Local and long-distance connectomics of the visual cortex

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Over the pastdecade, new tools have emerged for studying the structure and function of cortical circuits, an approachthat has been given the unfortunate but nowunavoidablename of functionalconnectomics. Our group has been usingfunctionalconnectomicsapproachesthatrely on two-photon calcium imaging, to assay the function of visual cortical neurons, followed by correlatedanatomicalstudies. The first approach—serial section electronmicroscopy (Bock et al., 2011, Lee et al., 2016)—allows the tracing of synaptic connections betweenfunctionallyimagedneurons. So far it has been possible to trace networks comprising ~100 neurons and ~1000 connections. Recentadvances in imaging and automated segmentation shouldsoonallow the study networks that are severalorders of magnitude larger.
Transsynaptic input mappingwith G-deletedrabies (Wickersham et al., 2007) isanother technique thatcanbecombinedwith cellular imaging to study structure-functionrelationships. Recenttechnicaladvances in this technique allow the routine functionalimaging of hundreds of inputs to a single postsynapticneuron. Whilethismany-to-one technique gives a more limitedview of network structure than EM, itpermits the of study long-distance feedforward and feedback connectivitybetween cortical areas. I will examine the near- and long-term prospects for functionalconnectomics and argue thatlongstanding questions of feedforward, feedback and recurrentconnectivity in cortical circuits maybesettled in the comingyears.