Cortical Oscillations During Memory Encoding Predict Successful Retrieval

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We examined the neurophysiological correlates of memory encoding that lead to successful retrieval. Previous work has demonstrated that changes in intracranial ERPs and fMRI BOLD signals predict subsequent recall in episodic memory tasks (Fernandez et al., 1999; Wagner et al., 1998). Recent work has shown that in free recall, 32-48Hz (gamma) phase synchrony in the medial temporal lobe (MTL) during study predicts subsequent recall (Fell et al., 2001).

To explore the role of a wide range of oscillations outside of the MTL, we tested whether changes in oscillatory activity at various frequencies and at widespread cortical sites during encoding predict successful episodic recall.

Recording from 675 widespread cortical sites in 7 patients undergoing treatment for medically resistive epilepsy, we examined oscillatory power between 2 and 64Hz as participants studied lists of common nouns. At many frequencies we found oscillations that predicted subsequent recall. We observed increased 32-64Hz (gamma) power associated with successful encoding of list items at 31 sites. We also observed decreased 9-16Hz (alpha) power predictive of subsequent recall at 46 sites. Sites exhibiting these two patterns at different frequency bands often appeared in the same brain region. Within a single frequency band, however, electrodes exhibiting increases and decreases in power that predicted subsequent memory clustered in topographically distinct regions. Electrodes exhibiting increases in gamma oscillations that positively correlated with subsequent recall were found at many cortical locations, but especially in the temporal lobe and subtemporal occipital region. Electrodes exhibiting decreases in alpha oscillations that predicted successful recall localized to the left and inferior regions of both the temporal and occipital lobes. These findings point to a crucial role of brain oscillations in episodic memory function.

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