**Hearing Phantoms. Focus on “Spectral Cues Explain Illusory Elevation Effects With Stereo Sounds in Cats”**

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The illusion of stereophonic sound is one that is experienced daily by many listeners. When faced with two loudspeakers or headphones playing, say, a selection of orchestral music, a listener might hear the sound of violins localized near the left speaker, the cellos near the right speaker, and the trumpets playing somewhere near the middle, where there is no speaker at all. In the parlance of psychoacousticians, this phenomenon is referred as “summing localization” (Litovsky et al. 1999). In the conditions best known in the laboratory, identical sounds are presented from two sources in the horizontal plane with a brief inter-stimulus delay (ISD) between the onsets of the two sounds. When the ISD is near zero, the listener reports an auditory image centered between the two sources. As the ISD is varied over the scale of a few hundred microseconds, the image moves progressively toward the leading source. When the ISD exceeds about 700 μs, the listener hears a single source located at the position of the leading source. Summing localization has been well characterized in humans, and a physiological correlate of summing localization has been demonstrated in the auditory cortex of cats (Mickey and Middlebrooks 2001). In this issue, Tollin and Yin (2003) explore the phenomenon behaviorally in cats. They confirm in cats the phenomenon that is well known in humans in the horizontal plane, and they demonstrate that summing localization also occurs in the vertical midline plane. Moreover, they demonstrate a rather unexpected vertical localization illusion that is produced by sound sources on the horizon. The latter illusion is explained well by a model that attributes vertical localization to recognition of spectral shape cues.

The most novel observation in the Tollin and Yin study is that, when cats were presented with simultaneous sounds located in the horizontal plane (i.e., 0° elevation), they oriented to a location on the vertical midline about 8° above the horizontal plane. The midline response in the horizontal dimension is precisely what is predicted by any model of horizontal localization based on interaural differences between the sounds at the two ears. It is the vertical response that is remarkable. Most present-day models of elevation in the vertical dimension assume that vertical localization cues result from elevation-dependent filtering of sounds by the listener’s external ears. Based on such a model, one would assume that the cats were somehow hearing sound spectra that they associated with an elevated source. That assumption was validated by a careful analysis by Tollin and Yin. They used measurements of the filter functions of a cat’s external ears and inferred the sounds that would have resulted from the addition of two sounds arriving at each eardrum. The spectra resulting from the interaction of two simultaneous sound sources located in the horizontal plane were marked by a conspicuous spectral notch centered near 12 kHz. Examination of the cats’ filter functions for single sounds showed that the filters for 0° elevation showed a notch centered near 11 kHz, whereas filter functions for elevations near 8° showed a notch near 12 kHz. This result is consistent with a popular model in which vertical localization is attributed entirely to identification of the frequency of a spectral notch (Rice et al. 1992), although the result cannot exclude the possibility that the cats were basing their location judgments on some other feature of the spectrum.

The beauty of Tollin and Yin’s observation of a vertical localization illusion in cats is that it provides us with a useful animal model of vertical localization. A previous study has demonstrated in the cat’s auditory cortex a correlate of a vertical localization illusion (Xu et al., 1999), but that study used a narrowband sound that probed vertical localization mechanisms rather selectively. The new result opens a door to physiological study of vertical localization of broadband sounds that will permit us to examine the neural substrates that underlie the computations that listeners perform routinely to localize everyday environmental and communication sounds.

**REFERENCES**


