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Principal dynamic mode analysis of hippocampal neuronal networks

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Background

Principal dynamic modes (PDMs) are a primary set of basis functions that describes the dynamics of the system. By using PDMs, we attempt to show the differences between the dynamics of the epileptic neuronal network and the normal (non-epileptic) neuronal network.

Methods

The input-output data required for training and modeling was acquired from acute slices of the rat hippocampus. A seizure-like state was induced by perfusion with low Mg^{2+} artificial cerebrospinal fluid. Gaussian white-noise (GWN) was applied as input to CA3 pyramidal neuron and the output was measured from the same CA3 pyramidal neuron. PDMs were computed using the Laguerre expansion technique.

Discussion

Computed PDMs of the normal neuronal network confirmed that the two classical modes, integrative and differential modes, are the most dominant modes of the hippocampal neuronal network. As well, higher order modes which are higher in frequency exist and are essential in characterizing the network. In epileptic neuronal network, these higher frequency modes become more dominant over the integrative and differential modes. In addition, the length of memory required to optimally compute the PDMs were increased in epileptic network from the normal network. This suggests changes in the synaptic connections in the epileptic hippocampal network from the normal network.