【Grant-in-Aid for Scientific Research(S)】
Biological Sciences (Biological Sciences)

Title of Project : Cellular and synapse-level interaction across multiple cortical areas

Kenichi Ohki
(Kyushu University, Graduate school of Medical Sciences,
Professor)

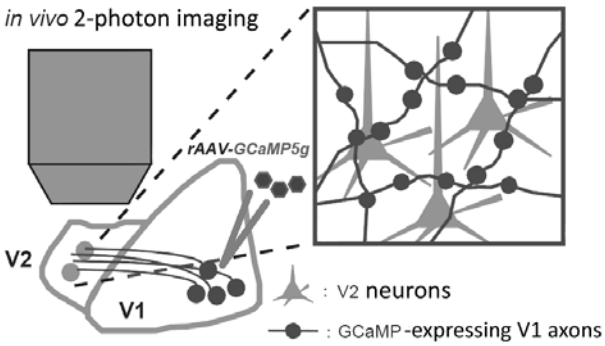
Research Area : neuroscience
Keyword : Cerebral cortex, visual cortex, inter-areal interaction, two-photon imaging, synapse

【Purpose and Background of the Research】

Information processing in cerebral cortex is achieved by local cortical circuits in each area as well as interaction across multiple areas. In visual information processing, there are two types of interaction: bottom-up interaction from primary visual cortex (V1) to higher visual areas, and top-down interaction from higher visual areas to V1. Visual information processing is achieved by such bi-directional interaction.

Such inter-areal interaction has been studied as large-scale interaction without cellular or synaptic resolution using fMRI, local field potential, and EEG / MEG, but the underlying neural circuitry has not been studied at cellular or synaptic level. In this project, we will investigate three questions. (1) How information from V1 is distributed to multiple higher visual areas. (2) How complex visual selectivity of neurons in higher visual areas is formed from simple visual selectivity of V1 neurons. (3) How attention modulates neuronal response in V1. We will address these questions by imaging visual response of axons projecting from other areas and cell bodies of local neurons, using two-photon calcium imaging, and examining interaction between those axons and cell bodies.

【Research Methods】



Simultaneous input /output imaging in V1

(1) Infect V1 with GCaMP5g (calcium-sensitive fluorescent protein) - carrying adeno-associated virus (AAV), and load V2 neurons with calcium indicator, Oregon Green BAPTA-1.

(2) Simultaneously monitor visual response of axons projecting from V1 to a higher visual area (V2) and V2 local neurons, by imaging V2 with two-photon calcium imaging.

Simultaneous input /output imaging in V2

(1) Infect V2 with GCaMP5g (calcium-sensitive fluorescent protein) - carrying adeno-associated virus (AAV), and load V1 neurons with calcium indicator, Oregon Green BAPTA-1.

(2) Simultaneously monitor visual response of axons projecting from V2 to V1 and V1 local neurons, by imaging V1 with two-photon calcium imaging. (Reverse V1 and V2 in the figure)

【Expected Research Achievements and Scientific Significance】

By recording visual response of cortico-cortical axons with two-photon calcium imaging, we will be able to examine, for the first time, what information is transmitted between cortical areas. We will understand the mechanism of global information processing across multiple cortical areas.

【Publications Relevant to the Project】

- Ohki K, Reid RC. Specificity and randomness in the visual cortex. ***Curr Opin Neurobiol.*** 17, 401-7, 2007.
- Ohki K, Chung S, Ch'ng YH, Kara P, Reid RC. Functional imaging with cellular resolution reveals precise micro-architecture in visual cortex. ***Nature.*** 433, 597-603, 2005.

【Term of Project】 FY2013-2017

【Budget Allocation】 96, 700 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.physiol2.med.kyushu-u.ac.jp/
kohki@med.kyushu-u.ac.jp