## Active and Passive Spatial Learning in Human Navigation

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Previous studies show that active exploration of an environment contributes to spatial learning more than passive visual exposure (Chrastil & Warren, 2013; Chrastil & Warren, 2015). Active navigation and cognitive decision-making within a novel environment leads to increased spatial knowledge and memory of that environment, compared to a passive exploration that removes the decision-making component.

There is evidence of theta oscillations in EEG recordings from the hippocampus and pre-frontal cortex (PFC) that reflect spatial navigation and memory performance, as these low-frequency waves are involved in communication between the formerly named brain regions (Klimesch, 1996). These frontal oscillations are found to be involved in complex behaviors such as decision making, spatial navigation and spatial working memory in both rats and humans. They have been identified in frontal brain regions involved in decision making processes, which could contribute to increases in the spatial memory found in subjects actively exploring, rather than passively exploring, a novel environment.

As they are known to contribute to spatial coding, low-frequency theta oscillations could indicate the encoding of new information into memory and can be visualized in electroencephalography (EEG) recordings. Oscillations found at 4-8 Hz have been found to increase with virtual movement and searching, suggesting a role in attention and sensorimotor integration during navigation (Ekstrom et al, 2005). These increases in theta power, focused in the frontal regions, integrate the many complex brain functions involved between the PFC and hippocampus. Because the communication between these two regions is mediated by theta oscillations, active decision making during navigation may lead to increased spatial memory of a novel environment. This summer, I analyzed these frontal theta oscillations in EEG recordings during active and passive decision making for human spatial navigation and memory.

In our experiment, we had two experimental groups, a Free and a Guided group, who navigated through a maze in either an active or passive manner, respectively. They explored the maze and then were required to undergo a spatial memory task. In behavioral results, we expect similar results to previous studies, the Free group performing better on a spatial memory task than the Guided group. The Explore phase is when an increase in theta oscillations is expected because the subject is actively making decisions or passively following a guided navigation. Thus, EEG data should show a significant increase in theta oscillations at a frequency of 4-8 Hz in the frontal channels for the Free group during the Explore phase. Increases in theta power have been previously found in EEG data for frontal areas involved in decision making, which may contribute to the observed behavioral increase in spatial memory for those in the Free group. In the future, we hope to explore the individual differences between subjects and continue to further analyze the data.

**Faculty Mentor: Erika Nyhus**

**Funded by the Kufe Family Research Fellowship**

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