

Analyzing the Effects of Meditation on Memory

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Many methods and practices -- such as yoga, meditation, and breathing exercises -- are often proposed as potential remedies for stress and anxiety, or to improve one's concentration and mental clarity. Meditation involves self-reflection and focus, often slowing one's breath and increasing awareness of thoughts and feelings -- both wanted and unwanted. The increased self-awareness is meant to allow the person to relax and be more focused. It is often suggested as a way to improve cognition and memory. But is it actually effective?

Previously, meditation has been found to improve attention (Brefczynski-Lewis et al., 2007), visuospatial processing, working memory, and executive function (Zeidan et al., 2010). Additionally, hippocampal gray matter density -- the region associated with memory storage and retrieval -- has been shown to be increased in subjects who practiced mindfulness meditation (Holzel, 2011). The prefrontal cortex -- the region that allows for recall of specific details of memories -- was more active in the subjects who practiced mindfulness (Zeidan, In Press). The prefrontal cortex and hippocampus communicate through low frequency neural oscillations called theta oscillations, which are linked to source memory. Theta activity has been found to be increased in subjects who meditated long-term (Aftanas & Golocheikine, 2002).

There is very limited literature on the effects of meditation on long-term memory. Our project investigates the effects of mindfulness meditation on a type of long-term memory called episodic memory. The data was previously collected by another student at Bowdoin, in an EEG study where subjects completed memory tasks, involving different methods of associating words given with a *place* or how *pleasant* the word is. During the EEG recording, subjects were presented words and had to indicate if it was one they had to associate with *place*, *pleasant*, or if it was a *new* word entirely. After the first memory test, the experimental group underwent a four-week mindfulness meditation course before completing follow-up tests. The control group also did a follow-up test, but without the meditation course. The hypothesis was that subjects who completed the mindfulness meditation course would demonstrate improved memory task scores from the first to the second test, as well as increased theta oscillation power compared to the control group.

The data were preprocessed and cleaned using MATLAB to increase signal to noise ratio before beginning analysis. We focused on behavior, examining whether the meditation group has greater changes in memory from pre-test to post-test compared to the control group. Source memory has been found to be improved for subjects in the experimental group compared to the control, based on improved scores post meditation. The experimental group reported a significant increase in mindfulness whereas the control group reported no change. The neural oscillations will continue to be analyzed, with focus on the target regions (prefrontal cortex and hippocampal areas), to answer the question: does meditation actually improve your memory?

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References

- Aftanas, L. I., & Golocheikine, S. A. (2002). Non-linear dynamic complexity of the human EEG during meditation. *Neuroscience Letters*, 330(2), 143-146.
- Brefczynski-Lewis, J. A., Lutz, A., Schaefer, H. S., Levinson, D. B., & Davidson, R. J. (2007). Neural correlates of attentional expertise in long-term meditation practitioners. *Proceedings of the National Academy of Sciences of the United States of America*, 104(27), 11483-11488.
- Holzel, B. K., J. Carmody, M. Vangel, C. Congleton, S. M. Yerramsetti, T. Gard and S. W. Lazar (2011). "Mindfulness practice leads to increases in regional brain gray matter density." *Psychiatry Res* 191(1): 36-43.
- Zeidan, F. (in press). *The Neurobiology of Mindfulness. The Handbook of Mindfulness*. New York, NY: Guilford Press.

Zeidan, F., S. K. Johnson, B. J. Diamond, Z. David and P. Goolkasian (2010). "Mindfulness meditation improves cognition: evidence of brief mental training." *Conscious Cogn* 19(2): 597-605.