Working memory

Working memory is the system that is responsible for the transient holding and processing of new and already stored information, an important process for reasoning, comprehension, learning and memory updating. Working memory is generally used synonymously with short term memory, but this depends on how the two forms of memory are defined.

see also Verbal working memory.

see also Tactile Working Memory.

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-Rs [1].

Working memory is mediated by the coordinated activation of frontal and parietal cortices occurring in the theta and alpha frequency ranges. Here, we test whether electrically stimulating frontal and parietal regions at the frequency of interaction is effective in modulating working memory. We identify working memory nodes that are functionally connected in theta and alpha frequency bands and intracranially stimulate both nodes simultaneously in participants performing working memory tasks. We find that in-phase stimulation results in improvements in performance compared to sham stimulation. In addition, in-phase stimulation results in decreased phase lag between regions within working memory network, while anti-phase stimulation results in increased phase lag, suggesting that shorter phase lag in oscillatory connectivity may lead to better performance. The results support the idea that phase lag may play a key role in information transmission across brain regions. Thus, brain stimulation strategies to improve cognition may require targeting multiple nodes of brain networks [2].

Working memory can be impaired after traumatic brain injury (TBI) in the absence of overt damage to the prefrontal cortex (PFC). The cellular and molecular mechanisms that contribute to this deficit are largely unknown. In a study, Kobori et al. examined whether altered protein kinase A (PKA) signaling in the PFC as a result of TBI is a contributing mechanism. They measured PKA activity in medial PFC (mPFC) tissue homogenates prepared from sham and 14-day postinjury rats. PKA activity was measured both when animals were inactive and when actively engaged in a spatial working memory task. The results demonstrate, for the first time, that PKA activity in the mPFC is actively suppressed

in uninjured animals performing a working memory task. By comparison, both basal and working memory-related PKA activity was elevated in TBI animals. Inhibition of PKA activity by intra-mPFC administration of Rp-cAMPS into TBI animals had no influence on working memory performance 30 min postinfusion, but significantly improved working memory when tested 24 h later. This improvement was associated with reduced glutamic acid decarboxylase 67 messenger RNA levels. Taken together, these results suggest that TBI-associated working memory dysfunction may result, in part, from enhanced PKA activity, possibly leading to altered expression of plasticity-related genes in the mPFC [3)]

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