Sidney Wiener:

Neural correlates of learning in the hippocampo-prefrontal pathway

The Wisconsin Card Sorting task is used to diagnose prefrontal damage in human patients. This task requiring self-generating set-shifting and rule creation was adapted for rats. Then we recorded local field potentials (LFPs) in hippocampus and prefrontal cortex as well as multichannel unit recordings in prefrontal areas PL/IL during learning and shifting between spatial and cue-guided strategies in a Y maze. The prefrontal neurons changed behaviorally correlated activity after rule changes and as the rat acquired new rules. Furthermore, during rule acquisition there was increased coherence of prefrontal and hippocampal LFPs in the theta band when the rat was at the fork of the Y maze, during response selection. With a new principal components analysis of unit ensemble co-activations permitting high temporal resolution, we determined that during slow wave sleep (SWS) that there was replay of prefrontal neural ensemble coactivations appearing during the awake learning experience. This mostly occurs during hippocampal sharp wave ripples, which correspond to periods of replay in the hippocampus also. Examination of prefrontal neuron modulation by hippocampal LFP theta oscillations demonstrated a subpopulation that had increased modulation during high coherence of hippocampal and prefrontal LFPs. Moreover, prefrontal cell assemblies formed during high coherence periods are reactivated during ripples occurring during sleep after learning the task. This suggests a new mechanism of increased inter-region communication during high LFP oscillatory coherence periods, facilitating selection of relevant information to be stored in long term memory.