EXPLORING INTERNEURON SPECIFIC CONTROL OF ORIENS-LACUNOSUM MOLECULARE (OLM) INTERNEURON RECRUITMENT IN CA1 HIPPOCAMPUS

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Introduction

Interneuron subtypes 3 (IS3) cells are vasointestinal peppolypeptide and somatostatin positive (VIP+CSN) cells that only target the dendrites of other inhibitory interneurons, and primarily Oriens-Lacunosum Molecular (OLM) cells.

- IS3 cell control over OLM cells has been demonstrated experimentally in vitro in the context of theta-phased synaptic stimulation of CA1 cells, however it remains unclear whether this finding is dependent on resultant activity from other interneuron types in CA1 (e.g., feedforward inhibition/excitation), or on contributions of h-current and/or T-type calcium currents to post-inhibitory rebound spiking.
- OLM cells receive inputs from several other populations, including local interneurons (IS3 cells), long range inputs from medial septum (MS), and local CA1 pyramidal (PYR) cells.
- It is also unclear whether OLM cells will display bursting or lack resilience to phase, since neurons have been shown to be capable of switching their spike resonance properties when put in in vitro-like settings.

To test these questions, we perform simulations using recently developed OLM cell multi-compartment models, with synaptic inputs constrained to specific inhibitory and excitatory input populations that are known to synapse onto OLM cells.

Models

Multi-Objective Optimization of Spiking Electrophysiology Using BluePyOpt and Neuroscience Gateway (NSG)

Synaptic Inputs

- Literature values of EPSCs and IPSCs to OLM cells are used to fit synaptic parameters to OLM Cell Multi-Compartment Models

- In Vitro-Like Simulations

- IS3 cell inputs alone do not elicit post-inhibitory rebound spiking

- IS3 cell perturbations cause I\textsubscript{h}-dependent phase advances only when baseline spike rate is low

- Phase Advance = Phase Shift > 0
- Phase Delay = Phase Shift < 0

Conclusions and Future Work

- IS3 cells can recruit OLM cells through disassociation of PPY cells in vitro
- IS3 cells can also recruit OLM cells in vivo if they show a high degree of phase locking to its endogenous spike resonance frequency
- If IS3 cell inputs are not phase locked enough, OLM cell spiking will mainly just be suppressed, which may be beneficial for behavioral state transitions
- The effects of inhibitory perturbations in vivo will also be modulated by their interactions with the various channel currents present in OLM cells, which show different contributions in vivo and at different spike rates

References


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