Interplay between population firing stability and single neuron dynamics in hippocampal networks.

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Abstract:

Neuronal circuits’ ability to maintain the delicate balance between stability and flexibility in changing environments is critical for normal neuronal functioning. However, to what extent individual neurons and neuronal populations maintain internal firing properties remains largely unknown. In this study, we show that distributions of spontaneous population firing rates and synchrony are subject to accurate homeostatic control following increase of synaptic inhibition in cultured hippocampal networks. Reduction in firing rate triggered synaptic and intrinsic adaptive responses operating as global homeostatic mechanisms to maintain firing macro-stability, without achieving local homeostasis at the single-neuron level. Adaptive mechanisms, while stabilizing population firing properties, reduced short-term facilitation essential for synaptic discrimination of input patterns. Thus, invariant ongoing population dynamics emerge from intrinsically unstable activity patterns of individual neurons and synapses. The observed differences in the precision of homeostatic control at different spatial scales challenge cell-autonomous theory of network homeostasis and suggest the existence of network-wide regulation rules.

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