Session 263 - Cortical and Hippocampal Circuits: Place Cells

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263.08 / III22 - Degenerate mechanisms mediate decorrelation and pattern separation in the dentate gyrus

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Presenter at Poster
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Disclosures
P. Mishra: None. R. Narayanan: None.

Abstract
A prominent hypothesis regarding the physiological significance of neurogenesis is its role in pattern separation, a process by which similar afferent inputs impinging on a network result in distinct (decorrelated) population responses. In this computational study involving heterogeneous conductance-based models of dentate granule (GC) and basket cells (BC), we quantitatively delineated the specific contributions of different forms of neuronal diversity to response decorrelation. We first employed a random-sampling procedure to build physiologically and biophysically constrained populations of BCs and GCs that exhibited significant parametric variability and weak pair-wise correlations. We constructed a dentate gyrus (DG) network of these models (500 GCs and 75 BCs) with connectivity defined by anatomical data. Based on a virtual animal's traversal in a square arena (1 m × 1 m) at rodent speeds, this DG network received external inputs from the medial (grid-like) and lateral (contextual) entorhinal cortices. In one set of experiments, we fed identical external inputs to the network, and assessed response decorrelation in networks built with different combinations of intrinsic, synaptic and neurogenesis-induced variability. We demonstrate that the mere presence of experimentally constrained intrinsic biophysical variability was sufficient to introduce significant decorrelation of GC responses to identical inputs. Additionally, correlations between population responses decreased when the strengths of excitatory or inhibitory synapses were increased. Next, we incorporated synaptic and neurogenesis-induced diversity (in addition to intrinsic diversity) into the network, and found that population correlations achieved with either form of diversity were comparable to those attained solely with intrinsic variability. In a second set of experiments, we designed two distinct arenas and gradually morphed one to the other, fed spatial information from these morphed arenas to the network and computed response correlations of the same cells across different arenas. Here, we show that efficient pattern separation could be achieved by the presence of intrinsic and synaptic variability, with non-significant contributions from an additional layer of variability introduced by neurogenesis. Our results suggest that degenerate mechanisms (1), involving disparate combinations of intrinsic, synaptic, connectivity and neurogenesis-induced forms of variability, contribute to pattern separation/decorrelation in the DG.

Reference

1. Edelman GM & Gally JA (2001) Degeneracy and complexity in biological systems. *PNAS,* 98(24):13763-13768.