The possible ways to strengthen lost memories

Scientists have shown that having amnesia is no longer a storage problem, but a retrieval problem. There are now possible ways to strengthen lost memories.

Scientists have found an increase of synaptic strength when they began using learning-dependent cell labeling in consolidated memory-engram cells. Induced amnesia, especially via optogenetic control of these neurons, results in memory retrieval, and a specific pattern of connectivity of engram cells may be crucial for memory information storage.

Glossary:

- Protein synthesis inhibition - a substance that stops or slows the growth or proliferation of cells.
- Proliferation - rapid increase in numbers.
- Synaptic potentiation - persistent strengthening of synapses.
- Engram - a ""recording"" of a past painful event not normally accessible to the conscious mind.
- Presynaptic - a nerve cell that releases a transmitter substance into a synapse during transmission of an impulse to a postsynaptic cell (another nerve cell or a muscle cell).
- Dendritic spine density - a small membranous protrusion from a neuron's dendrite.
- Dendrite - extension of a nerve cell where impulses received from other cells at synapses.
- Capacitance - the ability of a body to store an electric charge.
- Ex-vivo - takes place outside an organism.
- Opsins - a light-sensitive receptor protein. In the last five years, scientists have found new approaches to retracing memories in patients with retrograde amnesia involving large groups on neurons, also called “Hub Networks” or engrams.

Neurons are usually connected to 100 other ones, causing few neurons to have high correlations with the local network and making it very hard to find a whole memory. There are rare cases, especially high with patients suffering from PTSD, when a neuron becomes very connected and focused on a certain memory, and this is the one that scientists are trying to find. Our AC-CA - the anterior cingulate of the prefrontal cortex - creates these hub networks and train them to remember, leading to full access of memories.

Scientists having started using optogenetics to retrieve and strengthen - and in some cases turn off - memories. Neuroscientists Tomás J. Ryan and Dheeraj S. Roy, have conducted studies on mice at MIT, and recently finished their third stage of testing. In this article, they explain the basic level of electrical circuits they are using, as the nervous system of any mammal is considered to be highly complex. Every neuron in a mouse's brain is similar to the structure which humans have, and they contain a variety of pump and channel proteins which control the flow of ions across its membrane. In their optogenetic study, Ryan and Roy took the genetic code of certain neurons from subjects that had retrograde amnesia and studied them to add a genetically modified code to it. Their design allowed neurons to make special proteins, called opsins, which respond to light. In the laboratory, Ryan inserted these neurons into 10 mice, but

left the other 10 untouched. Standard to other neurological studies, the researchers put these mice into separate boxes and sent an electrical charge through them.

The neurotransmitters in their brains recorded high levels of glutamate, the chemical behind fear. They were repeatedly put in the box and shocked for 14 days. Before the second round of testing, researchers returned back to the genetically modified neurons and encoded a light sensitive channel, which they got from the proteins of algae, in the experimental group of mice. The anxious mice became calmer when a controlled light was shined into their eyes, as the neurons fired an electrical signal, or “action potential” to the modified hub engrams. These hub engrams withered, as their synapses were blocked using the proteins. When scientists turned the light off, the firing action potentials stopped, but they seemed to have no more anxiety, concluding that these researchers were able to successfully weaken a memory these mice had. When the second round of testing began, the mice whose brains were altered did not recognize the box where they were electrically shocked in. The control group had raised levels of anxiety and tried to find a way out of the box as soon as they were placed in.

In future studies, Ryan and Roy plan to use optogenetics to study how the amygdala sends connections to other parts of the brain, especially the emotion of fear. Projected to be used on humans in the next decades, there are many important factors involved in using optogenetics. What happens when people’s brains can become remote controlled? Although a mouse’s brain can be turned on and off how will humans bioethically use this technology? On what kinds of people will optogenetics be used on? Will it threaten or modify the human brain?