Memory accuracy and strength can be manipulated during sleep

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The sense of smell might seem intuitive, almost something you take for granted. But researchers from NYU Langone Medical Center have found that memory of specific odors depends on the ability of the brain to learn, process and recall accurately and effectively during slow-wave sleep—a deep sleep characterized by slow brain waves.

The sense of smell is one of the first things to fail in neurodegenerative disorders, such as Alzheimer's disease, Parkinson's disease, and schizophrenia. Indeed, down the road, if more can be learned from better understanding of how the brain processes odors, researchers believe it could lead to novel therapies that target specific neurons in the brain, perhaps enhancing memory consolidation and memory accuracy.

Reporting in the *Journal of Neuroscience* online April 9, researchers in the lab of Donald A. Wilson, PhD, a professor in the departments of Child and Adolescent Psychiatry and Neuroscience and Physiology at NYU Langone, and a research scientist at the NYU-affiliated Nathan Kline Institute for Psychiatric Research, showed in experiments with rats that odor memory was strengthened when odors sensed the previous day were replayed during sleep. Memories deepened more when odor reinforcement occurred during sleep than when rats were awake.

When the memory of a specific odor learned when the rats were awake was replayed during slow-wave sleep, they achieved a stronger memory for that odor the next day, compared to rats that received no replay, or only received replay when they were awake.

However, when the research team exposed the rats to replay during sleep of an odor pattern that they had not previously learned, the rats had false memories to many different odors. When the research team pharmacologically prevented neurons from communicating to each other during slow-wave sleep, the accuracy of memory of the odor was also impaired.

The rats were initially trained to recognize odors through conditioning. Using electrodes in the olfactory bulb, a part of the brain responsible for perceiving smells, the researchers stimulated different smell perceptions, according to precise patterns of electrical stimulation. Then, by replaying the patterns electrically, they were able to test the effects of slow-wave

sleep manipulation.

Replay of learned electrical odors during slow-wave sleep enhanced the memory for those odors. When the learned smells were replayed while the rats were awake, the strength of the memory decreased. Finally, when a false pattern that the rat never learned was incorporated, the rats could not discriminate the smell accurately from the learned odor.

"Our findings confirm the importance of brain activity during sleep for both memory strength and accuracy," says Dr. Wilson, the study's senior author. "What we think is happening is that during slow-wave sleep, neurons in the brain communicate with each other, and in doing so, strengthen their connections, permitting storage of specific information."

Dr. Wilson says these findings are the first to demonstrate that memory accuracy, not just memory strength, is altered during short-wave sleep. In future research, Dr. Wilson and his team hope to examine how sleep disorders affect memory and perception.

Provided by New York University School of Medicine

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