Cost-efficiency in Neural Presentations

D P Yang,[1,2] H J Zhou,[3] and C S Zhou[1,2,4,*]

[1]Department of Physics, Hong Kong Baptist University, Hong Kong

[2]Centre for Nonlinear Studies, Institute of Computational and Theoretical Studies, Hong Kong Baptist University, Hong Kong

[3]Institute of Theoretical Physics, The Chinese Academic of Sciences, China

[4]Beijing Computational Science Research Center, China

***Email of Presenting Author: cszhou70@yahoo.de**

Brains are believed to be capable of information processing with remarkable efficiency but low metabolic cost. Cost-efficiency of neural representation, as an underlying design principle, may be reflected in the co-organization of ubiquitously observed cortical activity: irregular firing, synchronized oscillations and neuronal avalanches. Here we provide computational evidence that these salient features of cortical activity can be simultaneously accounted in a generic neural circuit capturing the excitation-inhibition balance with realistic synaptic dynamics. Their simultaneous organization achieves maximal information efficiency and minimal firing rate when individual irregular firings are coordinated as well as shaped by moderate synchrony to reduce otherwise redundant spikes. Such cost-efficient dynamical modes could be employed as a foundation for further efficient information processing with low energy cost.

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