

Research on learning and memory is fundamental to understanding cognition and directly relevant to the training of military personnel and to the diagnosis and rehabilitation of injured soldiers. Functional magnetic resonance imaging (fMRI) studies of memory have identified a cortico-hippocampal network that is critical for remembering past events. Recent evidence indicates that regions in this network generate rhythmic electrophysiological oscillations in the theta band (4-8 Hz), and that theta oscillations may be related to cognitive states that promote successful memory retrieval. The objective of this project is to use three empirically motivated methods to manipulate theta activity and determine effects on memory and on recruitment of brain networks measured with electroencephalography (EEG) and fMRI. Rhythmic sensory stimulation (Aim 1), transcranial alternating current stimulation (Aim 2), and reward motivation (Aim 3) will be used to manipulate theta activity during memory retrieval tasks. EEG studies will determine how theta enhancement affects the magnitude and timing of theta activity during memory retrieval, and fMRI studies will determine effects on recruitment of the cortico-hippocampal network. We will also use advanced multivariate analysis techniques to decode how information about past episodes is represented in neural activity patterns and test whether theta enhancement sharpens these representations. This project will advance basic science by directly connecting neural oscillations, which are currently poorly understood, to specific cognitive processes and to activity in a cortico-hippocampal network that is thought to play a crucial role in episodic memory. Moreover, the proposed studies can lead to the development of novel **biomarkers** for memory function and dysfunction (e.g., to assess service-connected cognitive impairment) and of **systems for accelerating learning** (e.g., in training situations) and **rehabilitating memory** (e.g., in injured soldiers). The work can also contribute to the development of **memory-guided brain-computer interface technologies**.