Spontaneous Activity, Lateral Interactions and Cortical Maps

(1R01MH073357-01-FY04)
Kwabena Boahen
University of Pennsylvania

Matthew Dalva
University of Pennsylvania

Marcos Frank
University of Pennsylvania

Geoffrey Goodhill
University of Queensland

During development, maps of stimuli in the world are established in the cortex. Motivated by both experimental and theoretical studies, a prevailing computational model for how maps are formed has been that afferent activity, either spontaneous or environmentally evoked, drives their development. This model assumes that intracortical connections play a subservient role to feedforward ones, that intrinsically generated spontaneous activity does not significantly influence cortical plasticity, and that intraconnections are more or less fixed during development. However, recent data undermine all of these assumptions: Modeling studies have shown that maps can arise without patterned feedforward connections. Electrophysiological records of spontaneous activity during initial map formation reveal correlations that may arise from intraconnections patterned by molecular cues. And, photo-stimulation experiments suggest that extensive changes occur in intraconnections during subsequent map development. 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, this study will: (1) Characterize activity patterns in sleep and wake during initial map formation and subsequent map remodeling in vivo. (2) Map the extent of excitatory and inhibitory intraconnections in vitro. (3) Develop computational models that reproduce the patterns of cortical activity imaged in vivo based on the patterns of lateral connectivity mapped in vitro, and that predict the time-course of map formation and interactions between sleep and wake during map remodeling.