Attention and Meditation Quantification Using Neural Networks

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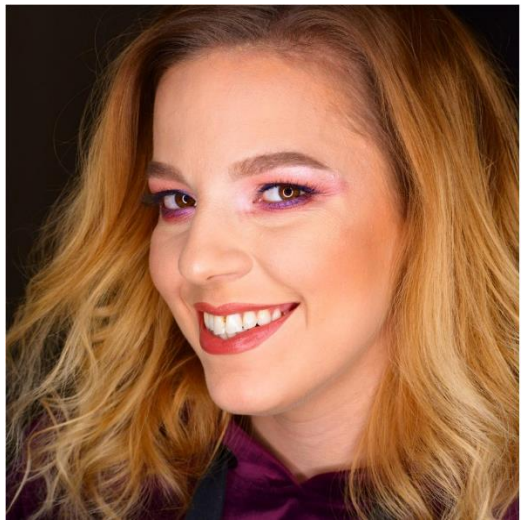

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Aims and Contribution of the Paper

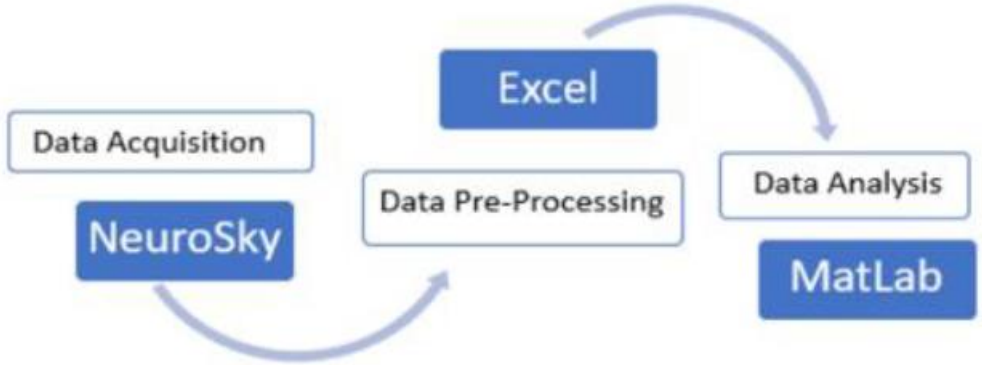
Aims:

- identifying behavioral and learning patterns using BCI enabled by a data analysis framework for evaluating the impact of various brainwave frequencies on human attention
- comparing the effectiveness of various working scenarios that have been developed for the subjects targeting to enhance their level of attention.

Contribution:

- enabler created through the employed methodology of monitoring attention and meditation levels that can provide instructional designers with knowledge for better designing the learning mix, evaluating required cognitive efforts to foster attentional processes and ensure better training results.

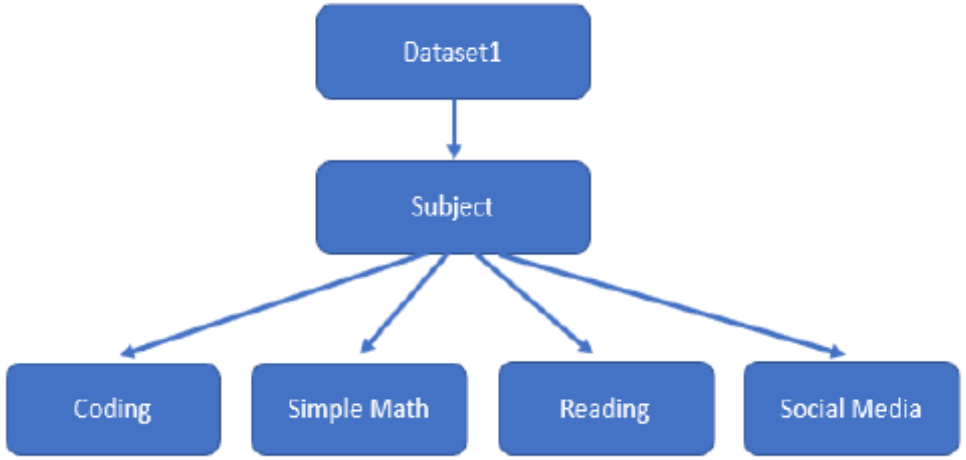
Process Diagram and System Components



- Hardware Component – NeuroSky Headset - Brainwave Data Harvesting - (Delta, Theta, Alpha1, Alpha2, Beta1, Beta2, Gamma1, Gamma2)
- Software Component – Neural Network Tool – Brainwave Data Analysis

