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

Scientific Dream Interpretation

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Purpose and Background of the Research

Why do we dream? Dreams have fascinated humanity since ancient times and have influenced philosophy, religion, art, and even scientific discovery. Yet, their fundamental mechanisms and functions remain unclear.

One major reason is methodological. Dream content relies on verbal reports, making it subjective and ambiguous. Moreover, in animals or neonates, which cannot report their dreams, direct studying of dreams has been particularly challenging.

Figure 1. Dreams as a fundamental unresolved question

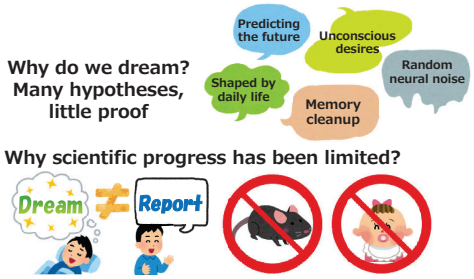

Figure 2. Barriers to scientific research on dreaming

Recent advances are beginning to overcome these limitations. In humans, improving brain imaging and analysis techniques are making it possible to infer dream content from neural signals. In parallel, studies of REM sleep behavior disorder—where individuals physically act out their dreams—have inspired the development of mouse models that display behaviors during sleep that potentially reflect dream content. These "dream-enacting" models offer a new experimental window into dreaming.

Dreams may also play a functional role. They have long been linked to creativity and problem-solving, and recent findings suggest that sleep-related brain activity reorganizes past experiences into novel combinations, potentially enabling preparation for situations not yet encountered.

Dream abnormalities are associated with various disorders. For example, recurrent nightmares following severe stress can significantly impair quality of life. Understanding dreaming may contribute to a better understanding of these disorders.

Finally, dream-like states may not be unique to humans. In octopuses, transient increases in brain activity during sleep are accompanied by dynamic changes in skin patterns, suggesting a possible dream-like process. Such observations raise the possibility that dreaming represents a fundamental biological mechanism that has emerged across evolution.

Against this background, this project reconceptualizes dreaming as a process in which the brain simulates reality during periods of inactivity. We aim to understand dreaming in a unified framework as a phenomenon that may be shared across humans, animals, and even artificial systems. By elucidating its mechanisms and functions, this research seeks to establish a new interdisciplinary field.

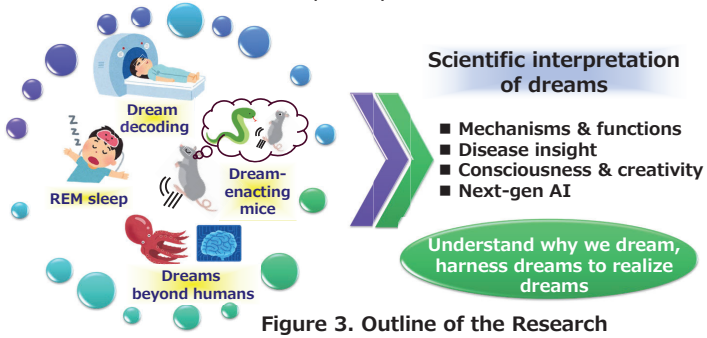

Figure 3. Outline of the Research

Expected Research Achievements

This project addresses the question "Why do we dream?" from three perspectives.

(1) How are dreams generated?

We aim to identify the mechanisms underlying dream generation. Brain activity arises from interactions among large populations of neurons, and dreams are thought to represent one form of such activity. Using animal models, we will identify neural circuits involved in dreaming and manipulate their activity to test how dream occurrence is regulated—approaching the neural basis of a "dream switch."

(2) What functions do dreams serve?

We next examine the functional role of dreaming, particularly its relationship to creativity and problem solving. During sleep, the brain may not simply replay past experiences but recombine them into novel patterns, allowing the simulation of situations not yet encountered. This process resembles mental training in sports and may help prepare future behavior. By analyzing neural activity associated with dreaming in humans and animals, we aim to clarify its role in insight and inference.

(3) Can dreams be read and controlled?

We also seek to develop methods to decode and potentially influence dream content. Advances in neural analysis are beginning to enable inference of dream content from brain activity. Building on this, we aim to objectively visualize dreams and test whether targeted neural interventions can alter them. Such approaches may contribute to treatments for conditions such as nightmares and support creative thinking.

Overall, this project tackles the long-standing question of "what dreams are" using state-of-the-art science. The term "dream" encompasses not only experiences during sleep but also imagination and aspiration. The human ability to envision alternative realities and strive to realize them has long been shaped by dreaming. By elucidating its underlying mechanisms and functions, we aim to establish a new interdisciplinary field of "dream science" and contribute to advances in both knowledge and technology.

Website(s)	http://dreamscience.jp