

Scientists discover new mechanism of how brain networks form

December 26 2016



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Scientists have discovered that networks of inhibitory brain cells or neurons develop through a mechanism opposite to the one followed by excitatory networks. Excitatory neurons sculpt and refine maps of the external world throughout development and experience, while inhibitory

neurons form maps that become broader with maturation. This discovery adds a new piece to the puzzle of how the brain organizes and processes information. Knowing how the normal brain works is an important step toward understanding the nature of neurological conditions and opens the possibility of finding treatments in the future. The results appear in *Nature Neuroscience*.

"The [brain](#) represents the external world as specific maps of activity created by networks of neurons," said senior author Dr. Benjamin Arenkiel, associate professor of molecular and human genetics and of neuroscience at Baylor College of Medicine, who studies neural maps in the olfactory system of the laboratory mouse. "Most of these maps have been studied in the excitatory circuits of the brain because excitatory neurons in the cortex outnumber [inhibitory neurons](#)."

The studies of excitatory maps have revealed that they begin as a diffuse and overlapping [network](#) of cells. "With time," said Arenkiel, "experience sculpts this diffuse pattern of activity into better defined areas, such that individual mouse whiskers, for instance, are represented by discrete segments of the brain cortex. This progression from a diffuse to a refined pattern occurs in many areas of the brain."

In addition to excitatory networks, the brain has inhibitory networks that also respond to external stimuli and regulate the activity of neural networks. How the inhibitory networks develop, however, has remained a mystery.

In this study, Arenkiel and colleagues studied the development of maps of inhibitory neurons in the olfactory system of the mouse.

Studying inhibitory brain networks of the mouse sense of smell

"Unlike sight, hearing or other senses, the sense of smell in the mouse detects discrete scents from a large array of molecules," said Arenkiel, who is also a McNair Scholar at Baylor.

Mice can detect a vast number of scents thanks in part to a complex network of inhibitory neurons. Inhibitory neurons are the most abundant type of cells in the mouse brain area dedicated to process scent. To support this network, newly born inhibitory neurons are continually added and integrated into the circuits.

Arenkiel and colleagues followed the paths of these newly added neurons in time to determine how inhibitory circuits develop. First, they genetically labeled the cells so they would glow when the neurons were active. Then, they offered individual scents to the mice and visually recorded through a microscope the areas or networks of the brain that glowed for each scent the live, anesthetized animal smelled. The scientists repeated the experiment several times to determine how the networks changed as the animal learned to identify each scent.

Surprising result

The scientists expected that inhibitory networks would mature in a way similar to that of excitatory networks. That is, the more the animal experienced a scent, the better defined the networks of activity would become. Surprisingly, the scientists discovered that the inhibitory brain circuits of the mouse sense of smell develop in a manner opposite to the excitatory circuits. Instead of becoming narrowly defined areas, the inhibitory circuits become broader. Thanks to this new finding scientists now better understand how the brain organizes and processes information.

Arenkiel and colleagues think that the inhibitory networks work hand-in-hand with the excitatory networks. They propose that the interaction

between excitatory and inhibitory networks could be compared to a network of roads (excitatory networks) whose traffic is regulated by a network of traffic lights (inhibitory networks). The scientists suggest that the formation of useful neural maps depends on inhibitory networks driving the refinement of excitatory networks, and that this new information will be essential towards developing new approaches for repairing brain tissue.

More information: Developmental broadening of inhibitory sensory maps, *Nature Neuroscience*, [nature.com/articles/doi:10.1038/nn.4467](https://doi.org/10.1038/nn.4467)

Provided by Baylor College of Medicine

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