

Press Release

2020.6.4 | International Institute for Integrative Sleep Medicine (WPI-IIIS)

Dreaming with purpose

Researchers from University of Tsukuba and the University of Tokyo identify neurons responsible for memory consolidation during REM sleep

Tsukuba, Japan – The presence of dreaming during rapid-eye-movement (REM) sleep indicates that memory formation may occur during this sleep stage. But now, researchers from Japan have found that activity in a specific group of neurons is necessary for memory consolidation during REM sleep.

In a study published this month in *Neuron*, researchers from University of Tsukuba and the University of Tokyo have revealed that adult-born neurons (ABNs) in the hippocampus, which is a brain region associated with memory, are responsible for memory consolidation during REM sleep.

Neurogenesis, the process by which new neurons are formed, takes place in the hippocampus throughout the lifespan of animals, including humans. At present, little is known about the contribution of ABNs to memory formation during sleep, something the researchers at University of Tsukuba and the University of Tokyo aimed to address.

“Although ABNs in the dentate gyrus region of the hippocampus are rare and not frequently active, they show heightened plasticity, indicating their potential role in the formation of memories,” says lead author of the study Associate Professor Masanori Sakaguchi. “We wanted to investigate how manipulating ABN activity would affect memory consolidation in freely behaving mice.”

To do this, the researchers exposed mice to a context-specific fear memory task. Then, they recorded activity in specific ABNs across the learning, consolidation, and retrieval stages of memory.

“We found that young ABNs that were most active during REM sleep after the memory task were most likely to have been active during learning,” explains Professor Masashi Yanagisawa, the other senior author of the study. “Further, when we then examined the effects of optogenetic silencing on young ABN activity during sleep, we found that the consolidation of contextual fear memories was impaired.”

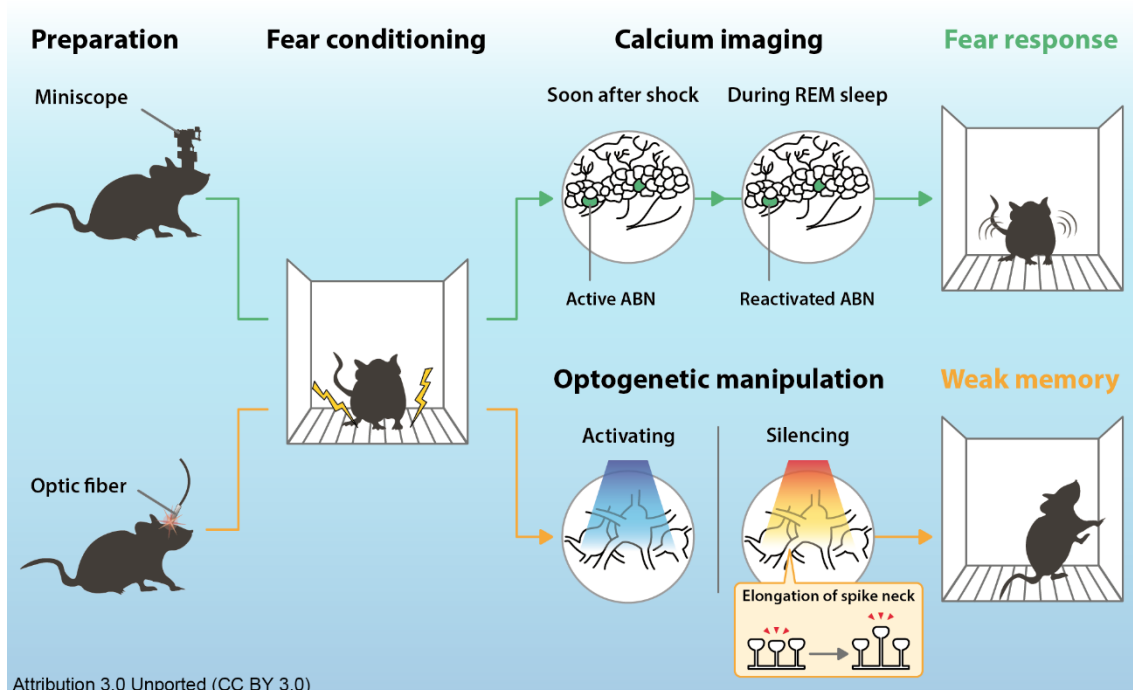
Their data represent causal evidence that activity in young ABNs during REM sleep is necessary for memory consolidation. This is an important development as the activity and role of ABNs in memory consolidation during sleep was previously unknown, as was the type of hippocampal neuron responsible for memory consolidation during sleep.

“During learning, specific ABNs may undergo synaptic changes that enable memory consolidation. Further, these synaptic changes may depend on synchronization between specific ABNs and brain oscillations that take place during REM sleep,” says Professor Sakaguchi.

Clarification of these possibilities may lead to a deeper understanding of how memories are formed, retrieved, and consolidated, and could facilitate the development of new treatments for memory disorders.

About IIS

IIS was launched by the Ministry of Education, Culture, Sports, Science and Technology of Japan with the aim of building globally visible research centers with high research standards and excellent research environments to accommodate globally prominent researchers. IIS is the world’s premier institute aiming to elucidate the fundamental principles of sleep/wake biology, develop new strategies to diagnose, prevent, and treat sleep disorders, and contribute to promote human health through research activities. The research was funded by the Japan Society for the Promotion of Science and the Japan Science and Technology Agency.



The activity of ABNs during REM sleep consolidates memory.

Fear learning recruits a population of young adult-born neurons (ABNs); these ABNs are reactivated during subsequent rapid eye movement (REM) sleep. Optogenetic manipulation of this ABN activity alters structural remodeling of ABN spines and impairs memory consolidation.

Bibliographic information

Kumar D, Koyanagi I, Carrier-Ruiz A, Vergara P, Srinivasan S, Sugaya Y, Kasuya M, Yu T, Vogt KE, Muratani M, Ohnishi T, Singh S, Teixeira CM, Chérasse Y, Naoi T, Wang S, Nondhalee P, Osman BAH, Kaneko N, Sawamoto K, Kernie SG, Sakurai T, McHugh TJ, Kano M, Yanagisawa M, Sakaguchi M (2018) Sparse Activity of Hippocampal Adult-Born Neurons during REM Sleep Is Necessary for Memory Consolidation

Neuron

DOI:10.1016/j.neuron.2020.05.008

Media Contact

Alliance and Communication Unit, International Institute for Integrative Sleep Medicine (WPI-IIIS), University of Tsukuba, Japan

E-mail: wpi-iiis-alliance@ml.cc.tsukuba.ac.jp