THE MEMORY STORAGE OF THE TEMPORAL SEQUENCES BY THETA PHASE PRECESSION IN THE HIPPOCUMPUS - A THEORETICAL STUDY.

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It was suggested that theta phase precession is considered as a temporal compression of the behavioral temporal sequence into theta cycles contributing to synaptic plasticity for the memory storage (Skaggs. et al. 1996). Yamaguchi and McNaughton (1998) proposed the model of hippocampal closed circuit, in which phase precession is generated by synchronization of neural oscillators with gradual increase in individual native frequencies. When the temporal sequence representing the typical evolution of place fields is fed into the circuit, the sequence is stored in unidirectional connections in CA3 according to LTP with asymmetric time window. It is important to clarify the stability of the memory storage in various conditions. In this paper, we elucidate the memory storage with respect to the time scale of the input sequence by using computer experiments. It is found that the temporal sequence gradually varying in the time scale of 1~10 seconds is robustly stored in CA3 network with phase precession, even in the presence of noises. On the other hand, the memory storage in the absence of phase precession (i.e., in rate coding) is restricted to the temporal sequence within the synaptic time scale (< 1 theta cycle), moreover in the absence of noises. Besides, the repetition of input is not necessary for the learning in the presence of phase precession. It is concluded that encoding by phase precession is efficient dynamics in the hippocampus for the sake of memory storage of the temporal sequence in various time scales experienced only one time.

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