Ph.D'S Dissertation Defense

Organization of Spectrotemporal Preferences in the Inferior Colliculus and its Role for Encoding Natural Sounds.

By

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Abstract:

A central hypothesis in sensory coding suggests that auditory neurons are optimized to represent sounds experienced by an organism in natural environments. In order to characterize the relationship between physical characteristics of natural sounds and their neural representation, we first quantified spectral and temporal modulations of a large ensemble of natural sounds that included animal vocalizations, human speech and environmental background sounds. We examined the neural responses to these sound cues in the central nucleus of the inferior colliculus (CNIC). We will demonstrate that neural filtering properties in the CNIC are optimized for encoding natural sounds in a manner that maximize power transfer across the ensemble of neurons.

We next tested whether spectro-temporal sound preferences are hierarchically organized within the CNIC neural ensemble. A distinct laminar organization for sound frequency (tonotopy; Merzenich and Reid 1974; Semple and Aitkins 1979) and temporal modulation preferences (Schreiner and Langner 1988) has been previously demonstrated within the CNIC lamina; yet it is not clear whether higher-level spectral and temporal sound cues are systematically represented within the three-dimensional volume of the CNIC. To test this hypothesis, we recorded neural responses to dynamic moving ripple sounds (Escabi and Schreiner 2002) with a 16 channel acute recording probe placed orthogonal to the isofrequency lamina of the CNIC. The probe spatial position was referenced to a three-dimensional coordinate system using a stereotaxic frame assembly. Each penetration was separated by 300µm along the laminar plane. This procedure allowed us to fully sample the three-dimensional volume of the CNIC. Spectrotemporal receptive fields (STRF) were computed from the neural responses using reverse correlation procedures. We will show that the reconstruction of the spectro-temporal preferences along and across the isofrequency lamina exhibits a systematic organization for important acoustic parameters. Such a distributed organization has implications for how spectral and temporal features in natural sounds are encoded in the CNIC.

In summary, these results provide evidence for an orderly neural representation of spectral and temporal sound cues that is consistent with efficiency coding principles