Biological clock may shut down long-term memory at night

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UH Professor Arnold Eskin receives $2.5 million in grants to continue learning, memory research

If you crammed for tests by pulling 'all nighters' in school, ever wonder why your memory is now a bit foggy on what you learned? A University of Houston professor may have the answer with his research on the role of circadian rhythms in long-term learning and memory.

Arnold Eskin, the John and Rebecca Moores Professor of Biology and Biochemistry at UH, was recently awarded two grants totaling $2,472,528 from the National Institutes of Health (NIH) to continue pursuing his investigations of memory formation and the impact of the biological clock on learning and memory.

Scientists have known for a while that the brain's biological (or circadian) clock influences natural body cycles, such as sleep and wakefulness, metabolic rate and body temperature. New research from Eskin suggests the circadian clock also may regulate the formation of memory at night. This new research focuses on "Circadian Modulation of Long-term Memory Formation" and "Long-term Regulation of Glutamate Uptake in Aplysia," with NIH funding to be disbursed over four years.

"There is a lot of research going on in memory," Eskin said. "How do we remember things given that we don't have a camera in our brain to record events? What changes take place in our brains that allow us to

remember? These grants are about fundamental learning and memory and about modulation of memory."

For the grant on circadian modulation of long-term memory formation, Eskin will continue studies based on his data that reveal the circadian clock modulates several forms of long-term memory in the marine snail Aplysia.

These studies involved experiments on the defensive reflexes and feeding responses of Aplysia. Eskin's results showed that Aplysia form long-term memory when they are trained during the day but not when they are trained at night. However, short-term memory of the same behaviors is formed equally well during the day and night, which might explain why all-night cram sessions may have helped you get through certain classes in school, but did not leave you with enough of a lasting impression to become part of your long-term store of knowledge.

"Somewhere in the molecular circuit, in the neural circuit in the brain, the biological clock is shutting that circuit off at a particular time of night. It's shutting molecules down so that long-term memory can't happen," Eskin said.

Lisa Lyons, a research assistant professor at UH, is the primary investigator on this grant and is already investigating molecules involved in memory formation that might be activated during the day but not at night. NIH funding will help advance the pursuit of this line of research.

For the grant on long-term regulation of glutamate uptake in Aplysia, Eskin will focus on the transmitter substance glutamate, which is involved in memory formation.

"The formation of memory happens at places in the brain called synapses, where cells 'talk' to one another through the release of

chemicals called transmitter substances," Eskin said. "In order for transmitters to work, once they are released they have got to be cleared away so that others can subsequently act. So, there are not only important mechanisms to release the transmitters, but also mechanisms to get rid of them, and these are called reuptake systems."

Eskin is studying glutamate reuptake and glutamate transport to understand the mechanism or change that takes place at the synapses of nerve cells (or neurons) that enables people to remember. In previous research, Eskin found that glutamate transport molecules, which act as the brain's cleaning crew during learning and memory formation, actually increase once the long-term memory-forming process begins. Deficiencies in these glutamate transporters that affect the strength of connections among the neurons associated with memory may explain why memory lapses such as forgetting where you last set down your keys occur.

"This research will provide significant information toward understanding memory and thus diseases that affect memory," Eskin said.

With the potential to shed light upon neurodegenerative diseases such as Alzheimer's Ц marked by a loss of brain function due to the deterioration of neurons Ц studying these nerve cells could one day take this research from helping you be better able to find your glasses to providing relief from a debilitating illness.

"At the end of the day, we can't make memory better or improve it unless we understand how memory works and is modulated," he said. "That's what this research is all about."

He is currently completing the last year of another NIH-funded grant on "Glutamate Transport Regulation and Synaptic Plasticity" that complements these two new grants, but investigates the role of glutamate

uptake in associative learning in mammals. This research project on mammals represents a great example of traslational research in which basic findings in a simple system (i.e. Aplysia) were quickly applied to a higher organism (i.e. mammals). They found that glutamate transport increased in the brains of mammals during learning as also found in Aplysia. (See related release at www.uh.edu/admin/media/nr/2002 … 2/eskinlearning.html.)

Coming to UH more than 25 years ago, Eskin guided the merger of two departments into what is now the Department of Biology and Biochemistry in the College of Natural Sciences and Mathematics. As department chair from 1994 to 2000, Eskin tripled research grants to approximately $6 million per year and developed the department's research foci of neuroscience, the biological clocks and infectious disease. The author or co-author of more than 150 publications, he has received numerous honors, including the Esther Farfel Award, the university's highest faculty honor. He is the only faculty member to receive both the Farfel Award and the Moores Professorship in the same year. Eskin earned his bachelor's degree in physics from Vanderbilt University and his doctorate in zoology from the University of Texas.

UH's Biological Clocks Program is one of the world's leading centers for circadian rhythms research, with five laboratories and a team of more than 30 scholars. In addition to Eskin, the group is led by four other tenured faculty members in the biology and biochemistry department Ц Associate Professor Gregory M. Cahill, Professor Stuart Dryer, Professor Paul Hardin and Professor Michael Rea. For more information on the biological clocks program at UH, visit www.bchs.uh.edu/research_clocks.htm.

Source: University of Houston