Sparse Representation of Sounds in the Unanesthetized Auditory Cortex

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How do neuronal populations in the auditory cortex represent acoustic stimuli? Although sound-evoked neural responses in the anesthetized auditory cortex are mainly transient, recent experiments in the unanesthetized preparation have emphasized subpopulations with other response properties. To quantify the relative contributions of these different subpopulations in the awake preparation, we have estimated the representation of sounds across the neuronal population using a representative ensemble of stimuli.

We used cell-attached recording with a glass electrode, a method for which single unit isolation does not depend on neuronal activity, to quantify the fraction of neurons engaged by acoustic stimuli (tones, frequency modulated sweeps, white-noise bursts, and natural stimuli) in the primary auditory cortex of awake head-fixed rats. We find that the population response is sparse, with stimuli typically eliciting high firing rates (>20 spikes/second) in less than 5% of neurons at any instant. Some neurons had very low spontaneous firing rates (<0.01 spikes/second). At the other extreme, some neurons had driven rates in excess of 50 spikes/second. Interestingly, the overall population response was well described by a lognormal distribution, rather than the exponential distribution that is often reported.

Our results represent the first quantitative evidence for sparse representations of sounds in the unanesthetized auditory cortex. Our results are compatible with a model in which most neurons are silent much of the time, and in which representations are composed of small dynamic subsets of highly active neurons.

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