Fewer synapses equal more efficient learning

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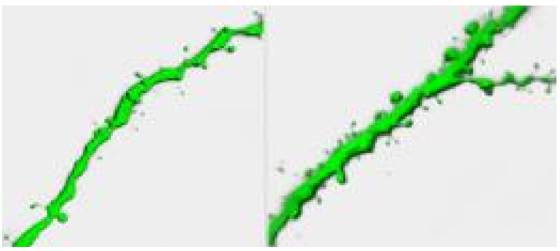

When the amount of SynCAM1 was increased in experiments, the neurons formed a much greater number of synapses (cf.: picture on the right with increased SynCAM1). However, in the learning test, these mice performed worse than animals that lacked the protein. Credit: Valentin Stein

(PhysOrg.com) -- Neurons exchange information via special connections, the synapses. New synapses are constantly being formed, existing synapses are reinforced and redundant synapses are eliminated. Scientists from the Max Planck Institute of Neurobiology and the Yale University studied the adhesion protein SynCAM1, which glues synapses together. When they increased the amount of SynCAM1 in neurons, the number of synapses grew.

This would offer the neurons more routes for transmitting information. However, a behavioral experiment showed that mice without SynCAM1 learned better than animals with normal levels of the protein. These results suggest that both the formation and the elimination of synapses are essential for learning and memory - a finding that could be potentially interesting with regard to certain diseases. (*Neuron*, online publication December 8, 2010)

The brain resembles a large construction site. Tiny protrusions constantly form on the surface of neurons. If such a protrusion meets the corresponding structure of an adjacent cell, the ends of these processes mature into a synapse. A synapse, in turn, makes it possible to transmit information from one cell to another. If an existing synapse is inefficient or is no longer needed, it will be eliminated. Scientists agree that the capacity to learn, forget and remember depends on this constant "remodelling" of the brain.

The functions of a synaptic adhesive

Although synapses are tiny, their function is relatively well understood. However, synaptogenesis - the process of synapses formation - and the molecules involved in this process are far more difficult to study. Several proteins have been identified, which keep both sides of a synapse in position while the connection matures. Scientists from the Max Planck Institute of Neurobiology in Martinsried and the Yale University in New Haven have now been able to shed light on several functions of SynCAM1, one of these proteins.

Alexander Krupp from the Max Planck Institute of Neurobiology explains: "The protein SynCAM1 creates adhesion between the two sides of a synapse, much like glue. This raised the question of whether SynCAM1 affects the number and lifetime of synapses". The scientists addressed these questions by studying genetically modified mice either with increased levels of SynCAM1, or no SynCAM1 at all. The changes observed under the microscope and in behavioral tests surprised the neurobiologists.

The results showed that SynCAM1 is important both for the formation of synapses and their maintenance. When the amount of SynCAM1 was artificially increased, the neurobiologists found a significantly greater number of synapses. If the amount of SynCAM1 was then again reduced through a genetic trick, the additional synapses disappeared. Moreover: the effect was not limited to an early phase of postnatal brain development, the time when most synapses are formed; it could also be observed in the adult brain.

Easier learning without SynCAM1

"One would perhaps think that animals with an increased number of synapses would be able to process or store information better", Valentin Stein, one of the two heads of the study, suggests. In reality, it was quite the opposite - these animals were poor learners. A behavioral test demonstrated that mice without SynCAM1 learned faster and remembered better.

At first glance this finding may seem counterintuitive. It's true that with SynCAM1 more synapses are formed. However, the synapses are also more stable, which makes it harder to eliminate redundant or ineffective connections. The neurobiologists therefore propose that the observed difference in learning capacity can be explained by the elimination of unused synapses. Without SynCAM1, it is easier to break up connections again. "Our results show how important the elimination of synapses is for learning and memory", says Stein. This is a small breakthrough in its own right. In addition, SynCAM1 could play an important part in diseases that involve changes in synapse formation, such as autism. There is also a chance that SynCAM1 could be used in the future for treatment of, for instance, Alzheimer's disease. These are aspects which the scientists will consider in their future research.

More information: Elissa M. Robbins, et al. SynCAM 1 adhesion dynamically regulates synapse number and impacts plasticity and learning, *Neuron*, available online from December 8, 2010.

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