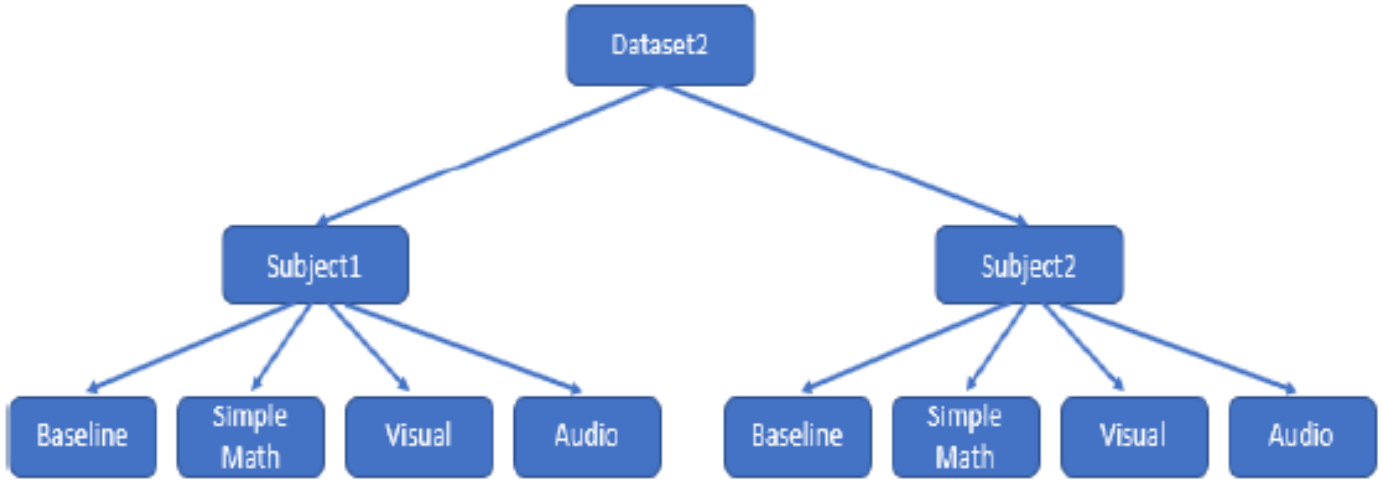
Experimental Setup NeuroSky Headset

- Scenario 1 - Coding - spent 11 minutes working at coding a math game.
- Scenario 2 - Simple math - spent 2 minutes doing simple math.
- Scenario 3 - Reading - spent 2 minutes spent on reading the article When Biking and Bears Don't Mix (Random article on NY times).
- Scenario 4 - Social Media - spent 1 minute looking at social media on the phone.



