What Does Activity Have to Do with It? Development of Visual Circuits before Vision

Michael C. Crair

Department of Neurobiology, Yale University, USA

The ability of the human brain to perform complex cognitive tasks is a natural product of the intricate way in which its neurons are interconnected. A primary goal of developmental neurobiology is to understand how these complex brain circuits get wired up during development. Achieving this goal will necessarily produce fundamental insights into basic brain function and dysfunction. Towards this end, we have focused on the development of neural circuits in the mammalian visual system, as the function and basic anatomical properties of the visual system are relatively well understood, making progress on how these circuits develop more tractable and achievable. Early stages of brain development are governed by molecular processes dependent on the expression and regulation of specific molecules and genes. For example, the differentiation of precursor cells into neurons and glia or the morphological development of different cortical areas and lamina are governed principally by molecular events. In contrast, late stages of neural circuit development are sensitive to, and in some respects dependent on, neuronal activity through sensory experience. For instance, monocular deprivation during a critical period in development causes profound and permanent loss of visual function through the deprived eye. We will describe experiments that examine the properties and role of 'spontaneous' neuronal activity on visual system development during an intermediate developmental stage following the early morphological development of the visual system but before the onset of sensory experience. These experiments suggest that patterned spontaneous activity in the developing visual system is necessary for the formation of neural circuits mediating vision.