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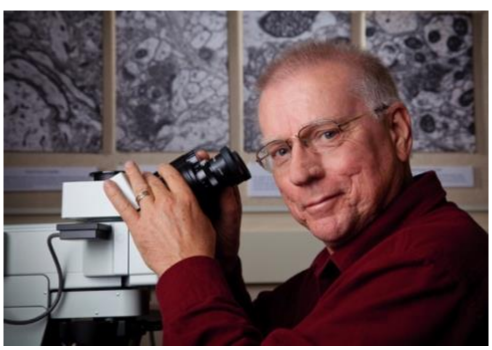
U of L researchers earn $918,000 CIHR grant to test a new idea in memory formation

Drs. Bruce McNaughton and Robert Sutherland, neuroscientists from the University of Lethbridge's Canadian Centre for Behavioural Neuroscience, will explore a hypothesis about memory formation thanks to a grant of $918,000 over five years from the Canadian Institutes of Health Research (CIHR).

"The U of L's nexus of research and academic programming in neuroscience is internationally renowned," says Dr. Robert Wood, vice-president (research). "Our University's reputation and impact in this area is a direct reflection of foundational and novel research being conducted by talented neuroscience colleagues such as Dr. McNaughton and Dr. Sutherland. The strength and importance of this project is further reflected in the fact that only about 15 per cent of applications in the national CIHR competition were successful."

As age-related memory problems are on the rise, McNaughton and Sutherland are looking to unlock some of the mysteries of the memory-making process and, if successful, their research could open up new avenues for therapeutic treatments.



"The main point of the project grant is to test an idea about the organization of long-term memory that's never been directly tested before," says Sutherland. "We have had a long, long interest in trying to understand this particular process. It's relevant to aging, dementia and almost any kind of failure of long-term memory."

Two systems are involved in the memory formation process, one in the hippocampus and one in the neocortex. New information is replayed in the hippocampus during short-term memory storage while replay in the neocortex is involved in long-term memory storage.

"The real trick in trying to understand how long-term memories work is trying to understand how these two systems interact," says Sutherland. "We know, for example, that when the interaction between the cortex and the hippocampus becomes rather weak, there's a correlated memory problem. So, it could well be that this is an early problem in age-related memory decline or perhaps even some dementias."

In the McNaughton lab, researchers observed a replay phenomenon in the hippocampus of rodents called sharp wave ripples. This distinct pattern of brain activity occurred after the animals had learned a certain task and while they were at rest or sleeping. For example, if the animal was running from one room to another during the learning task, the hippocampus, during rest or sleep, repeats the same sequence of activity during sharp wave ripple events.

"Anytime the brain is not busy processing input, it could be emitting sharp wave ripples," says McNaughton. "They do occur sporadically when an animal is sitting there eating, which is kind of a reflexive, non-attentive behaviour. The hippocampus seems to have two modes. It has acquisition mode where it processes external input and it has replay mode."

"The idea that's been kicking around for quite a while in various models of how long-term memory could work is that somehow that replay strengthens the representation of information outside the hippocampus, and in particular, in other parts of the cortex," adds Sutherland.

The specifics of an episode, what you ate for breakfast, for instance, are replayed in the hippocampus during rest or sleep. In the neocortex, the memory system extracts the information and interleaves it with other information about what you are likely to eat for breakfast. This neocortical memory is called semantic memory and can be thought of as general world knowledge.

"The long-term memories stored in the cortex are partly distinct memories, but more often than not, it's kind of a semantic or schematic representation of how the world works," says McNaughton. "We hypothesize this storage of general knowledge about the world is constructed by amalgamating and extracting the gist of many episodes."

Associated with replay in the neocortex is a distinctive pattern of brain activity called the K-complex, which can be easily detected with microelectrodes.

"These cortical and hippocampal replays are thought to be shuffled together during rest and sleep, like a deck of cards, except that the number of old patterns exceeds the numbers of recent ones, of course," says McNaughton. "What's happening during this replay is the cortex is kind of re-evaluating its assumptions about the world."

While scientists know that interfering with sleep can interfere with memory storage, testing to see if these patterns of activity are necessary for memory formation is more difficult. But

McNaughton and Sutherland have devised a way to test it out in rodents by disrupting the sharp wave ripple and K-complex patterns using weak electrical stimulation of brain circuits.

“We don’t know for sure whether these two processes do the work that we just described,” says Sutherland. “If we do know that’s how new episodic memories are stored together with older memories, then those become very significant targets for therapeutic intervention.”

This news release can be found online at memory formation.

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