Experimental Setup NeuroSky Headset

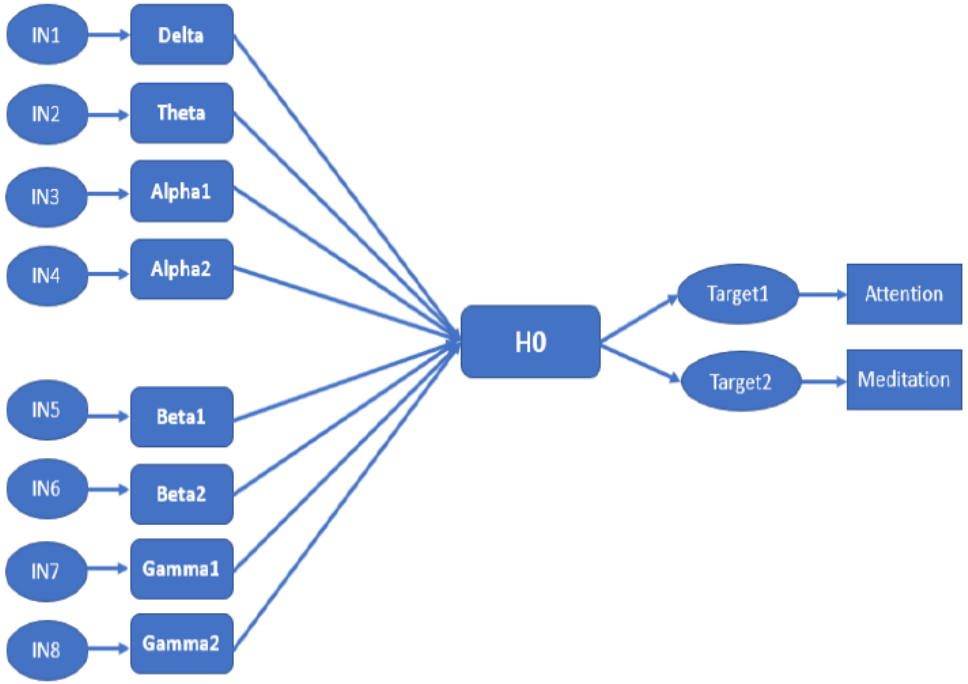
- Scenario 1 - Baseline experiment for 5 minutes in a quiet room.
- Scenario 2 - Simple math for 2 minutes obeying also the baseline requirements.
- Scenario 3 - Visual experiment for 2 minutes that respect all the criteria mentioned into the baseline scenario.
- Scenario 4 - Audio experiment contains three sub-scenarios that are wrapped into one; the subject will listen to three different audio files at different times.



Experimental Setup Neural Network

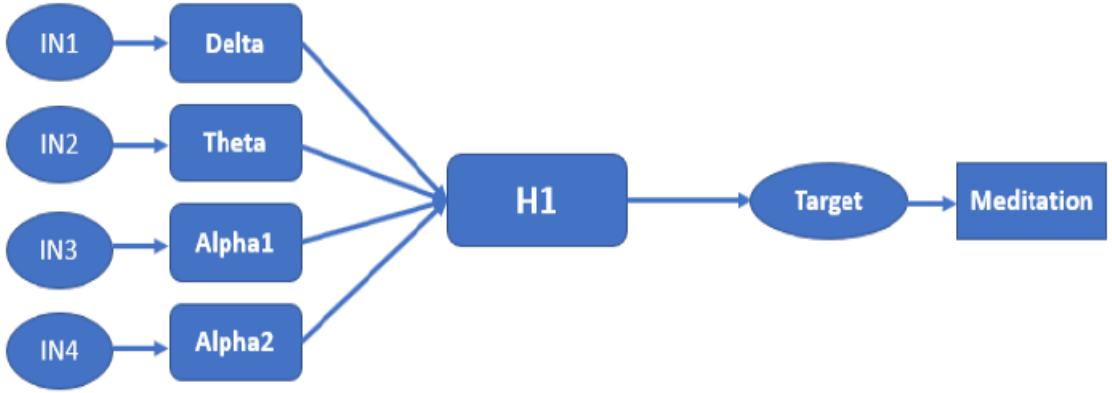
The following hypotheses are considered:

- **H0** Both meditation and attention levels are equally affected by all eight types of brainwaves defined by the NeuroSky headset protocol (Delta, Theta, Alpha1, Alpha2, Beta1, Beta2, Gamma1, Gamma2).

