Neurons critical for learning divided into two subpopulations with different functions

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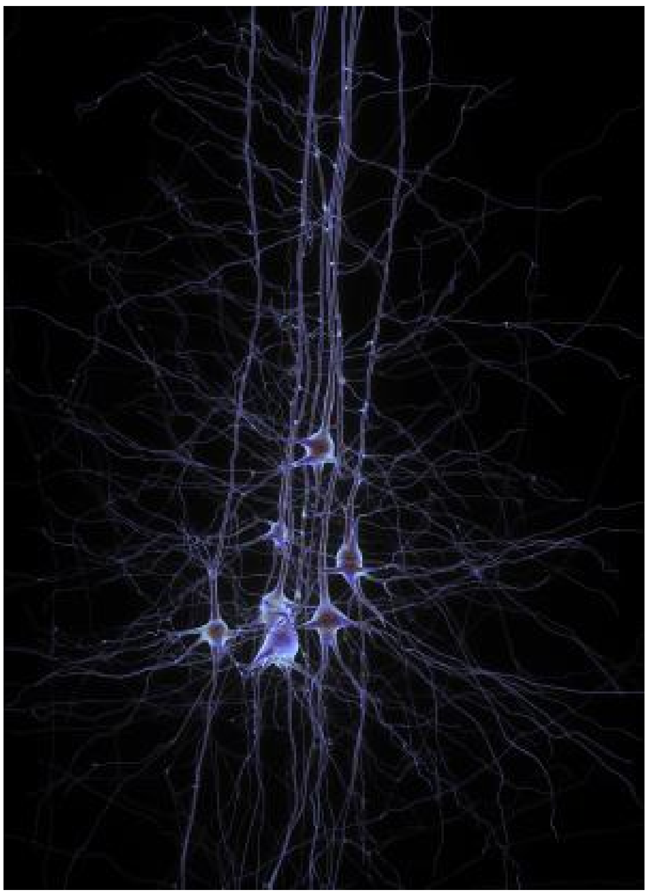

This is a group of neurons. Credit: EPFL/Human Brain Project

Neurobiologists at the Friedrich Miescher Institute for Biomedical Research (FMI) have shown that neurons critical for learning can be divided into two subpopulations with different functions. Almost as if learning processes in the brain mimicked machine learning, one subpopulation is responsible for collecting a broad range of potentially relevant information, while the second subsequently helps to consolidate a successful strategy. This is the first evidence of how neuron networks are adapted to facilitate learning.

Self-driving cars, smartphones that can answer our questions and computers that can defeat world chess champions – we are increasingly surrounded by intelligent machines capable of dealing with a wide variety of situations. When machines "learn", they follow clearly defined strategies specified by programmers. At the start of the learning process, they try out many different paths and test various tactics. As soon as they are close to a solution, however, their approach changes and they focus on refining a procedure that has proved successful. But while the processes and algorithms involved in machine learning are reasonably clear, little is understood about the networks of neurons in the brain which underlie different learning strategies in humans.

In a study published in *Neuron*, Pico Caroni – a Group Leader at the FMI and Professor at Basel University – and Flavio Donato and Ananya Chowdhury – both members of Caroni's research group – demonstrate that the tactics employed by the brain are akin to those used in machine learning.

The scientists show that a type of neuron in the hippocampus previously thought to be homogeneous actually consists of two distinct subtypes. These basket cell subpopulations – which are generated at different stages of brain development – differ in their connectivity to other hippocampal neurons and, most importantly, exhibit distinct regulation and roles in learning.

Networks of basket cells generated at a later stage in brain development are reconfigured by inhibitory neurons in trial-and-error learning, when the broadest possible range of information needs to be acquired; they are regulated through inhibition. In contrast, excitatory connections are formed to early-born basket cell networks when what has been learned needs to be refined and consolidated; they are regulated through excitation. What would this mean in terms of learning a behavior such as swimming the front crawl? The late-born basket cells support learning when we try out various types of kick – from poorly coordinated leg-waving to an alternating flutter. The early-born basket cells subsequently help us to apply the leg kick consistently and to perfect it by optimizing our leg extension, hip movement and foot position.

Caroni comments: "Learning in the brain thus employs the tactics we're familiar with from machine learning. There are clearly defined structures for the wide-ranging initial steps – the collection of information – and other structures to refine the successful strategy. This is an important step forward in our understanding of learning and memory, and it also gives us insights which could be valuable for disorders such as autism or schizophrenia."

More information: Donato F, Chowdhury A, Lahr M, Caroni P (2015) "Early- and late-born parvalbumin basket cell subpopulations exhibiting distinct regulation and roles in learning." *Neuron*, 85:770-86. www.sciencedirect.com/science/ … ii/S0896627315000379

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