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Brain's connective cells are much more than glue; they also regulate learning and memory

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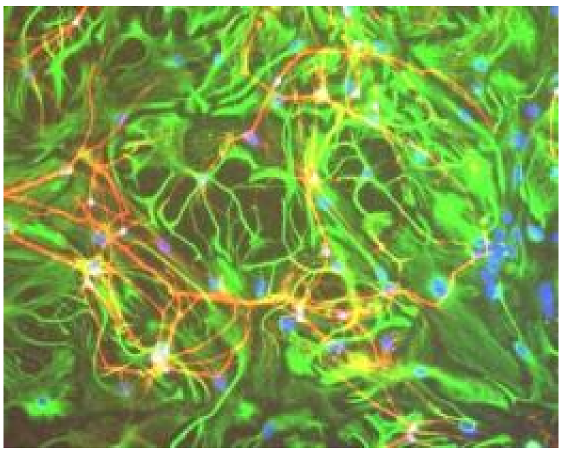

This is a network of neurons (in red) and glia cells (in green) grown in a petri dish. Blue dots are the cells' nuclei. Credit: Pablo Blinder/American Friends of Tel Aviv University (AFTAU)

Glia cells, named for the Greek word for "glue," hold the brain's neurons together and protect the cells that determine our thoughts and behaviors, but scientists have long puzzled over their prominence in the activities of the brain dedicated to learning and memory. Now Tel Aviv University researchers say that glia cells are central to the brain's plasticity — how the brain adapts, learns, and stores information.

According to Ph.D. student Maurizio De Pittà of TAU's Schools of Physics and Astronomy and Electrical Engineering, glia cells do much more than hold the brain together. A mechanism within the glia cells also sorts information for learning purposes, De Pittà says. "Glia cells are like the brain's supervisors. By regulating the synapses, they control the transfer of information between neurons, affecting how the brain processes information and learns."

De Pittà's research, led by his TAU supervisor Prof. Eshel Ben-Jacob, along with Vladislav Volman of The Salk Institute and the University of California at San Diego and Hugues Berry of the Université de Lyon in France, has developed the first computer model that incorporates the influence of glia cells on synaptic information transfer. Detailed in the journal *PLoS Computational Biology*, the model can also be implemented in technologies based on brain networks such as microchips and computer software, Prof. Ben-Jacob says, and aid in research on brain disorders such as Alzheimer's disease and epilepsy.

Regulating the brain's "social network"

The brain is constituted of two main types of cells: neurons and glia. Neurons fire off signals that dictate how we think and behave, using synapses to pass along the message from one neuron to another, explains De Pittà. Scientists theorize that memory and learning are dictated by synaptic activity because they are "plastic," with the ability to adapt to different stimuli.

But Ben-Jacob and colleagues suspected that glia cells were even more central to how the brain works. Glia cells are abundant in the brain's hippocampus and the cortex, the two parts of the brain that have the most control over the brain's ability to process information, learn and memorize. In fact, for every neuron cell, there are two to five glia cells. Taking into account previous experimental data, the researchers were able to build a model that could resolve the puzzle.

The brain is like a social network, says Prof. Ben-Jacob. Messages may originate with the neurons, which use the synapses as their delivery system, but the glia serve as an overall moderator, regulating which messages are sent on and when. These cells can either prompt the transfer of information, or slow activity if the synapses are becoming overactive. This makes the glia cells the guardians of our learning and memory processes, he notes, orchestrating the transmission of information for optimal brain function.

New brain-inspired technologies and therapies

The team's findings could have important implications for a number of brain disorders. Almost all neurodegenerative diseases are glia-related pathologies, Prof. Ben-Jacob notes. In epileptic seizures, for example, the neurons' activity at one brain location propagates and overtakes the normal activity at other locations. This can happen when the glia cells fail to properly regulate synaptic transmission. Alternatively, when brain activity is low, glia cells boost transmissions of information, keeping the connections between neurons "alive."

The model provides a "new view" of how the brain functions. While the study was in press, two experimental works appeared that supported the model's predictions. "A growing number of scientists are starting to recognize the fact that you need the glia to perform tasks that neurons alone can't accomplish in an efficient way," says De Pittà. The model will provide a new tool to begin revising the theories of computational neuroscience and lead to more realistic brain-inspired algorithms and microchips, which are designed to mimic neuronal networks.

Provided by Tel Aviv University

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