

Measuring the Effectiveness of Mantra-based Meditation using EEG Data Analysis

Angqi Li¹, Pratham Pradhan¹, Annie Wozniak¹, Barry H. Cohen², Krishna Ika³, Saiprasad Ravishankar^{1,4}

Dept. Computational Mathematics, Science and Engineering, Michigan State Univ., East Lansing, MI¹

Dept. Applied Psychology, New York University, New York, NY², Brainwave Science, Inc., Southborough, MA³

Dept. Biomedical Engineering, Michigan State Univ., East Lansing, MI⁴

Overview

- Our study uses a quasi-experimental design to explore the effects of mantra-based meditation on cognitive abilities. Our aim is to provide a non-pharmacological approach that improves attentional focus.
- Based on the results from two groups, mantra-based meditation shows promise for enhancing cognitive abilities, especially attentional focus.

Background

- Types of Meditation [1]:** So far, most research has focused on the effects of four types of meditation (Figure 1).
- Mantra-Based Meditation (MBM):** Involves repeating a specific word or sound (mantra) [2] for deep concentration and relaxation.
- P300:** The P300 [3] event-related brain potential (Figure 2).
 - Shorter latencies are related to superior cognitive performance.

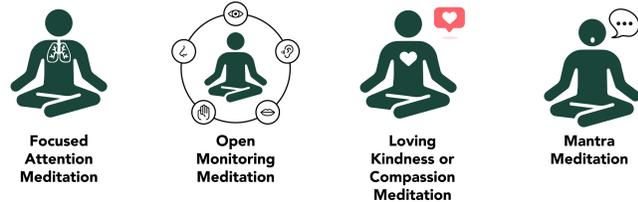


Figure 1: Four types of prevalent studied meditation

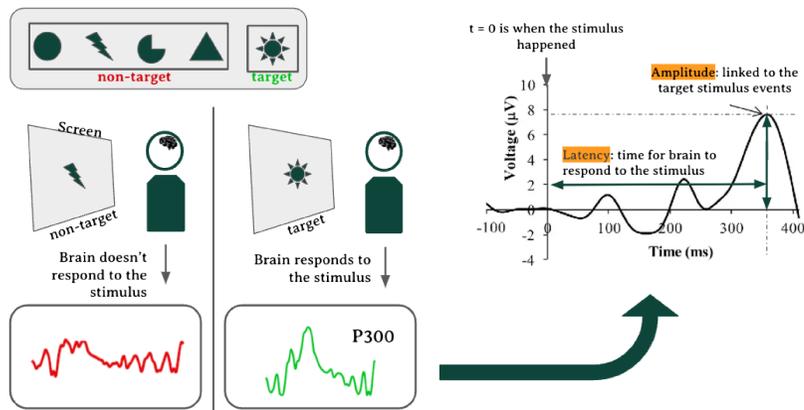


Figure 2: How the P300 waveform is generated

Acknowledgments

- This research was funded in part by Brainwave Science, Inc., whose EEG headset and software were used in the study. The P300 results were collected by iCognitive instrumentation made by Brainwave Science, Inc.
- We are deeply thankful to The Harmony Collective, Ypsilanti, for providing both space and dedicated volunteers for our data collection.

References

[1] K. Matko and P. Sedlmeier, "What is meditation? proposing an empirically derived classification system," *Frontiers in psychology*, vol. 10, p. 2276, 2019.
 [2] J. P. Dudgeon, "Scientific analysis of mantra-based meditation and its beneficial effects: An overview," *International Journal of Advanced Scientific Technologies in Engineering and Management Sciences*, vol. 3, no. 6, pp. 21-26, 2017.
 [3] T. W. Picton et al., "The p300 wave of the human event-related potential," *Journal of clinical neurophysiology*, vol. 9, pp. 456-456, 1992.

Methods

- EEG Device:** EEG data was collected by the AIKA health EEG headset (made by Brainwave Science, Inc.), and recorded from Fp1, Fp2, Cz1, Cz2, Cz3, Pz1, Pz2, and Pz3 electrodes. Data is processed by the software provided by the company to obtain the P300 results. (See Figure 4.)
- Participants:** The EEG data was acquired from twenty-three pre-screened participants and they all signed IRB approved consent forms. They were divided into two groups based on their prior experience with MBM. (Table 1)
- Procedures:** The two groups follow the different pipelines shown in Figure 3.
- P300 Speller Test:** The flow chart for this task is shown in Figure 5.

	MBM Group		Novice Group		Total
	M = 10	F = 2	M = 8	F = 3	23
Age(years)	30±3.9		23±5.7		
Years of practice meditation (years)	≥ 2		0		

Table 1: Info. of Mantra-Based Meditation (MBM) Group and Novice (non-meditator) Group. Male (M) and female (F) counts in each group are also shown.

