Talk 2.2

Spontaneous Activity, Lateral Interactions and Cortical Maps

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Objectives: During development, maps of stimuli in the world are established in the cortex. That afferent activity—either spontaneous or environmentally evoked—drives map development is challenged by recent data. To test the hypothesis that intrinsic spontaneous activity reinforces pre-existing, rudimentary cortical circuits during early map formation, and reinforces changes in cortical maps during subsequent periods of heightened plasticity, we are: **1**. Characterizing activity patterns in sleep and wake during initial map formation and subsequent map remodeling *in vivo*. **2**. Mapping the extent of excitatory and inhibitory intraconnections *in vitro*. **3**. Modeling the patterns of cortical activity imaged *in vivo* based on the patterns of lateral connectivity mapped *in vitro* to predict the time-course of map formation and interactions between sleep and wake during map remodeling.

Preliminary findings: **1**. Hypothesizing that neurons that share response properties fire together spontaneously, we explored the role of spontaneous activity during sleep. We found that neurons with similar eye-preference fire in a correlated manner during NREM sleep in P45 ferrets. **2**. Using our lentiviral-based siRNA knock-down system, we dissected the role of specific synapses. We found that injection of virus encoding the obligate NR1 subunit of the NMDAR knock-down siRNA may have profound effects on the orientation map. **3**. Using a two-layer excitatory-inhibitory recurrent network model, we analyzed the role of oscillatory activity observed during sleep. We found that orientation computation is facilitated when activity alternates between layers. And using an elastic-net model, we analyzed the representation of angioscotomas. We found that specific patterns of lateral connections are required to produce the experimentally observed interactions with columnar representations.

Publications

1. P A Merolla and K Boahen, “Dynamic Computation in a Recurrent Network of Heterogeneous Silicon Neurons”, *IEEE International Symposium on Circuits and Systems*, 2006. In press

2. C E Giacomantonio and G J Goodhill, “The Effect of Angioscotomas on Map Structure in Primary Visual Cortex”, *Journal of Neuroscience*. Submitted