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**Title:** Subsequent memory dependent EEG theta correlates with hippocampal BOLD response in human

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Patient studies of the hippocampal damage clearly demonstrated that the hippocampus is associated with object-place associative memory. It suggests the importance of the hippocampus in storing multiple information contents in the environment, while its neural mechanism is an open question. The authors have proposed a cortico-hippocampal network model of the memory task (Sato and Yamaguchi, Hippocampus 2005). In this model, a hippocampal neural dynamics, "theta phase precession", observed in rat hippocampus was applied to cortico-hippocampal system with a randomly saccadic visual input sequence. The computational experiments demonstrated that theta phase precession contributes to the formation of multiple object-place memories in the CA3 network consisting of spatial scale-related asymmetric connections among object and scene units. Human scalp EEG study (Sato and Yamaguchi, NeuroReport, 2007) demonstrated that EEG theta power and coherence during encoding increase in relation to the subsequently successful recall, while it remains unclear whether the hippocampus is associated with such a scalp EEG theta or not.

In this paper, we directly evaluated the relation between the scalp EEG theta and the hippocampal activity by using a simultaneous EEG-functional magnetic resonance imaging (fMRI) recording. Eight participants completed an object-place memory task consisting of a 10-sec encoding of four object-place associations and a recall with an 18-sec delay. BOLD signals were acquired with a 3-T Siemens Allegra MRI scanner during performing the task and 64-ch scalp EEG were simultaneously recorded. In the fMRI data analysis, hippocampal region of interest (ROIs) were individually defined and used for the subsequent memory analysis for successful and failed trials.

In the result, by removing large artifacts, we successfully detected the EEG theta power increase in relation to the subsequently successful recall. Moreover a cross-correlation analysis demonstrates that the EEG theta power at the central region is significantly correlated to the hippocampal blood oxygenation level dependent (BOLD) response. In conclusion, these results support the hypotheses that hippocampal theta dynamics, as observed in the rat hippocampus, facilitates the memory encoding of what and where in human episodic memory.

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