【Grant-in-Aid for Scientific Research on Innovative Areas (Research in a proposed research area)】
Biological Science

Title of Project : Mechanisms underlying the functional shift of brain neural circuitry for behavioral adaptation

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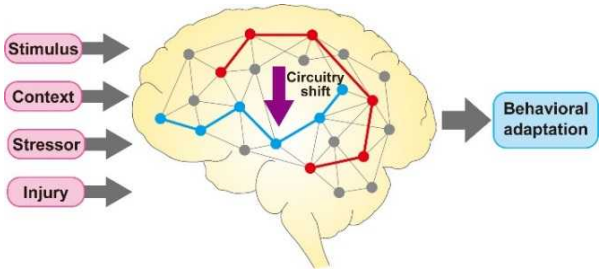
【Purpose of the Research Project】

Our brain functions are based on the network in which a number of neurons are connected (neural circuitry). The neural circuitry is known to undergo dynamic transition during the development and learning processes. For instance, the circuitry that mediates the acquisition of operant conditioning in which animals learn the behaviors through trials and errors is different from one that mediates execution of habitual behaviors. In addition, when the injury of the brain or spinal cord impairs motor functions, the neural circuitry in the brain is reorganized at a large scale during the training and rehabilitation.

The "functional shift" including the transition and rearrangement of neural circuitry is an important process for animals to adapt flexibly their behaviors to environmental changes and to recover the impaired functions. The mechanism on why and how the functional shift occurs has been poorly investigated. In this project, we use new technologies to manipulate and analyze the neural circuitry and aim to elucidate the mechanism underlying the development and transition of neural circuitry related to behavioral adaptation and the rearrangement of the circuitry following the brain and spinal cord injury.

【Content of the Research Project】

To understand the mechanism of the functional shift of the neural circuitry underlying the behaviors, it is important to manipulate the function of specific neuronal types and pathways that constitute the circuitry (circuitry manipulation) and to observe the resultant changes in the activity of brain regions and behaviors. Through this approach, we can clarify the causal relationship between the circuit structure and function.



Here we apply our new strategy to manipulate specific neural types and pathways, and combine the results with the functional imaging and large-scale computational modeling to characterize dynamic changes of the neural circuitry. By analyzing these changes leading to the behaviors, we study how the neural circuitry operates and shifts during the learning processes and behavioral switching. Furthermore, we try to understand the mechanism on how the neural circuitry is reorganized and achieves the recovery, when the brain or spinal cord is injured.

【Expected Research Achievements and Scientific Significance】

Dysfunction of the neural circuitry is related to the pathogenesis of neuropsychiatric and neurological diseases. The results obtained from the study of the circuitry shift will provide not only the academic information but also the significance in clinical science. The results lead to an understanding of the circuitry mechanism of the impairments of higher brain functions and the compensation after the neural injury. The detailed analysis of circuitry dynamics is expected to develop therapeutic and rehabilitative approaches based on scientific evidence to improve pathology of the diseases.

【Key Words】

Neural circuitry: A neuronal cell is composed of a cell body, dendrite, and axonal structure, and the axonal terminals make a synapse with other neuronal cells. Neurotransmitters are released from synaptic terminals and convey signals to another cell. Circuitry manipulation: Genetic manipulation technology provides the strategy to induce neuronal ablation and inhibit synaptic transmission. In addition, the technology enables us to control specific neuronal activity by optic stimulation and chemical substances.

【Term of Project】　FY2014-2018

【Budget Allocation】 1,213,600 Thousand Yen

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