

Poster presentation

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Emergent functional neural networks organized by spike timing dependent synaptic plasticity

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The synchronization of neural activities plays very important roles in the information processing in the brain. Recent studies on complex systems have shown that the synchronization of oscillators, including neuronal ones, is faster, stronger, and more efficient in small-world networks than in regular or random networks, and many studies are based on the assumption that the brain may utilize the small-world and scale-free network structure. The collective dynamical response and the functional neural network structure depend on each other due to synaptic plasticities, and this feedback process is believed to be closely linked to the mechanisms for learning and memory in the brain. Recent experimental studies have shown that in various brain regions, such as the hippocampus and the neocortex, both the sign and the magnitude of synaptic modification depend on the precise temporal relation of spike timing of two neurons, which is called the *spike timing dependent synaptic plasticity* (STDP). Here, we study the emergent functional neural networks organized by STDP. We show that STDP can lead a neural oscillator network into a functional structure which has both the small-world behaviors and the scale-free properties with hierarchical modularity. The STDP network has small average shortest path length between the neurons and high clustering coefficient. The degree distributions and the clustering coefficient depending on the degree follow power-law decays. We also show that the balance between the maximal excitatory and the inhibitory synaptic inputs is critical in the formation of the nontrivial func-

tional structure, which is found to lie in a self-organized critical state.