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Spontaneous pattern generation by a network with dynamic synapses

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Experimental evidence demonstrates that the ongoing spontaneous activity in the visual cortex in the absence of visual stimulation can exhibit complex spatiotemporal patterns. Voltage-sensitive dye imaging studies reveal that activity patterns similar to orientation maps can emerge and dynamically switch in V1 of anesthetized cats [1]. It has been shown that these patterns can be generated by an intracortical network which has intrinsic preferred states correlated with functional maps [2]. The suggested connectivity in such a network depends on the preferred orientation and on the degree of orientation selectivity of the interconnected neurons. In this network, single condition orientation maps are steady states of the neural dynamics and form a ring attractor. To account for dynamical switching between these intrinsic states, we introduced short-term depression into the synaptic connections in the network. We study the effects of synaptic dynamics on the stability of attractor states. We found that synaptic depression, first, stabilizes the overall network activity excluding the possibility of amplitude instability. On the other hand, synaptic depression provides a mechanism of smooth transition between states corresponding to neighboring orientations, observed experimentally. Together with a fluctuating afferent input synaptic dynamics induce dynamic switches between the ring attractor and linear phases. As a result, a complex behaviour emerges with statistical properties similar to the experimentally observed phenomena.

References

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