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Effects of Mindfulness Training on Working Memory

This review article discusses the effect mindfulness training or intervention can have on one's working memory. It begins by providing a brief explanation of what mindfulness and mindfulness training encompasses. Further it goes on to explaining how mindfulness intervention has been found to be beneficial for both physical and psychological health of an individual. A few contemporary studies have been reviewed in this article that focus on exploring the effects of mindfulness particularly on one's working memory. The connection between mindfulness and working memory has gained attention in the last decade and its importance of mindfulness in general is becoming a primary focus for researchers. The links between the two are identified and explored in the articles providing us with a more crystalized finding.

Mindfulness is a "practise" or "training" that necessitates a continuous change from an "automatic pilot" mindset to one that includes attention and awareness. Numerous programmes, including multi-component interventions like Mindfulness-Based Stress Reduction (MBSR), and specific types of mindfulness practise have been referred to as mindfulness (e.g., mindfulness meditation). In general, studies have demonstrated that mindfulness-based therapies are effective in generating positive benefits on physical and psychological functioning, especially in adults. It is crucial to start determining whether particular advantages may be specifically connected to particular forms of mindfulness practise, even though the overall advantages of mindfulness on physical and psychological functioning are reassuring as researchers emphasise the positive outcomes of mindfulness interventions.

Working memory (WM) is a cognitive skill that allows people to keep and manipulate task-relevant information selectively across short time periods while preventing it from interruption by irrelevant information. WM has been implicated in many higher order cognitive functions such as learning, decision-making and emotion regulation (Schmeichel & Tang, 2015 as cited from Jha et al., 2022). But WM can be rapidly degraded by several factors, including stress. This poses a unique challenge for individuals who must endure high-stress circumstances as a fact of their profession. According to Quach et al. (2015), exercises in mindfulness have been found to directly influence higher-order cognitive functions like executive functioning. Given that both structures depend on awareness of the present moment, the effect of mindfulness on working

memory has gained considerable attention. An individual can maintain information in consciousness long enough for thinking and comprehension to take place due to their working memory, which serves as a mental workbench. The brain uses this cognitive process to move information from short-term memory to long-term memory. Other higher-level cognitive functions including reasoning, understanding, and executive functioning are all impacted by working memory as well. According to adult literature, practising mindfulness meditation can help people's working memory especially in highly stressful situations. (Jha et al. 2022)

In order to explore the given relationship of mindfulness and working memory, the following search engines were resorted to - Google Scholars, PubMed, ScienceDirect and Springer.

The following researches reviewed have been selected as they further explore this relationship between mindfulness training and working memory in diverse populations and situations to give us a comprehensive view on the topic.

In a recent study, Bahrami et al. (2022) attempted to examine the efficacy of mindfulness practise along with music on working memory and cognitive flexibility of children with learning disorders. They carried out an experimental study using pre-tests and post-test design. 30 primary school students with learning disabilities were chosen at random and placed in either the experimental group or the control group. The control group did not receive any intervention, while the experimental group received music and mindfulness interventions for 8 sessions of 2 hours. The Hafbak Working Memory Questionnaire and the Cognitive Flexibility Questionnaire were administered on the students.

It was found that mindfulness can enhance the pattern of responding to unfavourable attitudes and consequently enhance the function of working memory by removing elements that degrade memory, such as stress symptoms, anxiety, and poor self-esteem. Additionally, learning and metacognitive methods must be used when engaging in mindfulness exercises. There is evidence to support the claim that these techniques enhance working memory and memory function.

Even though the current study establishes a link between mindfulness and working memory, the sample size of the study is relatively small to generalize the results. The participants were selected only from one school which further restricts the generalizability of the findings. A larger and a more diverse sample would give us a more accurate result.

Zanesco et al. (2018) conducted a study where their aim was to investigate whether Mindfulness Training (MT) might improve cognitive performance on measures of sustained attention and working memory, and reduce cognitive failures in daily life, in a sample of high-performing SOF personnel. At a U.S. Military location, 120 healthy active-duty male participants were selected. They had extensive military service, and many of them had previously experienced battle. An experienced mindfulness trainer taught either a 2-week or 4-week version of Mindfulness Based Attention training (MBAT) to staff members who were allocated to either group. Staff members who were assigned to the no-training control group (NTC) did not receive any mindfulness instruction but did engage in study evaluations. A modified version of the Sustained Attention to Response Task (SART) was used to measure sustained attention. Using a delayed-recognition test with distracting affective pictures, working memory was evaluated. The latency between encoding and retrieval was measured. At Test1 (T1) and Test 2 (T2), participants filled out the Cognitive Failures Questionnaire to evaluate attentional and cognitive lapses that occur in daily life.

The 4-week MBAT version showed significant increases in behavioural measures of detection accuracy in a sustained attention task and enhanced accuracy on a working memory task in the service personnel who underwent it. On these behavioural measures, however, neither the NTC nor the 2-week MT groups had any change. However, the self-reported cognitive deficits in daily life decreased in both the 2-week and 4-week MT groups. And last, for the 4-week group, there was a correlation between the quantity of outside-of-class mindfulness practise that MT participants engaged in and improvements in working memory accuracy. Over the course of the programme, mindfulness training and practise appeared to enhance performance on cognitive tasks requiring sustained attention and working memory.

