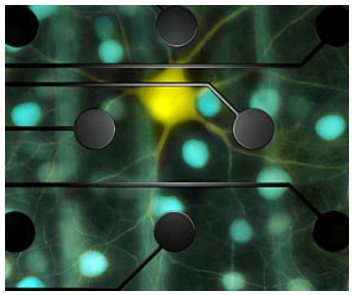
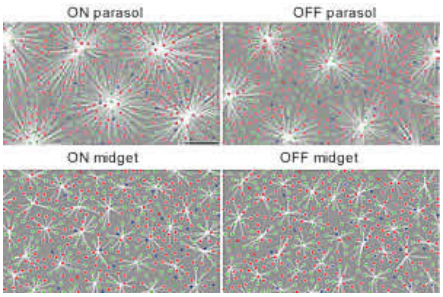
Neuroengineering Seminar

Functional Mapping of Complete Neural Circuits at Single Cell Resolution in the Primate Retina





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Systems Neurobiology Laboratory
The Salk Institute for Biological Studies

Monday, December 13, 2010
4:00-5:00pm
Fung Auditorium, Powell-Focht Bioengineering Building
University of California San Diego

To understand a neural circuit requires knowing the pattern of connectivity between its inputs and outputs. For example, the role of the retina in color vision depends on the pattern of connectivity between the lattice of cone photoreceptors and multiple types of retinal ganglion cells via the retinal circuitry. In the vertebrate nervous system, this kind of complete functional circuitry information has generally been out of reach. Here we report the first measurements of functional connectivity between input and output layers of the retina at single-cell resolution, and use the information to probe the neural computations subserving color vision. We employed a unique 512-electrode technology to record simultaneously from complete populations of the ganglion cell types which collectively mediate high-resolution vision in primates (midget, parasol, small bistratified). We then used fine-grained visual stimulation to separately identify the location and spectral type ([L]ong, [M]iddle or [S]hort-wavelength sensitive) of each cone photoreceptor providing input to each ganglion cell. The populations of ON and OFF midget and parasol cells each sampled essentially the complete population of L and M cones, with low redundancy. However, only OFF midget cells strongly sampled from S cones, an unexpected specificity. Statistical analysis revealed a non-random pattern of inputs from L and M cones to the receptive field centers of midget cells, while inputs to the receptive field surround were random. This specificity of cone inputs could not be explained by clumping in the cone mosaic, implying that developmental or adaptive mechanisms enhance opponent-color signals transmitted from retina to brain.

Biography: E.J. Chichilnisky studied at Princeton and did his doctorate and postdoctoral work with B. Wandell and D. Baylor at Stanford. Since 1998 he heads the Systems Neurobiology Laboratory at Salk where he is currently Associate Professor. Awards and honors he received include an Alfred P. Sloan Foundation Research Fellowship, a McKnight Scholar's Award, and a UCSD School of Medicine Basic Sciences Teaching Award. The Chichilnisky laboratory is focused on how the retina processes visual information and transmits this information to the brain. A key area of interest is how retinal neurons collectively communicate visual motion information to areas of the brain responsible for motion perception and behavior guided by motion.