


Working principle of the idling brain

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Purpose and Background of the Research

● Outline of the Research

In a Specially Promoted Research Project initiated in fiscal year 2018, we took on the challenge of analyzing the subconscious brain functions, which were extremely difficult to analyze. Using mice, we revealed that the idling brain actively participates in diverse information processing, thus pioneering a new academic field known as "Idling Brain Research" (Figure 1).

In this study, we will address three issues that have emerged during this process:

1. Mechanisms of information processing in the idling brain
2. Mechanisms by which traces of forgotten memories in the subconscious influence subsequent behavior
3. Mechanisms by which information processed in the idling brain surfaces to consciousness

(Note: idling brain refers to the brain during sleep or rest.)

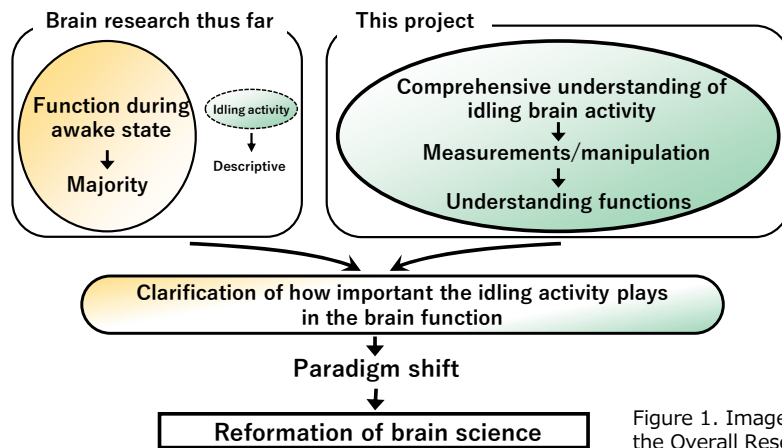


Figure 1. Image of the Overall Research

● The brain continues to be active not only during task performance but also during sleep and rest, revealing its state of idling. Everyone has experienced the sudden resolution of unresolved problems after sleep or relaxation (Figure 2). Using mice, we discovered that only a subset of hippocampal neurons that were active simultaneously during learning would reactivate (replay) during subsequent sleep and also during memory recall. This led us to hypothesize that sleep replay of specific neuronal groups is responsible for memory consolidation. These findings indicate that the idling activity of the brain encompasses a wider range of important functions than previously believed.

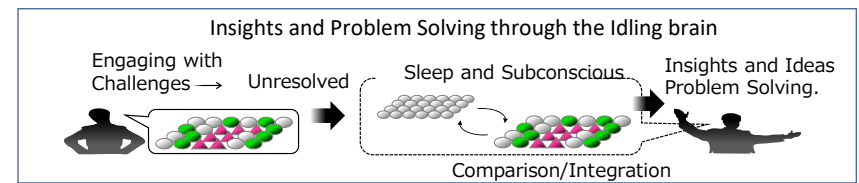


Figure 2. Potential function of the idling brain

Specially Promoted Research has uncovered three important aspects of the idling brain function:

1. It was discovered that the activity of neurons in the sleeping brain is essential for complex learning.
2. Even forgotten memories leave traces in the subconscious brain, influencing subsequent memories of similar experiences.
3. Information processed in the brain during sleep exists in the subconscious, providing clues about how this information emerges into consciousness. It is believed that these moments of emergence into consciousness (Eureka! moments) are related to insight and creativity.

The purpose of the research is to answer the following three questions, corresponding to the aforementioned discoveries:

1. What kind of neuronal activity during sleep is necessary?
2. How do forgotten memories impact subsequent memories of similar experiences?
3. How does information existing in the subconscious emerge into consciousness?

Expected Research Achievements

● Expanding the Research Using Mice (Figure 3)

1. Through measurements of neural activity, particularly during idling periods such as sleep, and analysis of neural circuits, we aim to elucidate the principles of information processing in the sleeping brain.
2. We seek to unravel the mechanisms underlying the interaction between traces of forgotten memories and traces of memories formed during subsequent learning.
3. By analyzing the neural activity at the moment when mice suddenly become aware of hidden rules, we aim to uncover the mechanisms by which information existing in the subconscious emerges into consciousness.

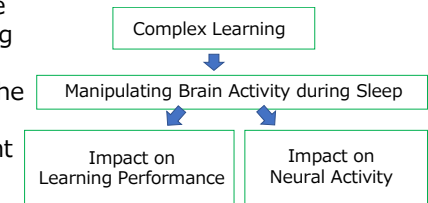


Figure 3. Overview of the Experiment

● Broader Academic and Societal Impact

In the future, it is expected that by assisting in understanding and optimizing brain activity during sleep, as well as improving sleep practices, we can further harness the latent abilities of the brain, leading to an enhancement in quality of life. Understanding the neuroscientific mechanisms behind moments of insight not only contributes to our understanding of creativity, which involves generating something new from scratch, but also holds the potential for future advancements in innovative artificial intelligence development.