

Abstract View

SPIKE TRAINS AS INTERNAL DOCUMENTS

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A central paradigm in neuroscience is the network conceptualization of the functioning nervous system. Though often disparaged as over simplified, particularly in computational implementations as arrays of neural nodes, the framework has persisted under the proposition that it retains the fundamental dynamics of the functioning nervous system. Moreover, computational network models have contributed new understandings of synchronous and oscillatory neural activity related to health and disease. On the other hand, applications of the network paradigm to cognitive function have not lead to models with capabilities that approach those which make our brains such astonishing organs. This long standing paradigm may not embody mechanisms essential for CNS function.

Due to varying configurations of facilitation, depression and other dynamics, central synapses display broad latitude in translating spike trains into exocytotic trains. Upon arrival of any given spike, exocytosis is probabilistic. From spike to spike the probability (Pr) changes rapidly and deterministically (Dobrunz and Stevens 1999). During in-vivo-like trains of 30 spikes, Pr can vary ten-fold, with up to five-fold changes in Pr between two sequential spikes. The determinism implies the pattern is consequential to the postsynaptic neuron. Given that a single spike train undergoes translations at thousands of diverse synapses, prospects appear limited for postsynaptic-impact to function as a constraint on the pattern of a spike train.

Through back-propagation into dendritic arbors, spike trains reach a second realm of influence. In addition to roles in plasticity, calcium cascades and ion channel modulation, back-propagation also binds dendritic regions that are otherwise electrically remote. Analogous to synaptic dynamics, back-propagation is rich in variations. But the variation has fewer degrees of freedom, suggesting that spike trains are more strongly, perhaps dominantly, constrained by dendritic-impact. If so, this implies that spike trains are primarily internal signals. Support Contributed By: NIH HHMI

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