Press Release

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Dopamine triggers sleep state transitions

Researchers from the University of Tsukuba find a novel neuronal mechanism that initiates rapid-eye movement sleep.

Tsukuba, Japan – historically, the neurological mechanisms underlying sleep-cycle generation have been elusive. But now, researchers from Japan have uncovered new information about how the brain transitions from one sleep state to another.

In a study published this month in Science, researchers from the University of Tsukuba have revealed that a temporary increase in dopamine levels in the basolateral amygdala, a brain region associated with emotion, initiates the transition from one sleep state to another.

The sleep cycle includes two different brain states, i.e., non-rapid eye movement (NREM) and rapid eye movement (REM) sleep, which alternate during sleep. However, the way in which the brain transitions from one sleep state to another has not been well defined, something the researchers at the University of Tsukuba aimed to address.

"Neuroimaging and intracranial recording studies have shown amygdala activation during REM sleep in humans," explains lead author of the study Professor Takeshi Sakurai. "We wanted to examine whether these changes in amygdala activation, induced by dopamine activity, would correspond to periods of transition between REM sleep and NREM sleep in mice."

To do this, the researchers examined changes in extracellular dopamine levels in mice in several different brain regions that receive projections from dopamine neurons in the amygdala. They used a finely tuned dopamine sensor to look for populations of dopamine neurons that were activated at specific movements during the sleep/wake cycle.

"The results were surprising," says senior Professor Sakurai. "We found that a transient increase in dopamine in the basolateral amygdala

led to a transition from NREM to REM sleep. Mimicking this dopamine increase during NREM sleep initiated REM sleep in mice."

Further, they found that a similar increase in dopamine preceded cataplexy attacks in narcoleptic mice. Cataplexy is a condition in which strong emotions can induce an unexpected transition into REM sleep, leading to involuntary muscle weakness and altered consciousness.

"Our findings have important implications for understanding changes in sleep state in both normal and pathological circumstances. For instance, positive emotions in individuals with cataplexy might lead to increases dopamine in the amygdala, mimicking the dynamics that trigger NREM-to-REM transitions," says Professor Sakurai.

The relationship between sleep state transitions and dopamine signaling in a brain area associated with emotional processing may have important implications for treating people with cataplexy and narcolepsy. Further, information about sleep cycle transitions may be useful for understanding conditions related to abnormal REM sleep, such as REM sleep behavior disorder, and diseases involving abnormal DA signaling, such as Parkinson's disease.

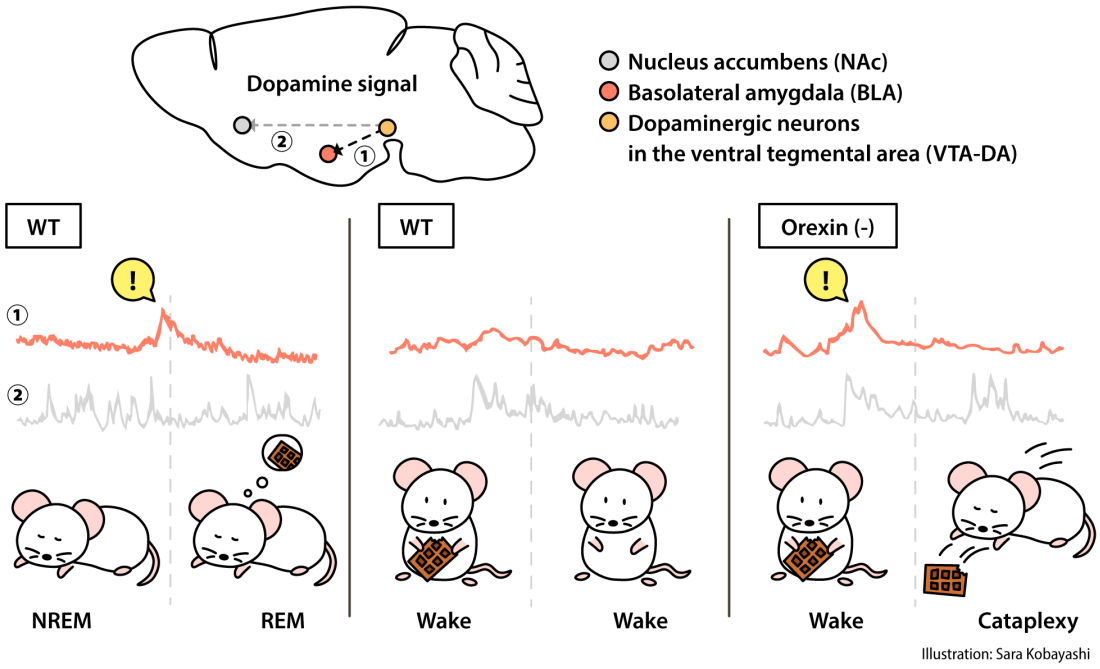

Fig1. Changes in dopamine levels in the basolateral nucleus of the amygdala and nucleus accumbens during the sleep-wake cycle.

Bibliographic information
Hasegawa E, Miyasaka A, Sakurai K, Cherasse Y, Li Y, Sakurai T. (2022) Rapid eye movement sleep is initiated by basolateral amygdala dopamine signaling in mice. Science 375(6584), pp. 994-1000
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