Rhinal-hippocampal contributions to declarative memory formation: Depth-EEG investigations

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The integrity of the medial temporal lobe (MTL) is essential for declarative memory, the ability to store and recall consciously events and facts. In the studies presented here, we explored neural activity during declarative memory formation by invasive EEG recordings from bilateral MTL depth electrodes in epilepsy patients. To obtain normal electrophysiological correlates of memory formation, only activity from the MTL not affected by epilepsy was included into our analyses. We compared event-related potentials (ERPs) elicited by items that were, or were not, successfully recalled in a subsequent free recall test. Two subsequent memory effects were observed in ERPs from either the rhinal cortex or the hippocampus. Larger activity was associated with subsequently recalled items in both MTL substructures. The rhinal ERP effect is partly based on phase reset of ongoing theta and alpha oscillations. An onset latency difference between these two ERP effects of 200 ms and a positive correlation between their sizes suggests a serial processing hierarchy. Enhanced phase-synchronization of induced gamma oscillations between rhinal and hippocampal activity for successful memory formation confirmed this interaction and identified a potential mechanism underlying this rhinal-hippocampal coupling. The enhanced gamma phase synchronization is accompanied by an enhanced rhinal-hippocampal coherence in the theta band, suggesting a close interaction of both mechanisms during declarative memory formation. While rhinal-hippocampal gamma synchronization may be closely related to the actual mnemonic process of declarative memory formation by enabling fast coupling and decoupling of both MTL substructures, theta coherence might be associated with slowly modulated coupling associated with an encoding state.