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

Title of Project : Elucidating the Neural Mechanism to Generate the "Partial Awareness" by Large-scaled Neuron Network Analysis and Circuit Manipulation Techniques in Non-human Primates

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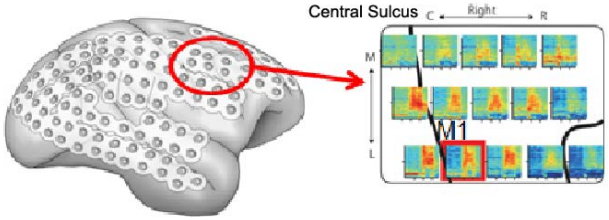
Research Area : Neuroscience
Keyword : Neural circuit, awareness, blindsight, primate, electrocorticography (ECoG)

【Purpose and Background of the Research】

It is known that some patients with damage to the primary visual cortex (V1) shows residual visuo-motor capacity to visual targets presented in the lesion-affected visual field, which is called "blindsight". To understand the neural mechanism of blindsight, we have been studying the cognitive function and neural activity of non-human primate models of blindsight with unilateral lesion of V1. The results of a series of studies have suggested that these monkeys has partial awareness of visual objects, which mimics "type II blindsight" human subjects, seen in patients who received V1 lesion at relatively young age, and in these animals, activity related to the partial awareness could be found in the midbrain superior colliculus. In this study, we aim at elucidating the neural mechanism of partial awareness by large-scaled neural recording from the blindsight monkeys.

【Research Methods】

We will place more than 100 channels of ECoG electrodes to cover the entire brain of monkeys as in the figure, and deep needle electrodes in deep brain structures such as pulvinar and superior colliculus to record local field potentials in monkeys with unilateral V1 lesion, an animal model of human blindsight. And then, we will analyze the default-mode network and visuo-motor responses during performance of visually guided saccades, and infer the circuit dynamics by analyzing the Granger causalities among signals recorded from individual channels. Based on such analysis platform, we aim at elucidating the neural mechanism of partial awareness by analyzing the difference in the state of the large-scaled network between the conditions with visual awareness and without awareness to the same visual stimuli, and change in the network dynamics induced by selective manipulation of individual components of the circuit.



(Figure) Pan-brain ECoG recording in monkey brain (adopted from Fujii and colleagues)

【Expected Research Achievements and Scientific Significance】

Recently, a large number of studies have been devoted to access the cognitive functions including attention and consciousness by applying fMRI imaging to the human brain. However, slow sampling frequency of the MRI imaging and limitation in manipulation of the human brain activity made it difficult to make in-depth analysis on the dynamics of the neural circuit. In this study, we will apply the large-scaled electrophysiological recording of brain activities combined with selective manipulation of specific component of the circuits by using optogenetics or other pharmacogenetical techniques with gene introduction with viral vectors to the brain of our blindsight model monkeys. Such studies are currently possible only in our group all over the world.

【Publications Relevant to the Project】

・Isa T, Yoshida M. (2009) Saccade control after V1 lesion revisited. Curr Opin Neurobiol, 19: 608 - 614.
・Takaura K, Yoshida M, Isa T (2011) Neural substrate of spatial memory in the superior colliculus after damage to the primary visual cortex. J Neurosci, 31: 4233-4241.
・Watanabe H, Sato M, Suzuki T, Nambu A, Nishimura Y, Kawato M, Isa T (2012) Reconstruction of movement-related intra -cortical activity from micro electrocorticogram array signals in monkey primary motor cortex. J Neural Eng, 9:036006
・Weiskrantz, L. (1986). Blindsight. A case study and implications., (Oxford: Clarendon Press).

【Term of Project】 FY2014-2018

【Budget Allocation】 150,000 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.nips.ac.jp/hbfp/