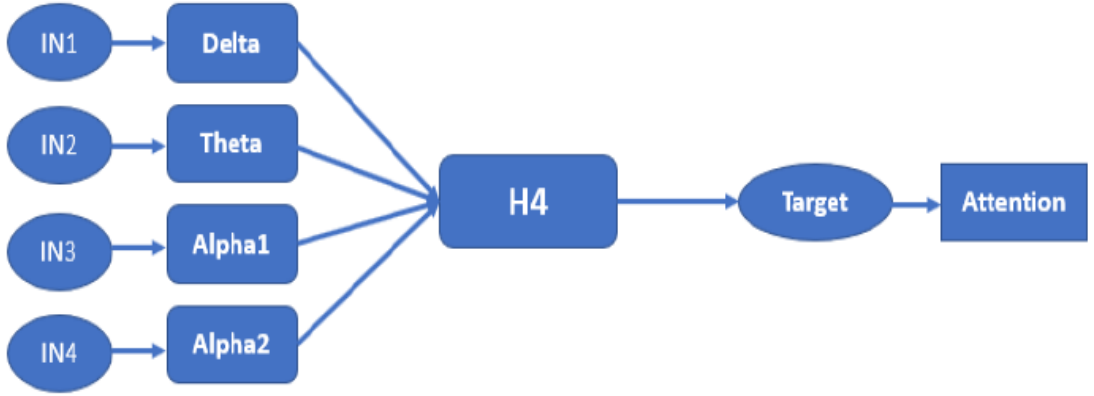


Experimental Setup Neural Network

- **H1** The meditation level is equally affected by the low to middle frequency brainwaves (Delta, Theta, Alpha1, and Alpha2).

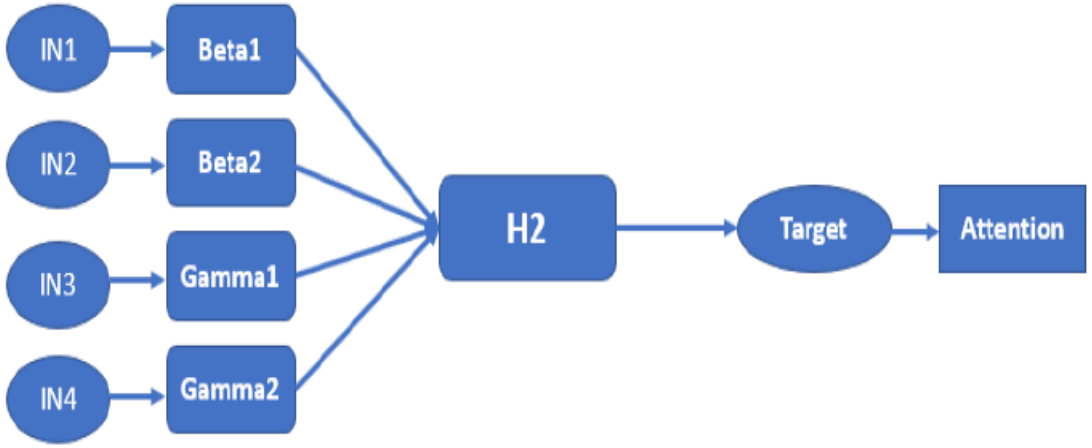


- **H4** contrasting the H1 hypothesis, the attention level is equally affected by the low to middle frequency brainwaves (Delta, Theta, Alpha1, and Alpha2).

