Researchers pinpoint brain mechanisms that make the auditory system sensitive to behaviorally relevant sounds

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(Medical Xpress)—How do we hear? More specifically, how does the auditory center of the brain discern important sounds – such as communication from members of the same species – from relatively irrelevant background noise? The answer depends on the regulation of sound by specific neurons in the auditory cortex of the brain, but the precise mechanisms of those neurons have remained unclear. Now, a new study from the Perelman School of Medicine at the University of Pennsylvania has isolated how neurons in the rat's primary auditory cortex (A1) preferentially respond to natural vocalizations from other rats over intentionally modified vocalizations (background sounds). A computational model developed by the study authors, which successfully predicted neuronal responses to other new sounds, explained the basis for this preference.

The research is published in the *Journal of Neurophysiology*.

Rats communicate with each other mostly through ultrasonic vocalizations (USVs) beyond the range of human hearing. Although the existence of these USV conversations has been known for decades, "the acoustic richness of them has only been discovered in the last few years," said senior study author Maria N. Geffen, PhD, assistant professor of Otorhinolaryngology: Head and Neck Surgery at Penn. That acoustical complexity raises questions as to how the animal brain recognizes and responds to the USVs. "We set out to characterize the

responses of neurons to USVs and to come up with a model that would explain the mechanism that makes these neurons preferentially responsive to these relevant sounds."

Geffen and her colleagues obtained recordings of USVs from two rats kept together in a cage, then played the recordings to a separate group of male rats, while their neuronal responses were acquired and recorded. The researchers also used USV recordings that were modified in several ways, such as having background sounds filtered out and being played backwards and at different speeds to mimic unimportant background noise. "We found that neurons in the auditory cortex respond strongly and selectively to the original ultrasonic vocalizations and not the transformed versions we created," says Geffen.

Using the data collected on the responses of A1 neurons to various USVs, the researchers developed a computational model that could predict the activity of an individual neuron based on the pitch and duration of the USV. Geffen observes that "the details of their responses could be predicted with high accuracy." It was possible to determine which aspects of the acoustic input best drove individual neurons. Remarkably, it turned out that the acoustic parameters that worked best in driving the neuronal responses corresponded to the statistics of the natural vocalizations rats produce.

The work makes clear for the first time, says Geffen, "the mechanisms of how the auditory system picks out behaviorally relevant sounds, such as same species communication signals, and processes them more effectively than less relevant sounds. This information is fundamental in understanding how sound perception helps animals survive. We conclude that neurons in the auditory cortex are specialized for processing and efficiently responding to natural and behaviorally relevant sounds."

More information: jn.physiology.org/content/109/7/1912.abstract

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