Shaping Neural Circuits by High Order Synaptic Interactions

Neta Ravid Tannenbaum, Yoram Burak

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Spike timing dependent plasticity (STDP) is believed to play an important role in shaping the structure of neural circuits. Here we show that STDP generates effective interactions between synapses of different neurons, which were neglected in previous theoretical treatments, and can be described as a sum over contributions from structural motifs. These interactions can have a pivotal influence on the connectivity patterns that emerge under the influence of STDP. In particular, we consider two highly ordered forms of structure: wide synfire chains, in which groups of neurons project to each other sequentially, and self connected assemblies. We show that high order synaptic interactions can enable the formation of both structures, depending on the form of the STDP function and the time course of synaptic currents. Furthermore, within a certain regime of biophysical parameters, emergence of the ordered connectivity occurs robustly and autonomously in a stochastic network of spiking neurons, without a need to expose the neural network to structured inputs during learning.

Full article at: http://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005056

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