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Session PSTR383 - Mechanisms and Significance of Brain Oscillations

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PSTR383.16 / B45 - Distinct extracellular signatures of chemical and electrical synapses impinging on active dendrites differentially contribute to ripple-frequency oscillations

October 9, 2024, 8:00 AM - 12:00 PM | MCP Hall A

Presenter at Poster
Wed., Oct. 9, 2024 11 a.m. - noon

Session Type
Poster

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Citation
***R. SIRMAUR**, R. NARAYANAN;
Mol. Biophysics Unit, Indian Inst. of Sci., Bangalore, India.
Distinct extracellular signatures of chemical and electrical synapses impinging on active dendrites differentially contribute to ripple-frequency oscillations. Program No. PSTR383.16. 2024 Neuroscience Meeting Planner. Chicago, IL. : Society for Neuroscience, 2024. Online.

Authors
***R. SIRMAUR**, R. NARAYANAN;
Mol. Biophysics Unit, Indian Inst. of Sci., Bangalore, India

Disclosures
R. Sirmaur: None. **R. Narayanan:** None.

Abstract
During slow-wave sleep and awake quiescence states, the hippocampus manifests signature activity patterns in the local field potentials (LFPs) known as sharp-wave ripples (SWRs). SWRs have been implicated in memory consolidation and are characterized by slow negative deflections (sharp waves) coupled with high-frequency oscillatory patterns (ripples). One of the several models for ripple generation postulates that the generation of basal dendritic spikes in response to the synchronous afferent activity from CA3 as well as the recurrent CA1 inputs onto basal dendrites together contribute to ripple generation. Here, we quantitatively assessed this postulate by studying the impact of active basal dendritic currents, generated as responses to recurrent and afferent inputs, on LFPs in the ***stratum oriens*** of CA1. We recorded LFPs using a 3D electrode array spanning the basal dendrites of a biophysically and morphologically realistic conductance-based model of a CA1 pyramidal neuron. We employed this setup to address two fundamental questions on the relationship between active dendrites and LFPs. First, we assessed the impact of active and passive basal dendrites, activated through either chemical synapses or gap junctions, on LFPs. We found striking differences between LFP signatures of inputs through chemical ***vs.*** electrical synapses, with excitatory chemical synapses yielding a sink near the synaptic location and electrical synapses manifesting as a source. Our analyses show that LFP signatures were qualitatively and quantitatively different for passive ***vs***. active dendritic structures, with distinct spectral profiles in LFPs associated with oscillatory inputs through chemical ***vs***. electrical synapses. Second, with specific reference to ripples, we evaluated the impact of four kinds of inputs on LFPs for active and passive basal dendritic models: randomly timed afferent inputs, precisely timed excitatory recurrent inputs through chemical or electrical synapses occurring in Gaussian pattern across time, and Gaussian-patterned inhibitory inputs impinging on basal dendrites. We detected ripple-frequency oscillations in LFPs when the basal dendrites were innervated by Gaussian-patterned inhibitory inputs, but not with randomly timed inputs, with quantitative differences in ripple power associated with passive ***vs*** active dendrites. Our analyses unveil a dominant mediatory role of Gaussian-patterned inhibition in ripple generation, with recurrent excitations through chemical synapses and gap junctions in conjunction with return-current contributions from active dendrites playing regulatory roles in determining ripple characteristics.