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

Design-build of brain through spontaneous brain multimodal activity
（脳多元自発活動の創発と遷移による脳のデザインビルド）

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Research Area Information	Number of Research Area : 22H05092　Project Period (FY) : 2022-2024 Keywords : Brain, spontaneous activity, synchronization, neural circuit formation, mathematic model

Purpose and Background of the Research

●Outline of the Research

Starting from a single fertilized egg, we need to create a brain with an appropriate neural network to perceive the world and behave. It has become clear that neural networks are excellent information processing systems, and the neural network model, a mathematical model of the brain, is an excellent model of the brain. Elucidating the mechanism by which the neural network is created and mathematically describing the process of its creation based on this knowledge would have immeasurable benefits not only for neuroscience but also for many other fields.

The discovery that neurons are spontaneously active (spontaneous neural activity) even before sensory input in the developing nervous system has fascinated scientists. Since this discovery, spontaneous neuronal activity has been shown to be necessary for normal synaptic connections of neurons and their refinement. Recent advances in imaging techniques have revealed that spontaneous activity during development is highly organized at the population level. These spontaneous activity patterns are spatiotemporally and temporally diverse and change with development (multimodal spontaneous brain activity). From these findings, we hypothesize that spontaneous activity not only carries local information that regulates the development of individual neurons, but also carries more information that enables the design of entire neural networks. To test this hypothesis, we have established a research area that combines experimental and theoretical scientists to quantitatively describe the emergence and transition in developmental spontaneous activity patterns through systematic studies from experimental data to theory, and to find out what the significance of organized spontaneous activity patterns is for the brain.

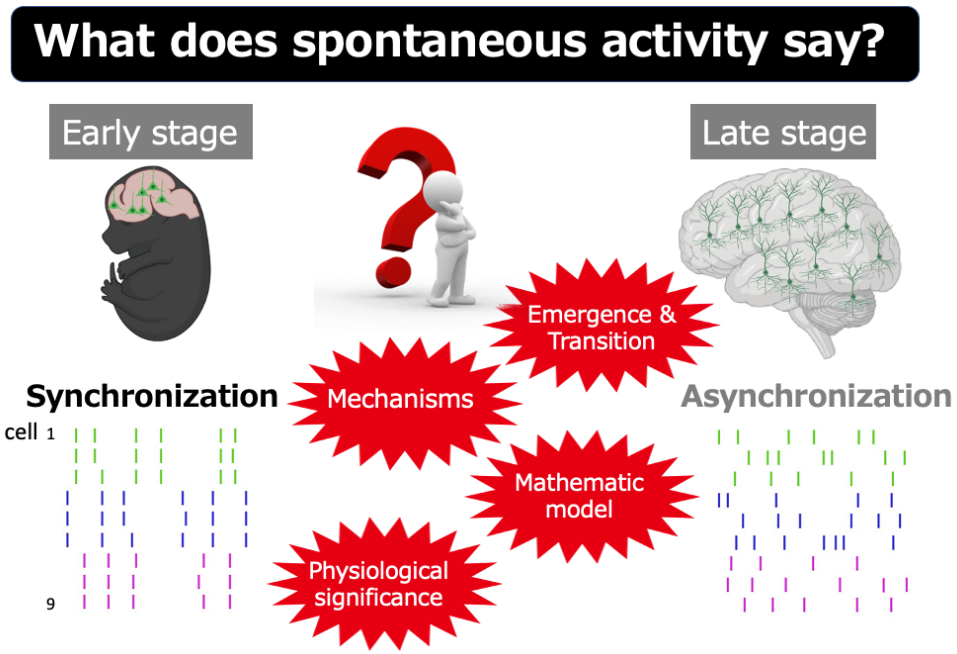

Figure 1. The research goal of this research area

Expected Research Achievements

● **Plan for this research area**

This research group tests the "whole brain design-build hypothesis", which proposes that spontaneous activity during brain development not only carries local information that regulates the development of individual neurons, but also diverse information that enables the design of entire neural networks. We are going to verify this hypothesis through both of experimental and theoretical research.

To this end, we will conduct the following four research themes.

1. What patterns of spontaneous activity occur in the developing brain and how do these patterns change with development?
2. What mechanisms generate and change spontaneous activity patterns in the developing brain?
3. What is a mathematical formula which models the generation and change of spontaneous activity patterns in the developing brain?
4. Can spontaneous activity in the developing brain design the whole brain?

While the importance of spontaneous activity in brain development has been suggested , little progress has been made for the mechanisms by which the highly organized spontaneous activity patterns during development are generated and transitioned. Furthermore, the significance of the emergence and the transition of highly organized spontaneous activity patterns for brain development has not been clarified. The main reason for the lack of progress in these studies is the technical difficulty of stably observing and manipulating spontaneous activity in the developing small, soft brain. We have been studying the mouse brain during embryonic and postnatal development for many years and are able to detect and manipulate spontaneous activity patterns in the developing mouse brain using original techniques.

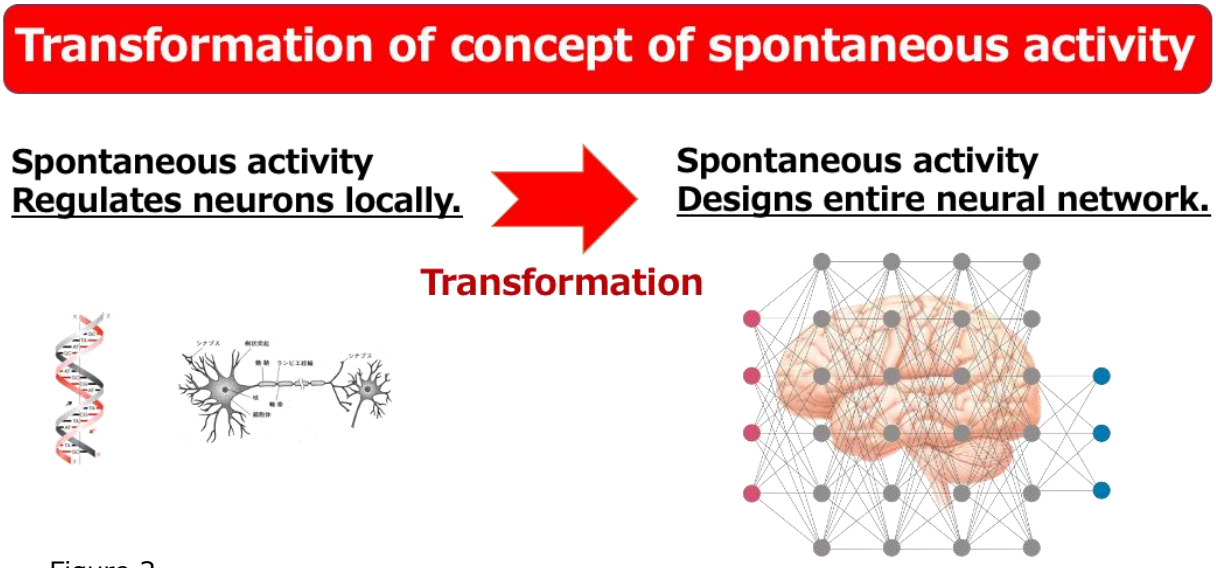

Figure 2.
Transformation of concept
by our research

Homepage Address, etc.	This research area HP under construction Principal investigator HP https://uesaka0808.wixsite.com/website

Logo of this research area. It is anthropomorphic with motifs of the brain, children and mathematics