

Feedback connections stabilize spike propagation in cortical neural networks

Samat Moldakarimov¹, Maxim Bazhenov^{1,2} and Terrence J. Sejnowski^{1,3,4}

¹The Salk Institute for Biological Studies, La Jolla, CA 92037, ²Department of Cell Biology and Neuroscience, University of California, Riverside, CA 92521, ³Howard Hughes Medical Institute, ⁴Division of Biological Sciences, University of California at San Diego, La Jolla, CA, 92093

Abstract

It has been previously shown that processing in pure feedforward neural networks is not reliable: Spikes can propagate or fail to propagate depending on firing rates and spike synchrony among neurons in the layers. Previous efforts to overcome this problem suggested that neural activity should be enhanced in each layer by noise or recurrent excitation. Here we suggest an alternative hypothesis: synchrony among neurons can enhance spike propagation. In multilayer neural network models we show that synchrony among neurons can stabilize stimulus processing. We discuss advantages of the suggested hypothesis over the previous models and argue that our approach not only show how spike propagation can be enhanced but also 1) demonstrates how to enhance stimulus processing, by increasing synchrony, and at the same time preserving information about the stimulus, and 2) we also describe neural mechanisms responsible for enhancement of stimulus processing.