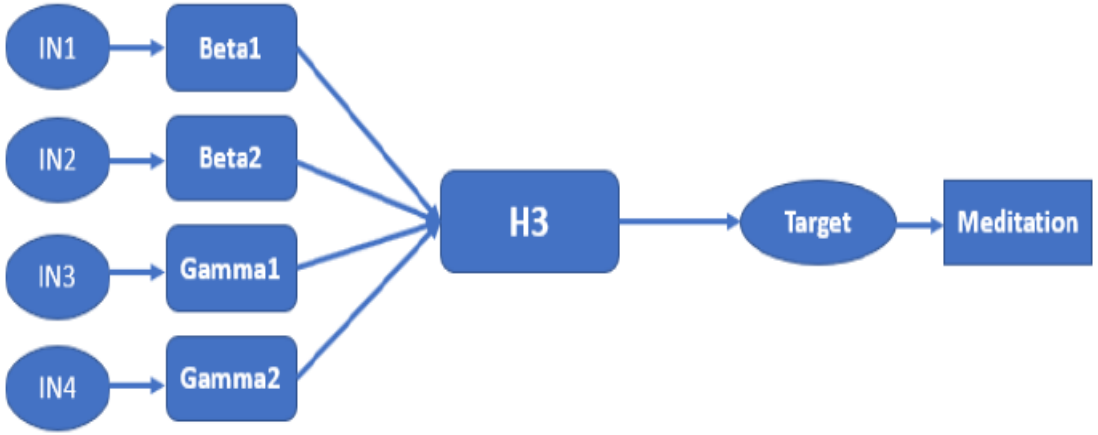


Experimental Setup Neural Network

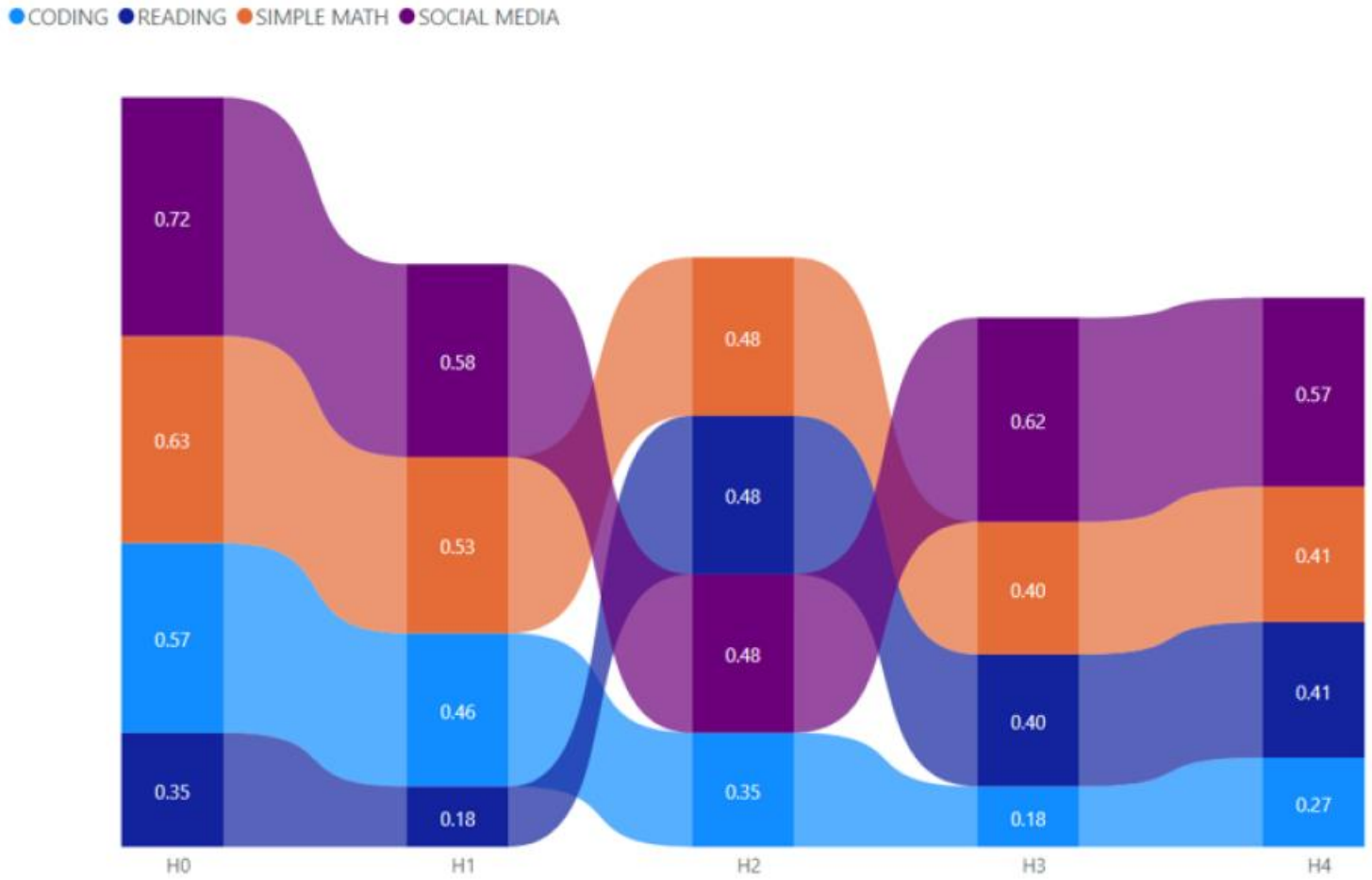
- **H2** The attention level is equally affected by the high frequency brainwaves (Beta1, Beta2, Gamma1, Gamma2).



