Store and supply: How the brain saves time

December 21 2016

A storage of RNA molecules allows the brain to rapidly react to neuronal stimuli.

Credit: University of Basel, Biozentrum

Neurons in the brain store RNA molecules—DNA gene copies—in order to rapidly react to stimuli. This storage dramatically accelerates the production of proteins. This is one of the reasons why neurons in the brain can adapt quickly during learning processes. The recent results of a research group at the University of Basel's Biozentrum have been published in the current issue of *Neuron*.

Our brain is not only the most complex organ of the human body, it is also the most flexible. But how do neurons in the brain adapt their function in response to stimuli within a very short time frame?

The research group of Prof. Peter Scheiffele at the Biozentrum, University of Basel, has demonstrated that neurons store a reserve stock of RNA molecules, copies of the DNA, in the cell's nucleus. These RNA molecules form the blueprint for new proteins. After a neuronal stimulus, the stored RNA molecules are mobilized in order to adjust the function of the neuron. The process of RNA synthesis (DNA copying) is very slow, especially for large genes. Thus, this newly uncovered mechanism for mobilization of stored RNAs saves time and provides new insights regarding the fast adaptation of the brain during learning processes.

Storage for RNA molecules

The RNA blueprint for proteins is produced by a sophisticated copying process: First, a basic RNA copy of the DNA is generated. From this copy, individual sections, so-called introns, are subsequently cut out to provide a finalized blueprint for the production of a specific protein. This process is called RNA splicing.

So far, it was assumed, that neuronal stimuli trigger the complete process for the production of new RNA molecules. However, the team of Peter Scheiffele now discovered that neurons in the brain pre-manufacture certain immature RNA copies which are only partially spliced. These RNA molecules still contain some introns and are stored in the cell nucleus. Signals induced by neuronal stimulation trigger the splicing completion of the immature RNA molecules.

"The copying process of the DNA, the so-called transcription, is already finalized in advance by the neurons. Hence, mature RNA molecules can be produced within minutes," explains Oriane Mauger, the first author.

Prepared copies save time

For large genes, the production of the initial version of the RNAs itself takes dozens of hours. "The fact that the RNA molecules are already available in an immature form and only need to be completed, shortens the whole process to a few minutes", says Mauger. "Since the transcription is very time-consuming, the storage of RNA means a significant time saving. This enables neurons to quickly adapt their function."

"This study reveals a completely new regulatory mechanism for the brain", declares Scheiffele. "The results provide us with a further explanation of how neurons steer rapid plasticity processes."

More information: *Neuron*, DOI: 10.1016/j.neuron.2016.11.032

Provided by University of Basel