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AUDITORY SYSTEM

Hear, here

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When we hear someone call our name, and then turn towards them, we are relying on the brain's ability to calculate the source of a sound, mainly on the basis of the difference between the times at which the sound reached the two ears (the interaural time difference, or ITD). However, our traditional model of how this is achieved might not apply to mammals — or, at least, not to the Mongolian gerbil, which was investigated by Brand *et al*. in a recent study.

The existing model for calculating position from ITDs, which is supported by studies in birds, uses an array of neurons that receive inputs from the two ears along 'delay lines' of different lengths. The neurons fire most strongly when the two inputs arrive at the same time, which means that each of these neurons is tuned to a particular ITD. This simple and elegant system produces a topographic map of sound positions.

Brand *et al*. recorded neuronal activity in the medial superior olive (MSO) of the gerbil brain. Neurons in the MSO are tuned to specific ITDs and receive inputs from both ears, but the new findings suggest that they do not use a simple delay-line system to calculate sound position. Surprisingly, the MSO neurons fired most strongly at large ITDs that — because of the small size of the gerbil's head — could never occur naturally. The tuning of the neurons was arranged so that the steepest part of the tuning curve lay over the natural range of ITDs, so that biologically relevant ITDs would produce large differences in firing rate. They also showed different ITD tuning depending on their preferred frequencies — neurons that responded to high frequencies fired most strongly at short ITDs, whereas low-frequency neurons were tuned to longer ITDs.

It seems that each neuronal 'frequency array' responds to a small range of ITDs, and that the location of a sound might be encoded by the pattern of activity across the whole MSO, rather than the place of maximal firing in a topographical map. But Brand *et al*. also found that inhibitory inputs, which are not involved in the traditional model, were crucial for generating the ITD sensitivity of the MSO neurons. When inhibitory transmission was blocked, the MSO neurons all fired maximally at an ITD of around 0 μs. The authors conclude that precisely timed inhibition is needed to generate the range of ITD sensitivities observed in the MSO.

It remains to be seen whether this mechanism is common to all mammals, or whether it is specific to those, like gerbils, that have very small heads and therefore experience very small ITDs. But it is clear that there is more to sound localization than meets the eye — or ear.

References and links

ORIGINAL RESEARCH PAPER
Brand, A. *et al*. Precise inhibition is essential for microsecond interaural time difference coding. *Nature* **417**, 543-547 (2002) | Article | PubMed |
FURTHER READING
Pollack, G. D. Model hearing. *Nature* **417**, 502-503 (2002) | Article | PubMed |
