Neurons Tap Out a Code That May Help Locate Sounds

The brain is a history of past experiences, as well as a computer, weighing data and plotting our next move. But it’s also an atlas: The cerebral cortex contains a collection of neuronal maps showing where sensations come from. If you cut your left index finger, for example, your brain registers the location of the hurt by firing neurons in the part of the map of skin surfaces corresponding to that finger. If someone throws you a ball, you know where to reach out to catch it, because neurons in the appropriate part of the brain’s visual map register the ball’s approach.

The brain is also skilled at pinpointing sounds, but so far researchers looking for a spatial map in the auditory cortex—the brain area responsible for sound perception—have come up empty-handed, prompting speculation that the brain may have other tricks for registering the location of sounds. Now, John Middlebrooks and his colleagues at the University of Florida Brain Institute may have confirmed those speculations. On page 842, they report their finding that neurons in the auditory cortex convey information about a sound’s location not by the neurons’ spatial arrangement, but by their temporal pattern of firing. In effect, the brain may be tapping out the location of a sound in a neuronal equivalent of Morse code. That possibility is “what makes the paper interesting,” says auditory neuroscientist Eric Young of Johns Hopkins University in Baltimore.

“The higher auditory system, where sound perception probably happens, doesn’t seem to vary reliably with sound location,” Young says. “There is no a priori reason why it must store information in the form of a map. Although he doesn’t think his finding settles once and for all the issue of how sound location is coded, Middlebrooks says it would be logical for the auditory sense to record information chronologically while the visual system does so spatially. Information enters the visual system in map form, as an image projected on the retina; the brain merely preserves the map as it passes the information along.

But in the auditory system, the ears are mapping frequency, not location, and you have got to somehow take that information…and compute sound location,” says Middlebrooks. Once the brain has made that computation, there is no a priori reason why it must store the information in the form of a map.

Despite that reasoning, the jury is still out on whether the Middlebrooks group has indeed found the auditory system’s substitute for a spatial map. “The temporal pattern of firing of neurons changes as a function of sound location, so these patterns may constitute codes for sound location,” concedes Caltech’s Konishi. But, he adds, existence of the information is not enough. To settle the question, researchers must establish that the animal uses it. And that will require finding neurons that respond to the patterns, or experimental ways of altering the firing pattern to observe changes in the animal’s response to sound. Those experiments are difficult, but without them the research community is left with the existential question of whether, when the auditory neurons tap out their neuronal Morse code, anyone is listening.

—Marcia Barinaga