Emergence of connectivity motifs via the interaction of long-term and sort-term plasticity.

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Abstract

The identification of synaptic mechanisms that underlie learning and memory is a key challenge for neuroscience. These mechanisms are currently assumed to be captured by persistent modifications to the synaptic connections among neurons. Synaptic connections in microcircuits and networks are not random; experimental observations indicate the existence of specific microscopicpatterns (or connectivity motifs), with non-random features. However, it is unclear how plasticity of individual synaptic connections contributes to the formation of the observed motifs. In particular, for cortical pyramidal neurons, the degree of bidirectional connectivity varies significantly between the visual and somatosensory cortex areas. Recent evidence in prefrontal cortex and in the olfactory bulb suggest that some other features of synaptic physiology, such as the short-term dynamical nature of the synapse, may be correlated to specific connectivity motifs. The causes for these structural differences are still unknown.

I will present a theory based on a phenomenological, long-term synaptic plasticity "learning rule", that is able to accurately reproduce a vast corpus of experimental data. The rule captures dependencies on both the timing and frequency of neuronal signals, providing a very simple mechanistic explanation for the emergence of connectivity motifs, while shedding light on the long debate about the nature of the neuronal code.

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