This study successfully establishes a precise relationship between working memory and mindfulness. Additionally, a variety of tests and self-report questionnaires are utilised to collect data on the Participants' experiences, mental health and well-being, and motivation, which is a potential confounding factor for the majority of prior research of this sort. Individual differences and other circumstances, nevertheless, can still have an impact on the outcomes.

Vugt and Jha (2019) conducted a study to investigate whether mindfulness training (MT) influences information processing in a working memory task with complex visual stimuli. The participants' performance was assessed before (Test 1 -T1) and after (Test 2 - T2) taking part in a rigorous one-month MT retreat, and it was compared to a control group with similar age and

educational background. The experimental group had a month-long period of intense mindfulness training that was mostly based on the Four Foundations of Mindfulness-Sathipattana Sutra of the Buddhist canon. At two times, corresponding to the start and finish of the MT retreat, both groups completed a working memory test for complex and confusing faces.

They discovered that accuracy did not vary between groups at either point in time. At T2, the MT group responded more quickly and with much less variability than the control group. However, they employed a mathematical modelling approach to separate these components because these outcomes could be the consequence of mnemonic processes, speed-accuracy trade-offs, or non-decisional factors (such as motor execution). Through this model they further came to the conclusion that the increase in information quality reflected a decrease in encoding noise and not an increase in forgetting. The modelling outcomes thus validate the possibility that MT might enhance working memory.

Despite the fact that the study is unique in its attempt to apply a different modelling approach to get a more exact and precise conclusion, there are other factors that may have affected the findings. One of the most notable ones might be that the experimental group, who received mindfulness instruction in a retreat, was in a setting different from one's ordinary life, one in which there were fewer daily stressors and challenging situations to deal with. The results may have been influenced by additional variables such as participant motivation and individual differences in mindfulness as well as the working memory task. Thus, further attempt to deal with these can help us get more accurate findings.

According to Mrazek et al. (2013), improving one's ability to stay on task should lead to a general improvement in performance given that the capacity to pay attention to a task without becoming distracted underpins performance in a wide range of circumstances. In light of this, they carried out a randomized controlled trial to determine whether a two-week mindfulness program would enhance working memory capacity (WMC) and GRE performance, i.e., reduce mind wandering and enhance cognitive function. Using a mixed factorial pretest-posttest design, 48 undergraduate students were randomly assigned to either a nutrition class or a mindfulness class. Classes met for 45 minutes, four times a week for two weeks, and were instructed by experts with years of classroom experience. A reading comprehension test was utilized to gauge GRE, and the common Operation Span exercise was used to gauge WMC (OSPAN).

Training in mindfulness increased working memory capacity and GRE reading comprehension scores while concurrently lowering the frequency of distracting thoughts while taking the exam.

Reduced mind wandering among participants who were prone to distraction at the start of the program helped individuals perform better. These findings imply that developing mindfulness is a powerful and practical method for enhancing cognitive performance, with far-reaching effects. The current research suggests that applying this capacity to a difficult job can prevent distractions from displacing important task-relevant information.

The findings of less mind wandering are in line with recent reports showing mindfulness training decreases the default network's activation, a group of brain regions that are normally more active at rest than when performing externally directed cognitive tasks. The default network has been frequently linked to indicators of mind wandering, however it is unclear from this study if mindfulness training lessens mind wandering by reducing default network activation. This however should not be a limitation but a further point of research.

Through a randomized controlled trial comparing mindfulness meditation with hatha yoga and a waitlist control group, Quach et al. (2015) conducted a study to examine the impact of a mindfulness meditation intervention on working memory capacity (WMC) in teenagers. Participants were chosen at random from a big public middle school in the southwest of the United States and placed in one of three conditions: waitlist control, hatha yoga, or mindfulness meditation. At preintervention, postintervention, and waiting, participants completed a computerized assessment of WMC (Automated Operational Span Task), as well as self-report tests of perceived stress (Perceived Stress Scale) and anxiety (Screen for Childhood Anxiety Related Emotional Disorders). WMC, stress, and anxiety were examined at preintervention and postintervention using a variety of mixed-design analyses of variance.

In contrast to the waitlist control and hatha yoga groups, they discovered that participants in the mindfulness meditation condition significantly improved their WMC. Stress or anxiety did not show any statistically significant between-group differences. This is the first study to back up the advantages of brief mindfulness training, particularly mindfulness meditation, in enhancing WMC in teenagers. The importance of researching the elements of mindfulness-based therapies among adolescents is highlighted by the results, given that these interventions may enhance cognitive performance. The possibility for integrating mindfulness therapies into educational settings and current treatment procedures is increased by the fact that they can be offered in a condensed style more generally. These results imply that mindfulness meditation can be a useful strategy for enhancing WMC in teens. The current study's teenage sample was drawn from a public school in a lower-socioeconomic status (SES) area; therefore, its findings may not

generalize to samples from different contexts. To further demonstrate improvements in cognitive functioning, it may be useful to look at whether increases in WMC are connected to gains in all-around academic achievement.

In conclusion, the studies mentioned above have shown a connection between practising mindfulness or receiving mindfulness training and enhanced working memory in children, adolescents and adults in various settings. It appears that the connection between the two was only recently found, therefore more research in this area is required to fully comprehend the how and the why of the association. As a result of the vast scope of this research, numerous research gaps have been discovered that can be further investigated. This however should not be limited for research but can be used to make systemic changes and should be applied and made a part of training and education.

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