

Functional Connectivity and Neural Oscillations in Episodic Memory

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Whenever you are explicitly thinking about events in your past and the context in which they are derived, you are engaging your episodic memory. Given the complexity of these memories and the sensory activity associated with them, the brain must enlist a large network of areas to process and retrieve those memories. Through numerous studies on this memory system, cognitive neuroscientists suggest a strong involvement of the frontal cortex, parietal cortex, and hippocampus regions during episodic memory, particularly during the retrieval of memories (Nyhus and Curran, 2010). While understanding which areas of the brain light-up during specific cognitive tasks provides valuable insight, the ability to decipher how such brain areas interact provides a more detailed understanding of the underlying neural mechanisms. Magnetoencephalography (MEG) is a neuroimaging technique that enables the recording of electrical activity on the scalp of a person's head, thereby creating a direct measurement of the activity of neurons firing synchronously across brain networks. After various levels of preprocessing, during which noise from the surrounding environment is removed from the signal, we applied a mathematical model called Granger causality to analyze the directional flow of information at theta frequency. Based on past research, we predicted that information necessary for episodic memory will flow from the left inferior parietal cortex to the right dorsal lateral prefrontal cortex parts of the brain at theta frequency.

In order to begin pursuing the objectives of this project, I completed a nine-week course in Matlab, the computer program we primarily used to process our EEG data and implement the Granger causality analysis. Matlab carries a few software tools specific to EEG, such as EEGLab, that enable us to process our data and perform Granger causality analysis. In order to acquire a more practical understanding of EEGLab's application and to accelerate the progress of our project, I used the funding from the Grua-O Connell Grant to attend a teaching workshop at UC San Diego in November specific to EEGLab. With the training I received at the workshop, I was able to perform preprocessing on our raw data and begin to apply Granger causality to the data using a plugin called SIFT.