


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

Drowsology: understanding the mechanisms of generation and elimination of drowsiness (Drowsology)

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	Keywords : drowsiness, sleep analysis, multi-photon imaging, <i>in vivo</i> electrophysiology, mathematical modeling		

Purpose and Background of the Research

●Outline of the Research

We sleep and wake repeatedly. With the discovery of the sleep EEG, sleep and wake can now be objectively distinguished, and the control mechanisms of sleep/wake and the functions of sleep have been elucidated. However, the substance of "drowsiness" (the subjective sensation of sleepiness), which eventually arises with longer wakefulness, is still shrouded in mystery (Figure 1). In existing academic fields, "sleepiness" has been literally categorized as "sleep research" because of its strong association with sleep. However, sleepiness is a sensation that occurs upon awakening and is a physiological phenomenon that is clearly distinct from sleep itself. In addition, social losses due to sleep debt, which are often discussed in the public domain, are mostly due directly to the intensity of sleepiness caused by sleep deprivation, not to the amount of sleep time. Furthermore, in recent years, "pathological sleepiness" that is not relieved by sleep, as seen in developmental disorders and inflammatory diseases, has also become a problem. For these reasons, there is a need for an academic discipline that studies "sleepiness" independently of conventional sleep research. Based on these issues, this field of study aims to break away from the framework of conventional sleep research and create a scientific research field on sleepiness, « Drowsology ».

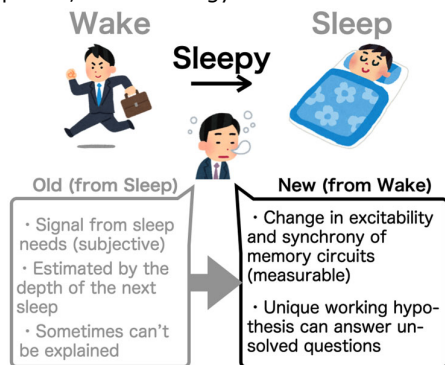


Figure 1. New understanding of sleepiness in this research area



Figure 2. Logo of this research area

● Multimodal approach independent of traditional sleep research

In order to achieve a new understanding of sleepiness, a sleep researcher with an original working hypothesis and members with expertise in different approaches (multi-photon imaging, membrane potential imaging, *in vivo* electrophysiology, and mathematical modeling) have been assembled in this area. By working from each approach and collaborating organically, it will be possible to understand sleepiness independent of conventional sleep research.

Expected Research Achievements

●Members and research plans

A01: Behavioral analysis (Hirosaki Univ, Niwa) /Cell physiology (Hamamatsu Med, Bando)

How drowsiness is sensed and converted will be clarified by behavioral analysis using individuals and cellular physiological analysis using tissues.

A02: Multi-photon imaging (Kyoto Univ, Sakamoto/Yamanashi Univ, Manita)

Develop ultra-luminance and high-sensitivity calcium sensors and novel probes for deep brain imaging to reveal circuit changes during sleepiness by multi-photon imaging.

A03: *in vivo* electrophysiology (Osaka Metro Univ, Miyawaki)

How drowsiness is resolved is revealed by large-scale electrophysiology, which can record neural activity in multiple brain regions at single-cell resolution for extended periods of time.

A04: Mathematical modeling (Tokyo Tech, Uriu)

Scale-free mathematical models connect the results of multimodal biological experiments obtained by each group to reveal the mysteries of the time scale from sleepiness accumulation to sleep.

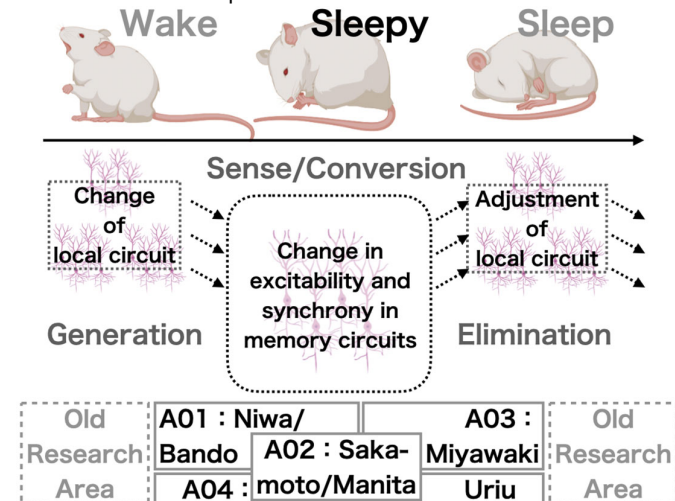


Figure 3. New understanding of sleepiness in rodents and layout of each group in this research area

● Ripple Effects of this Area

In modern society, drowsiness is often treated as a "bad" thing that significantly reduces our performance. Therefore, a correct understanding of drowsiness can lead to a change in modern society's values toward drowsiness, as well as a way to cope with the various social losses caused by drowsiness. Abnormalities in sleepiness are closely related to sleep disorders and neuropsychiatric disorders, and the results of this research area will have a large ripple effect on the prevention and treatment of human diseases.

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