects episodic memory (Lekhak et al., 2020). One hypothesis is that mindfulness practice may not improve memory but may be protective against further decline (Jha et al., 2010; Whitfield et al., 2022). It is also possible that meditation leads to adult neurogenesis (Tang et al., 2015). In one study comparing the impacts of meditation and prayer on episodic memory in older adults, meditation did not have a significant effect on episodic memory, while prayer did (Lekhak et al., 2020). However, meditation data were only collected once, and subjects were not asked about their meditation practice. Similarly, trait meditation capacity did not have any impact on episodic memory, as tested through free recall tests (Requier et al., 2023). However, this study did not require subjects to engage in mindfulness practice. Finally, a recent study found a positive effect of meditation on healthy older adults' prospective memory, which depends on episodic memory, although they did not directly study episodic memory (Tsang et al., 2024). Therefore, mindfulness may be beneficial for improving memory in some clinical populations.

Discussion

Significant work has been done in the last decade to better understand the impacts of mindfulness meditation on episodic memory processes. This review paper explored common study types and methodologies in the field. Behavioral studies generally showed positive effects of mindfulness on veridical memory, mixed effects on false memory, and clinical applications in depression and aging.

For veridical memory, mindfulness improved delayed free recall and autobiographical memory, but not cued recall or recognition (Lykins & Baer, 2012; Shemesh et al., 2023). Because mindfulness has been shown to improve attention and executive function, it is possible that the effects of mindfulness on memory are greater under conditions requiring control of episodic memory (e.g., free recall) compared to recognition. This is consistent with the structural and functional changes in prefrontal cortex and the hippocampus (Fox et al., 2014, 2016; Tomasino et al., 2012) and theta oscillatory communication (Aftanas & Golosheikin, 2003; Brandmeyer & Delorme, 2018; reviewed in Cahn & Polich, 2006; reviewed in Delmonte, 1984; reviewed in Fell et al., 2010; Kubota et al., 2001; reviewed in Lee et al., 2018; reviewed in Lomas et al., 2015; Lou et al., 1999; Tang et al., 2009) thought to be involved in the top-down control of memory. Although mindfulness meditation has generally been shown to have positive effects on veridical memory, 8 weeks, but not 4 weeks, of meditation led to improvement in recognition memory (Basso et al., 2019), and a recent study showed no effect of mindfulness induction on episodic memory (Namias & Huff, 2024), suggesting that longer-term practice is necessary to observe improvement in memory.

The results for false memory were mixed, with some studies showing negative effects (Bitton et al., 2023; Wilson et al., 2015), some studies showing positive effects (Baranski & Was, 2017; Calvillo et al., 2018; Lloyd et al., 2016; Meeks et al., 2019; Rosenstreich & Ruderman, 2016, 2017), and one study showing positive effects only after a longer time (Wendt et al., 2021). Most of the studies reviewed relied on very short mindfulness inductions, some only a few minutes long, and all with novice practitioners. Therefore, it is possible that very short mindfulness inductions could have different cognitive impacts than longer inductions. In addition, because other research has generally shown positive effects of mindfulness on veridical memory when comparing beginner and expert meditators (Lykins & Baer, 2012; Shemesh et al., 2023) or following mindfulness training (Basso et al., 2019; Lykins & Baer, 2012; Nyhus et al., 2019; Shemesh et al., 2023), it is possible that brain changes that occur over a longer period of time differ from the immediate effects of mindfulness inductions in novices. Training in mindfulness meditation may cause long-lasting changes to brain structure and function that benefit memory.

In clinical practice, mindfulness interventions decreased negative memories for patients with depression (Alberts & Thewissen, 2011; Joss et al., 2024; van Vugt et al., 2012), but were generally not beneficial for memory decline in aging (Lekhak et al., 2020; Requier et al., 2023). Therefore, mindfulness interventions may not be beneficial for all clinical populations.

Limitations and Future Directions

The search strategy employed for this review was limited. We identified papers initially through a database search using search terms, but in order to identify all of the relevant papers, we also included papers cited in those results. In addition, papers were screened manually to meet our inclusion criteria, focusing on recent papers studying mindfulness and episodic memory. Therefore, the search strategy is not fully replicable or exhaustive, and there was potential for bias in the selection of papers.

Although the research reviewed here has shown some promising effects of mindfulness on episodic memory, more robust and unbiased research is needed. As mentioned, mindfulness meditation length and practices as well as memory paradigms vary, and the construct of mindfulness is often measured with subjective self-reports, making it difficult to interpret the results and draw strong conclusions. Future research should use more standardized methods for more accurate comparison across studies. It is likely that different lengths of meditation practice and different types of meditations have different impacts on memory (Levi &

Rosenstreich, 2019). Future research should compare different mindfulness lengths (e.g., longitudinal studies vs. induction and long vs. short induction) and practices (e.g., focused attention, open monitoring, and MBSR) to determine their effect on memory processes. In addition, the construct of mindfulness should be measured with validated measures. Finally, because most researchers have used a convenience sample of college-aged subjects, who tend to have generally good memory functioning already (Brown et al., 2016; Nyhus et al., 2019), the results do not generalize to broader populations. The use of more standardized methods in younger and older adults would allow for comparison of effects across age groups. Importantly, more studies on the impacts of mindfulness in older adults are necessary to understand the effects of mindfulness on memory decline.

In addition, future research should focus on brain region activation, particularly cross-region activation, as it relates to mindfulness and episodic memory (Tang et al., 2015). While there are some robust behavioral techniques used, such as the DRM, the preponderance of behavioral studies over brain imaging techniques limits understanding of the mechanisms underlying these effects. Only one study reviewed combined behavior and neural activity to study the effects of mindfulness on episodic memory (Nyhus et al., 2019). Future research should combine behavior with fMRI or EEG and utilize advanced analysis methods. For example, researchers should use fMRI and EEG to determine the effects of mindfulness on functional activity in the prefrontal cortex and hippocampus and theta oscillations thought to be involved in the top-down control of memory. Multivariate pattern analysis with fMRI or EEG data would provide a more detailed understanding of the changes in brain activity during episodic memory related to mindfulness. In addition, resting state connectivity analysis and network analysis could show how mindfulness practices affect the default mode network, which overlaps with the memory network. Finally, combining mindfulness meditation practice with neurofeedback or non-invasive brain stimulation to the frontal-parietal-medial temporal lobe memory network would allow us to understand whether these techniques can enhance the effects of mindfulness meditation practice on episodic memory. The mechanistic understanding gained from combining behavior with neuroimaging techniques would have clinical applications, informing mindfulness treatments for depression and memory decline in aging.

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