Emergence of adaptive computation by single neurons in the developing cortex.

Abstract:
Adaptation is a fundamental computational motif in neural processing. To maintain stable perception in the face of rapidly shifting input, neural systems must extract relevant information from background fluctuations under many different contexts. Many neural systems are able to adjust their input-output properties such that an input's ability to trigger a response depends on the size of that input relative to its local statistical context. This "gain-scaling" strategy has been shown to be an efficient coding strategy. We report here that this property emerges during early development as an intrinsic property of single neurons in mouse sensorimotor cortex, coinciding with the disappearance of spontaneous waves of network activity, and can be modulated by changing the balance of spike-generating currents. Simultaneously, developing neurons move toward a common intrinsic operating point and a stable ratio of spike-generating currents. This developmental trajectory occurs in the absence of sensory input or spontaneous network activity. Through a combination of electrophysiology and modeling, we demonstrate that developing cortical neurons develop the ability to perform nearly perfect gain scaling by virtue of the maturing spike-generating currents alone. We use reduced single neuron models to identify the conditions for this property to hold.