Active dendritic integration in CA3 contributes to memory recall by increasing pattern completion efficiency

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Abstract

Pattern completion is the ability of the brain to retrieve stored memories from partial or degraded recall cues. It is widely accepted that the hippocampal CA3 area, owing to its extensive recurrent circuitry, represents a key moderator of this process[1]. Although synaptic plasticity in CA3 is considered as the primary mechanism involved, no causal relationship between LTP in recurrent CA3 synapses and memory encoding has been established so far[1]. Meanwhile, recent evidence provides new insight on how active dendritic mechanisms may increase the mnemonic capacity of hippocampal networks[2]. To investigate whether or how NMDAR-mediated nonlinearities[3] contribute to pattern completion, we developed a simplified, yet biologically plausible model of the CA3 area, which consists of multicompartmental pyramidal neurons along with point inhibitory populations. We show that NMDA spikes facilitate the aggregation of temporally coherent EPSPs resulting in amplified voltage responses and increased network excitability even when partial input patterns are used. Furthermore, nonlinear integration mediates network bistability, which might serve as a threshold mechanism, ensuring reliable reactivation by a sufficient amount of temporally correlated input. Thus, we predict that NMDAR-mediated nonlinearities represent an efficient dendritic mechanism that can potentially enhance the retrieval of CA3-related memories.

References

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