【Grant-in-Aid for Transformative Research Areas（B）】

Section III

Title of Project： Holism in neuroscience: Large-scale recording and simulation

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Number of Research Area：21B304　Researcher Number：80712299

【Purpose of the Research Project】

The purpose of this Research Area is to discover and describe the holistic principle of the brain through the integration of large-scale recording and simulation, to elucidate the pathophysiology of psychiatric disorders, and to propose a new principle for building AI. Recently the field of AI research has made great progress, but all the advanced problem-solving capabilities of deep learning are based on abstractions of the functional optimization mechanisms of local subsystems of the brain. However, the brain is not just an organ that performs local optimization for a certain objective function, but it also organizes and transfers acquired information in parallel, appropriately generalizes the consequences of learning, and prepares for further learning in the future by constantly maintaining consistency as a whole. The continuous change of the whole brain system, which does not directly optimize the objective function, seems to provide generalization performance that current AI does not have and enables the long-term survival of animals in a constantly changing environment. When the holistic nature of the brain collapses, psychiatric disorders such as autism spectrum disorder (ASD), in which local brain functions are preserved but cannot keep consistency, may appear. Thus, the holistic nature of the brain connects the distinct issues of generalized performance of AI and psychiatric disorders, and opens up an interdisciplinary field.

【Content of the Research Project】

A01 (leader: Riichiro Hira) aims to elucidate the holism of the brain using large-scale multiple neural recordings.

A01-1. Development of a large-scale multiple recording method.

A01-2. Development of AI-driven complex closed-loop live-connectome system.

A01-3. Integration of circuit topology and dynamics into large-scale simulations.

A02. (leader: Shinichiro Tsutsumi) aims to elucidate how holistic nature of the brain is disrupted in psychiatric disorders by large-scale multiaxial observation of the cerebrum and cerebellum.

A02-1 Large-scale two-photon imaging of the cerebrum and cerebellum.

A02-2 Multiple cognitive tasks and transfer learning.

A02-3 Pharmacological and genetic models of psychiatric disorders

A03 (leader: Jun Igarashi) aims to develop mice whole-brain simulations to elucidate the holistic nature of the brain.

A03-1 Development of a whole-brain-whole-body simulation platform for rodents.

A03-2 Information processing mechanism of the brain through whole-brain-scale region interactions.

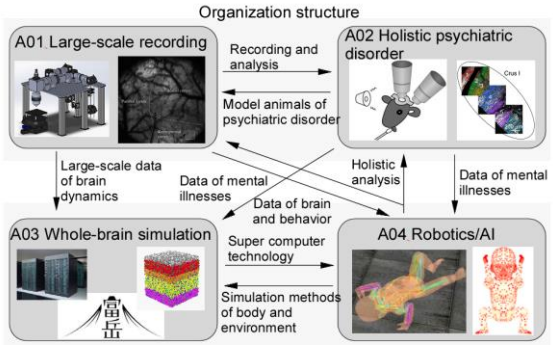
A03-3 Brain disease mechanisms in whole-brain-scale region interactions.

A04 (leader: Hiroki Mori) aims to understand the holistic nature of cognitive and motor development based on the interaction between brain, body, and environment.

A04-1. Construction of a developmental model of the entire environment, body, and nervous system.

A04-2. Intrinsic motivation model based on holistic approach: Emergence of cognition and action by meta-objective function.

A04-3. Analysis methods that enable understanding and description of wholeness



【Expected Research Achievements and Scientific Significance】

By clarifying the principles of holistic nature of the brain, such as its unity, integrity, and sustainable development, we will elucidate the brain's superior properties that are difficult to grasp with a reductionist approach. We expect to make various discoveries such as a new AI construction principle and a new treatment strategy by clarifying the relationship between the collapse of holistic nature of the brain and psychiatric disorders.

【Key Words】Holism: An approach where we try to find properties that emerges in the system as a whole and cannot be seen by detailed observation of individual elements.

【Term of Project】FY2021-2025
【Budget Allocation】**105,000** Thousand Yen
【Homepage Address and Other Contact Information】
http://cath.sakura.ne.jp/holistic_brain/index.html