

Abstract View

FLEXIBLE FUNCTIONAL CONNECTIVITY IN WORKING MEMORY NETWORKS WITH NON-MONOTONIC NEURAL RESPONSE FUNCTIONS.

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In most neural models the output firing rate of a single neuron is assumed to be a monotonic function (e.g. linear or logarithmic) of the rate of its inputs. However, there are circumstances where the output of a cortical neuron can be a non-monotonic function of its inputs (e.g. gaussian). We demonstrate here three different biophysical mechanisms that individually or in combination could produce strongly non-monotonic input/output-functions: 1) Synaptic depression and facilitation; 2) Strong voltage-gated conductances in dendritic spines or small dendritic arbors; and 3) Local interactions between co-activated pyramidal cells and interneurons. For example, high local densities of fast Na^+/K^+ channels might amplify

low-frequency/high-amplitude synaptic inputs, but currents with slower time courses (L-type Ca^{2+} , I_A) might favor high-frequency/low amplitude inputs. These mechanisms could allow a neuron to respond best to a narrow range in input activity levels, where the optimal range might be different for different synaptic connections. The consequences of non-monotonic response tunings were explored in a network of leaky-integrate-and-fire neurons. In such a network, one set of presynaptic neurons might activate different assemblies of postsynaptic neurons depending on its state of firing. Assuming that the 4-8 synaptic connections between pairs of pyramidal cells (e.g., Markram et al. 1997) have different frequency tunings, several different sets of functional connectivities can be stored in the same network such that different sets of synaptic connections will be activated depending on the firing rates of the neurons. This might explain how different spatial maps are stored in the same hippocampal network, how multi-stability arises in neural recordings during parametric working memory tasks, or how top down influences of context shape the transfer properties of a network.

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