Lecture 11,12: Thursday, July 12

All-optical closed-loop manipulation of neural circuits in vivo

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Abstract

Understanding the causal relationship between activity patterns in neural circuits and behavior will require the ability to perform rapid and targeted interventions in ongoing neuronal activity. I will describe a novel closed-loop all-optical strategy for dynamically controlling neuronal activity patterns in awake mice. This involves rapid tailoring and delivery of two-photon optogenetic stimulation based on readout of activity using simultaneous two-photon imaging of the same neural population. This closed-loop feedback control can be used to clamp spike rates at pre-defined levels, boost weak sensory-evoked responses, and activate network ensembles based on detected activity. By optically 'yoking together' neighboring neurons, it can also be used to induce long-term changes in network dynamics. This approach thus allows the rate and timing of activity patterns in neural circuits to be flexibly manipulated ‘on the fly’ during behavior.

BIOGRAPHICAL SKETCH

Michael Häusser is Professor of Neuroscience at University College London and a Principal Research Fellow of the Wellcome Trust. He received his PhD from Oxford University under the supervision of Julian Jack. He subsequently worked with Nobel Laureate Bert Sakmann at the Max-Planck-Institute for Medical Research in Heidelberg and with Philippe Ascher at the Ecole Normale Superieure in Paris. He established his own laboratory at UCL in 1997 and became Professor of Neuroscience in 2001. He is interested in understanding the cellular basis of neural computation in the mammalian brain using a combination of experiments and theory, with a special focus on the role of dendrites. His group has helped to pioneer several new optical approaches for probing the function of neural circuits in the intact brain.