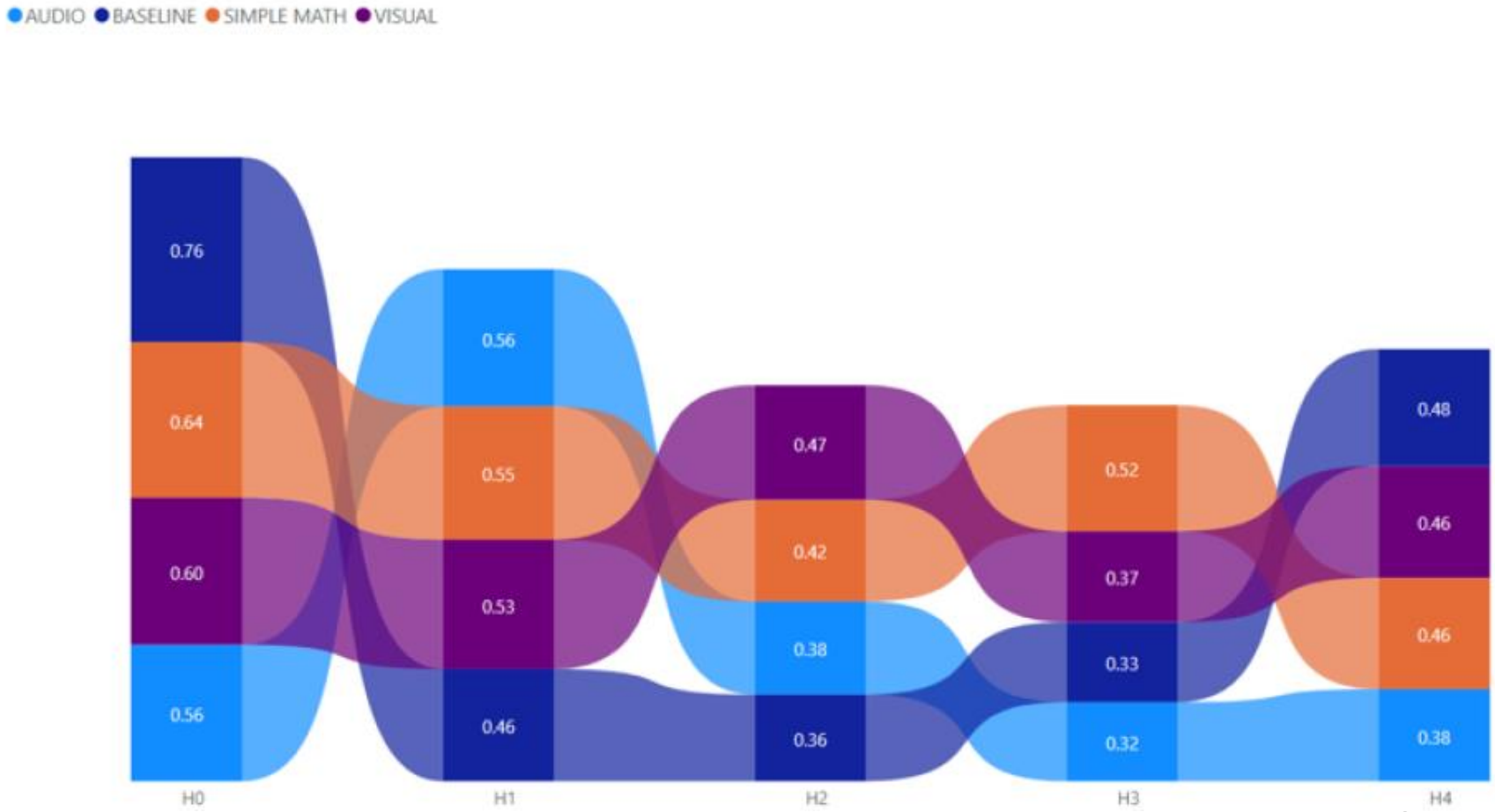
- **H3** contrasting the H2 hypothesis, the meditation level is equally affected by the high frequency brainwaves (Beta1, Beta2, Gamma1, and Gamma2).



