This Week in The Journal

How Finches Distinguish Calls from Noise

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(see pages 1015–1027)

Animal vocalizations often elicit vocal responses. Zebra finches, for example, respond to calls of distant finches with their own distance call. How do they recognize a sound as a call they should respond to? Two features of vocalizations likely help animals distinguish them from other sounds. First, in most vocalizations, some frequencies (pitches) are more prominent than others, imparting a tonal quality. This feature is called high spectral contrast. Second, the prominent frequencies in vocalizations tend to be harmonics, that is, integer multiples of a fundamental frequency. Because harmonicity and high spectral contrast co-occur, it is unclear which of these features animals rely on to distinguish conspecific vocalizations. To address this, So et al. synthesized calls that differed in spectral contrast and/or harmonicity using recorded calls of female zebra finches as templates. They then examined the responses of male finches to natural and synthetic calls, tones, and noise.

Finches reliably produced distance calls in response to natural calls, but not to noise or pure tones. They responded more often to synthetic calls than to noise, but only if the synthetic call had distinct frequency components, that is, high spectral contrast. For songs with sufficiently high spectral contrast, however, shifting frequency components to create inharmonic calls had no effect on response probability.

To elucidate the neural bases for this behavioral selectivity, the authors asked whether neurons in zebra finch auditory cortex are selective for calls with high spectral contrast and/or harmonicity. They recorded from neurons in the superficial, intermediate (thalamorecipient), and deep (output) layers of auditory cortex as birds listened to the calls used in behavioral experiments. Only in deep layers did neuronal responses differ depending on calls' spectral contrast: neurons responded more often

and with greater spike frequency to high-resolution than to low-resolution calls. Responses to spectral ripples in which spectral contrast and harmonicity were varied independently indicated that these deep-layer neurons were sensitive only to spectral contrast.

These data suggest that sensitivity to the spectral contrast of sounds arises in the output layers of auditory cortex in zebra finches. Given that such deep-layer auditory cortical neurons project to brainstem areas surrounding vocal control centers, these spectral-contrast-sensitive neurons are likely major drivers of response calls.

Male zebra finches respond to calls with high spectral contrast. See So et al. for details. Image by Jim Bendon from Karratha, Australia; cutie_1 Uploaded by snowmanradio, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=20504641>.

Taste Encoding in Human Gustatory Cortex

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(see pages 1042–1052)

The primary cortical area for taste is located in the insula. How taste representations are organized there remains unsettled, however. Calcium imaging in mice suggested that taste representations are organized topographically, with each taste represented in a distinct region of the insula; but neuroimaging studies have

suggested that if such topographical organization exists in humans, the map differs from person to person. Other studies suggest that tastes, like odors, are represented by ensembles distributed throughout primary gustatory cortex, with no area devoted to a single taste. The difficulty in defining taste representations results from multiple factors, including the low resolution of fMRI and the multidimensional nature of taste stimuli, which activate somatosensory as well as taste receptors, often evoke orofacial motor responses, and are innately attractive (sweet and umami), aversive (bitter and sour), or both, depending on concentration (salty). All these characteristics may be represented in gustatory cortex, complicating efforts to determine which ensembles encode taste per se.

To investigate taste coding in the human brain, Avery et al. used ultra-high-resolution fMRI (1.2 mm³ voxel size) with high magnetic field strength to record responses to sweet, salty, sour, and tasteless solutions. Subjects rated the salty and sour stimuli as similarly pleasant, but less pleasant than the sweet stimulus. As expected, all tastes evoked more activity than the tasteless liquid in the insula, as well as in somatosensory and motor areas and the gustatory thalamus. At the subject level, some voxels were selectively activated by particular tastes, but the patterns of taste-selective voxels were not consistent across days or across subjects. Furthermore, at the group level, no voxels showed a significant preference for any taste. In addition, no region appeared to distinguish tastes based on rated pleasantness. Nevertheless, multivariate pattern analysis identified activation patterns that discriminated the three tastes, not only in the insula, but also in sensory and valence-related areas, including orbitofrontal cortex, amygdala, and dorsal striatum. These data suggest that neither taste nor pleasantness is topographically represented in human gustatory cortex. Instead, taste appears to be represented by distributed populations of neurons.

This Week in The Journal was written by Teresa Esch, Ph.D.
<https://doi.org/10.1523/JNEUROSCI.twij.40.5.2020>.