Researcher observes active role of auditory neurons

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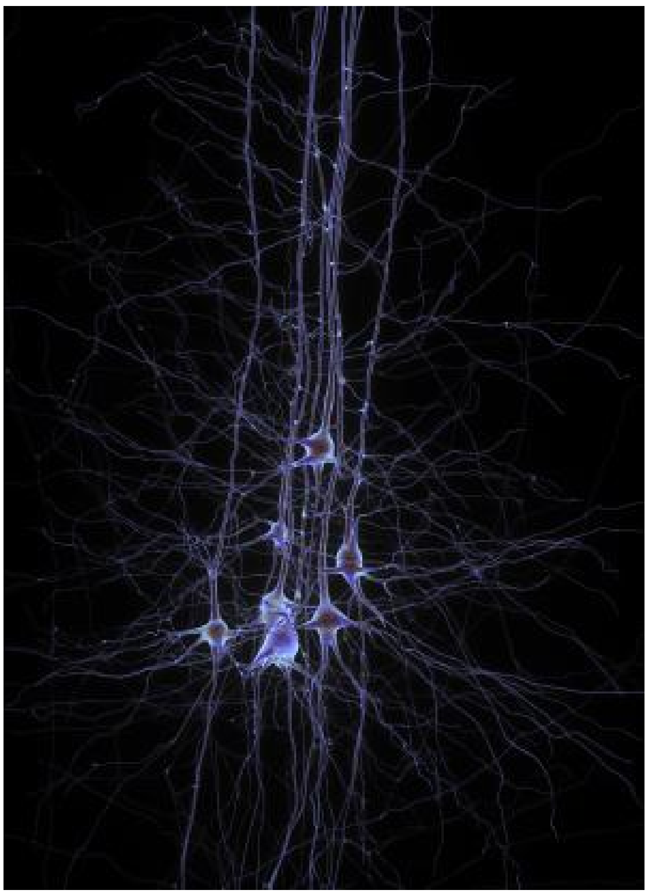

This is a group of neurons. Credit: EPFL/Human Brain Project

Cells in the brainstem that underlie sound localization, compare signals at the two ears and can pause while doing so. This was shown by researchers at the Laboratory for Auditory Neurophysiology in Leuven, who were the first to obtain both in- and outgoing electrical signals of these cells in Mongolian gerbils.

How do we know where in space a sound source is located? Our brain computes its location by computing differences between the signals that reach our two ears. Professor Philip Joris of the Laboratory of Auditory Neurophysiology: "The sound of a source to your right reaches both ears, but the sound at your right ear arrives a tiny bit earlier and is slightly more intense than the sound at your left ear. Our brain computes and interprets such differences in intensity and arrival time between the two ears. Humans are particularly sensitive to the time differences: we can detect differences 100 times smaller than a thousandth of a second."

Sound stimulates our snail-shaped cochlea in the inner ear, which transmits electrical pulses via the auditory nerve to cells in the brainstem, which in turn compare the sounds at the two ears. "The brainstem contains an array of hyper-specialized cells which each prefer a certain time difference. For example, one cell may respond to sounds right in front of us which reach both ears at the same time, while another cell may respond to sounds to our side, which reach the ears with a time difference of half a millisecond. Depending on which cell is active, we know where the sound source is in space. But how cells compute this time difference has been a matter of conjecture because it is exceedingly difficult to study these cells in the brainstem."

Up until now, it was thought that these cells function as coincidence detectors. Imagine again a sound on your right: your right ear receives the sound first, and the left ear a little later. It was generally thought that somewhere along the path from ear to brainstem cells, this time difference was compensated for, e.g. by slowing the signal from the right ear, so that the signals from the two ears would arrive coincidentally at a brainstem cell, which would then fire off an electrical pulse.

During his doctoral research, Dr. Tom Franken managed, for the first time, to test this hypothesis by inserting a fine electrode into cells of the brainstem to record both their in- and outgoing signals. He observed that, when stimulated with their preferred time difference, the incoming signals were not necessarily coincident. The cells could receive a signal from one side, a little later from the other side, and only then fire an electrical pulse. "These cells pause and remember being activated by one ear, and can wait for the signals coming from the other ear before firing off an electrical pulse. In other words, these cells have a more active role in time comparison than was thought."

This fundamental research is important for the development of hearing aids and cochlear implants. According to Joris: "These auditory prostheses brought a revolution for patients with hearing impairments, but they are far from perfect. Patients experience severe difficulties in localizing sound sources and in filtering out background sounds, tasks in which the detection of tiny time differences between the ears is a key element. This research on gerbils helps us understand how the brain accomplishes these tasks."

More information: "In vivo coincidence detection in mammalian sound localization generates phase delays," *Nature Neuroscience*: www.nature.com/neuro/journal/v … n3/full/nn.3948.html.

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