Sharp waves and ripples

Sharp waves and ripples (SWRs) are oscillatory patterns in the mammalian brain hippocampus seen on an EEG during immobility and sleep. There are three major network oscillation patterns in the hippocampus: theta waves, SWRs and gamma waves. Gamma oscillations are found in all major brain structures, whereas theta and sharp waves are specific to the hippocampus and its neighboring areas. SWRs are composed of large amplitude sharp waves in local field potential and associated fast field oscillations known as ripples. SWRs are shown to be involved in memory consolidation and the replay of wakefulness-acquired memory. These network oscillations are the most synchronous patterns in the brain, making them susceptible to pathological patterns such as epilepsy.

Learning and memory are assumed to be supported by mechanisms that involve the cholinergic transmission and hippocampal theta wave. Using G protein-coupled receptor-activation-based acetylcholine sensor (GRABACh3.0) with a fiber-photometric fluorescence readout in mice, Zhang et al. found that cholinergic signaling in the hippocampus increased in parallel with theta/gamma power during walking and REM sleep, while ACh3.0 signal reached a minimum during hippocampal sharp waves and ripples (SPW-R). Unexpectedly, memory performance was impaired in a hippocampus-dependent spontaneous alternation task by selective optogenetic stimulation of medial septal cholinergic neurons when the stimulation was applied in the delay area but not in the central (choice) arm of the maze. Parallel with the decreased performance, optogenetic stimulation decreased the incidence of SPW-Rs. These findings suggest that septohippocampal interactions play a task-phase-dependent dual role in the maintenance of memory performance, including not only theta mechanisms but also SPW-Rs¹.

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Zhang Y, Cao L, Varga V, Jing M, Karadas M, Li Y, Buzsáki G. Cholinergic suppression of hippocampal sharp-wave ripples impairs working memory. Proc Natl Acad Sci U S A. 2021 Apr 13;118(15):e2016432118. doi: 10.1073/pnas.2016432118. PMID: 33833054.

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