New insight into how environmental enrichment enhances memory

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It is well established that environmental enrichment, providing animals with rich sensory, motor, and social stimulation, produces both dramatic increases in the number of synapses in the brain and enhanced learning. However, causal relationships between synapse formation and improved memory have not been definitively established. Now, a new study published by Cell Press in the March 24 issue of the journal *Neuron* introduces a valuable model system for investigating the role of synapse turnover in learning and memory in adult animals and elucidates mechanisms that link loss of existing synapses and the establishment of new synapses with improved learning.

"It had seemed likely that the powerful behavioral consequences of environmental enrichment involve enhanced synaptogenesis, but testing this hypothesis has been prevented by the absence of tools to specifically interfere with synaptogenesis processes in the adult," explains senior study author, Dr. Pico Caroni from Friedrich Miescher Institut in Basel, Switzerland. "In our study, we introduced a mouse model with a specific deficit in the assembly of synapses under conditions of enhanced plasticity in the adult and exploited the model to investigate a role for enhanced synaptogenesis in learning and memory associated with environmental enrichment."

Specifically, Dr. Caroni and coauthor Dr. Ewa Bednarek studied synapse remodeling and learning upon enrichment in the presence and absence of a protein called β-Adducin which has been implicated in the regulation of plasticity and learning. Mice lacking β-Adducin failed to assemble

new synapses upon enhanced plasticity and exhibited diminished memory after environmental enrichment. Both mice lacking β-Adducin and control mice exhibited anatomical changes that could support new synapses (growth of new spine structures) upon enrichment, but these failed to establish synapses in the absence of β-Adducin. This suggests that in the adult, separate signals regulate anatomical changes and the actual formation of synapses. Remarkably, both the disassembly of pre-existing synapses and the assembly of new synapses were necessary to enhance learning and memory upon environmental enrichment.

Taken together, the findings provide new insight into the mechanisms that underlie enhanced long-term memory after environmental enrichment. "We have shown that circuit remodeling and synaptogenesis processes in the adult have important roles in learning and memory, and that β-Adducin is critically important to establish new synapses under conditions of enhanced plasticity," concludes Dr. Caroni. "Future studies will aim at elucidating how experience enhances synapse turnover and synaptogenesis, how this potentiates memory processes, and how impairment of these processes may produce memory loss in disease."

Provided by Cell Press