

Functional segregation of ferret auditory cortex probed with natural and model-matched sounds

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ABSTRACT

Sensory systems are adapted to extract and encode relevant features from natural stimuli despite their complexity. However, how this information is organized spatially in the brain remains poorly understood. Here, we combined a novel computational approach contrasting the brain responses to synthetic sounds matching either part or all of natural acoustic features with a cutting-edge high-resolution neuroimaging technique, functional UltraSound. Using this unique combination, we set out to explore functional cortical domains at the basis of natural sound processing in head-fixed ferrets.

We first mapped the classical tonotopy of ferret auditory cortex, highlighting core and belt regions. We then used a computational approach to confront auditory cortex responses with acoustic models of different complexity levels, based on cochlear and spectro-temporal modulation filters. We contrasted brain responses to original natural sounds and to synthetic sounds matching either part or all low-level original acoustic features. Doing so, we were able to reveal functionally distinct subregions in auditory cortex, based on either temporal or spectral features.

We compared fMRI responses in humans and fUS recordings in ferrets to speech/music and their model-matched counterparts. Interestingly, we observed speech selective regions in the ferret auditory cortex. However, and contrary to the real speech- and music-selective response components observed in human non-primary regions (Norman-Haigneré, 2015/2018), model-matched stimuli evoked similar responses in the ferret. Because speech and music are not ecologically relevant sounds for ferrets, we wanted to test whether ferret auditory cortex could discriminate between ferret pup vocalizations and their corresponding model-matched versions. We observed differences in animal motor activity for original vocalizations compared to model-matched stimuli, indicating that the animal is able to perceptually discriminate these two classes of sounds. We are currently investigating the neural correlates of this capability in auditory cortex responses. Follow-up work will test if ferrets can innately discriminate original vs synthetic speech, or whether perceptual learning is necessary to do so.

Keywords: natural sounds, model-matched sounds, functional UltraSound imaging

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