Sensitivity, selectivity and invariance in the auditory system.

Andrei S. Kozlov, Department of Psychology, UCSD

In this talk, I will describe two problems faced by the auditory system at two different levels of organization. The first problem arises in the cochlea during the conversion of a sound into an electrical signal. Although von Helmholtz recognized in the 19th Century that the ear contains an array of resonators like a piano that contains an array of strings tuned to particular frequencies, viscous friction in the liquid that fills the inner ear prohibits any passive resonance. Like the strings of a piano in honey, the ear's mechanotransduction elements are over-damped and will not resonate unless several conditions are satisfied. I will demonstrate that the balance of the viscous, inertial, and elastic forces in the ear's mechanotransduction organelle, the hair bundle, minimizes viscous friction and thus makes the sensitive hearing possible. The solution to this problem[1] reflects general principles of fluid-structure interaction that apply to other biological and non-biological systems at small Reynolds numbers.

The second problem relates to how the auditory system forms selective and invariant representations of natural communication signals. Classical models[2] of pattern recognition, developed in the visual system, achieve selectivity and invariance by assigning to individual cortical neurons either a computation equivalent to logical "AND", or one equivalent to logical "OR". I will demonstrate in the auditory system of a songbird using natural stimuli that individual neurons perform *both* operations. Unlike the fixed mapping between neurons and computations in the models of visual object recognition, auditory neurons' input-output logic is flexible, stimulus-dependent and influenced by sensory adaptation.

---

[1] Kozlov, A. S. et al. (2011). Forces between clustered stereocilia minimize friction in the ear on a subnanometre scale. *Nature* **474**, 376–379.

[2] Riesenhuber, M. and T. Poggio (1999). Hierarchical models of object recognition in cortex. *Nat Neurosci*, **2**(11): 1019–25.