Hippocampal Theta During Memory Guided Virtual Navigation in Human Intracranial EEG

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Theta (4-8Hz) frequency oscillations are prominent in the rodent hippocampal local field potential (LFP) during translational motion, particularly during the initiation of movement [Vanderwolf, 1969], and are commonly associated with spatial memory. However, the exact relationship between this Type I, movement-related, theta and human spatial learning is currently unclear. We therefore examined intracranial EEG recordings from hippocampal depth electrodes in pre-surgical epilepsy patients performing a self-paced virtual reality navigation and spatial memory task [Doeller, King and Burgess, 2008]. In this task, participants were asked to navigate towards, and encode the location of, various visible objects within a single environment. Participants were subsequently cued with the image of a single object, and then asked to navigate to the remembered location of that object. We found a significant increase in theta (4-8Hz) power on hippocampal electrodes associated with virtual movement onset compared to stationary periods, specifically during these recall trials [mean frequency = 8.1Hz, -100 to 500ms after movement onset]. This is in line with previous findings from MEG recordings in humans [Kaplan et al., 2012]. We also observed more sustained changes in theta power during movement epochs in encoding trials, and a general decrease in delta (2-4Hz) power during stationary epochs in all trials [mean frequency = 3.2Hz, 150 : 1000ms after stationary onset]. Further work will examine the relationship between theta power and memory performance in our task, and the correspondence between our findings and related findings in the literature concerning spatial navigation and memory.

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Vanderwolf CH (1969) Hippocampal electrical activity and voluntary movement in the rat. Electroencephalography & Clinical Neurophysiology, 26(4), 407-418