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Neuroscience 2015

Presentation Abstract

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Presentation Title:	Intrinsic plasticity during state-dependent calcium homeostasis in hippocampal model neurons
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Presenter at Poster:	Wed, Oct. 21, 2015, 10:00 AM - 11:00 AM
Topic:	++B.10.b. Modulation of neuronal firing properties
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Abstract:	How do neurons reconcile the maintenance of calcium homeostasis with perpetual switches in afferent activity? Here, we assessed state-dependent evolution of calcium homeostasis in a population of hippocampal pyramidal neuron models, through an adaptation of a recent study on stomatogastric ganglion neurons (O'Leary, T. *et al*., Neuron, 2014). Calcium homeostasis was set to emerge through cell-autonomous updates to 12 ionic conductances, responding to different types of synaptically driven afferent activity. We first assessed the impact of theta-frequency inputs on the evolution of these conductances towards maintenance of calcium homeostasis. Although calcium homeostasis emerged efficaciously across all models in the population, disparate changes in ionic conductances that mediated this emergence resulted in variable plasticity to several intrinsic properties, also manifesting as significant differences in firing responses across models. Further, intrinsic neuronal properties and the firing response were sensitive to the target calcium concentration and to the strength and frequency of afferent activity. Next, we studied the evolution of calcium homeostasis when afferent activity was switched between two behaviorally distinct types of activity: theta-frequency inputs and sharp-wave ripples. We found that the conductance values, intrinsic properties and firing response of neurons exhibited differential robustness to an intervening switch in the type of afferent activity. Finally, we asked how neurons that implement cell-autonomous calcium homeostasis react to knockout of specific ion channel conductances. To answer this, for each neuron,

we removed specific conductances, one at a time, after steady state in calcium levels was attained while receiving theta frequency inputs. We assessed neuronal intrinsic properties at two time points: immediately following the knockout of the conductance (acute measurements) and at steady state in the post-knockout emergence of calcium homeostasis (through update of conductances other than the one that was knocked out) with theta-frequency inputs. We found that the robustness of models to acute knockouts and compensation-induced restoration of function were critically tied to specific neuronal measurements, with significant variability across measurements and across specific channels that were knocked out. These results unveil critical dissociations between different forms of homeostasis, and call for a systematic evaluation of the impact of state-dependent switches in afferent activity and genetic knockouts on neuronal intrinsic properties during neural coding and homeostasis.

Disclosures: **S. Srikanth:** None. **R. Narayanan:** None.

Keyword (s): Ion channels

Intrinsic plasticity

Homeostasis