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Direct evidence of role of sleep in memory formation is uncovered

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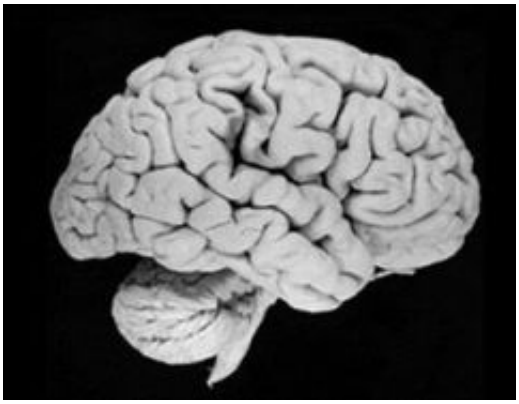

Modern human brain. Credit: Univ. of Wisconsin-Madison Brain Collection.

A Rutgers University, Newark and Collége de France, Paris research team has pinpointed for the first time the mechanism that takes place during sleep that causes learning and memory formation to occur.

It's been known for more than a century that sleep somehow is important for learning and memory. Sigmund Freud further suspected that what we learned during the day was "rehearsed" by the brain during dreaming, allowing memories to form. And while much recent research has focused on the correlative links between the hippocampus and memory consolidation, what had not been identified was the specific processes that cause long-term memories to form.

As posted online September 11, 2009 by Nature Neuroscience, György Buzsaki, professor at the Center for Molecular and Behavioral Neuroscience at Rutgers University, Newark, and his co-researchers, Gabrielle Girardeau, Karim Benchenane, Sidney I. Wiener and Michaël B. Zugaro of the Collége de France, have determined that short transient brain events, called "sharp wave ripples," are responsible for consolidating memory and transferring the learned information from the hippocampus to the neocortex, where long-term memories are stored.

Sharp wave ripples are intense, compressed oscillations that occur in the hippocampus when the hippocampus is working "off-line," most often during stage four sleep, which, along with stage three, is the deepest level of sleep.

During stage four sleep, Buzsaki explains, "it's as if many instruments and members of the orchestra come together to generate a loud sound, a sound so loud that it is heard by wide areas of the neocortex. These sharp, 'loud' transient events occur hundreds to thousands of times during sleep and 'teach' the neocortex to form a long-term form of the memory, a process referred to as memory consolidation." The intensity and multiple occurrence of those ripples also explain why certain events may only take place once in the waking state and yet can be remembered for a lifetime, adds Buzsaki.

The researchers were able to pinpoint that sharp wave ripples are the cause behind memory formation by eliminating those ripple events in rats during sleep. The rats were trained in a spatial navigation task and then allowed to sleep after each session. Those rats that selectively had all ripple events eliminated by electrical stimulation were impeded in their ability to learn from the training, as compressed information was unable to leave the hippocampus and transfer to the neocortex.

Identification of a specific brain pattern responsible for strengthening

learned information could facilitate applied research for more effective treatment of memory disorders.

"This is the first example that if a well-defined pattern of activity in the brain is reliably and selectively eliminated, it results in memory deficit; a demonstration that this specific brain pattern is the cause behind long-term memory formation," says Buzsaki.

The research also represents a move toward a new direction in neuroscience research. While previous research largely has focused on correlating behavior with specific brain events through electroencephalogram, neuronal spiking and functional magnetic resonance imaging studies, increasingly researchers are challenging those correlations as they seek to identify the specific process or processes that cause certain events and behaviors to take place.

More information: www.nature.com/neuro/journal/v … ent/abs/nn.2384.html

Source: Rutgers University (news : web)