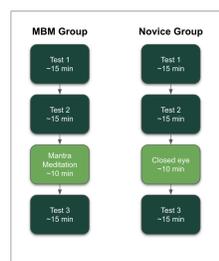


Figure 3: Different pipeline for MBM group and novice group



Figure 4: Photo of the device and participant taking the test.

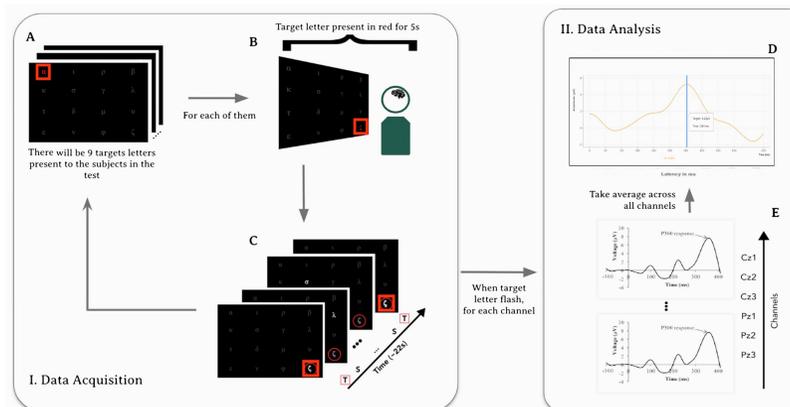


Figure 5: P300 Speller Test Flow Chart

Results

- Accuracy:** For each test, there are 9 target letters. For each target letter, participants will count the number of target letter flashes. We use the accuracy percentage: (# correct counts/9) × 100% as an index of attentional focus.

Group	Latency (ms)			Amplitude (µV)			Accuracy
	Mean	Median	SD	Mean	Median	SD	Mean
MBM	383	368	34	6.49	5.45	3.24	91.45
Novice	397	413	33	6.76	6.11	3.32	88.90

Table 2: P300 test latency, amplitude, and accuracy for different groups.

Results (contd.)

	Numbers of tests from participants			
	All correct	Not all correct	Total	Proportion of correct tests
	a	b	n = a+b	p = a/n
Novice	5	13	18	0.28
MBM	14	11	25	0.56
Total	19	24	43	

Table 3: Chi-square accuracy results ($\chi^2(1, N = 43) = 3.38, p\text{-val} = 0.066$)

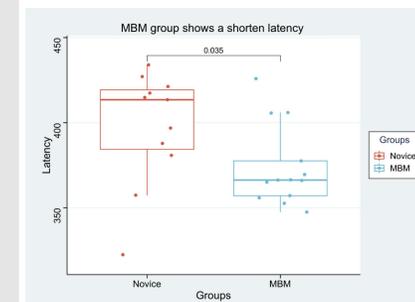


Figure 6: Latency boxplot of the two groups (t-val = 3.65, p-val = 0.0035)

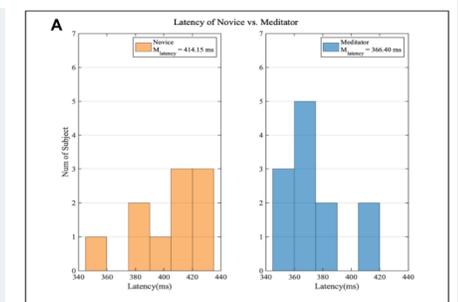


Figure 7: Histogram of latencies for novice (orange) and MBM (blue) groups.

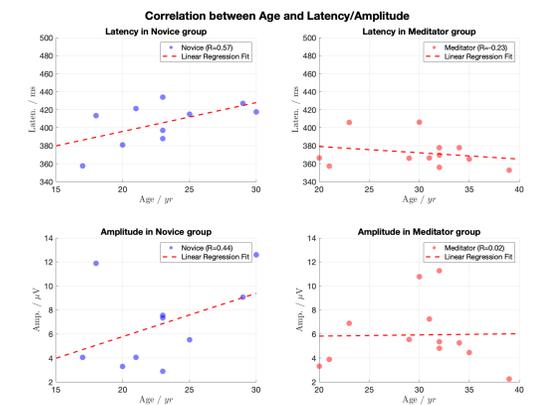


Figure 8: Correlation between age vs. latency or amplitude within the groups. The correlation (R) value is shown inside the legend box that is associated with each scatter plot.

Discussion

- The significantly shorter latency for the MBM groups (who used the Hare Krishna mantra) suggests improved attentional focus due to enhanced neural processing.
- The age-related latency trends between the two groups suggest that the age differences may confound the results.
- In conclusion, MBM shows promise for enhancing cognitive abilities, especially attentional focus.

Ongoing and Future Work

- Our ongoing studies also include music-based meditation. This research aims to differentiate its effects, contributing to the field of contemplative science.
- Future research will explore other meditation techniques, employ larger, age-matched samples, and investigate long-term effects, including measures of mental well-being.