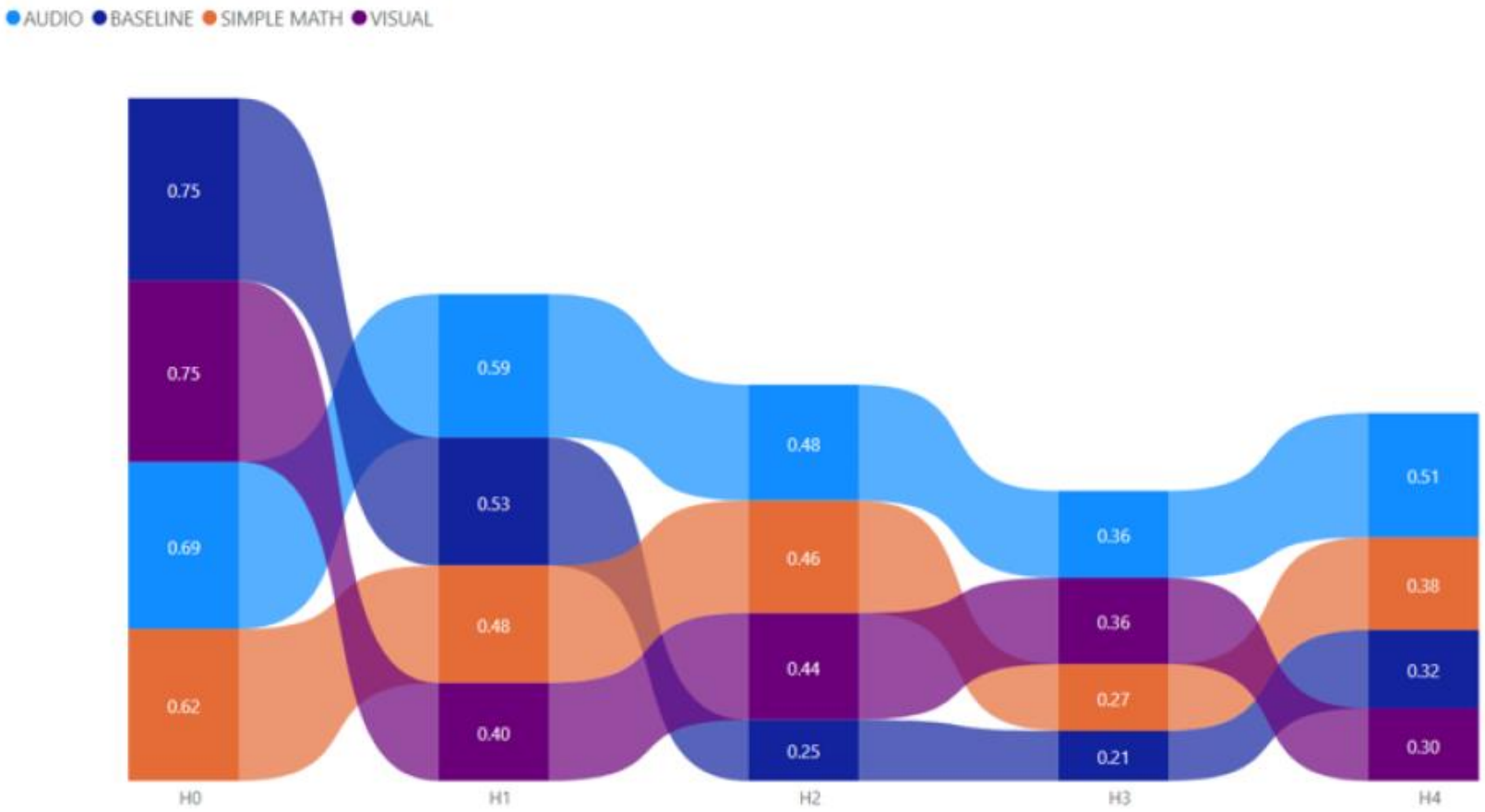
Experimental Results – Dataset1



Experimental Results – Dataset2



Experimental Results – Dataset2



Conclusion and Future Work

- In this paper, we evaluate several learners as they perform different tasks and discuss various methods to analyze and compare brainwave data. We observe common patterns for all users, despite the limitations faced in data interpretation. The goal is to expand and increase the experiments user base to detect patterns in user attention based on the audio-visual content presented. We believe that BCI can be employed successfully in improving the learning outcomes and fine tuning learning materials for adult learning.