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We can see how you hear

～Biological measures for auditory experience～

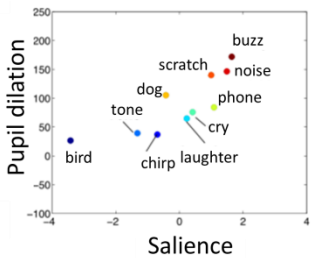
Abstract

Are you sure you can tell what another person is perceiving when they are listening to something? Our research group has been exploring various biological responses to sounds in order to develop objective methods to estimate how various listeners perceive sound, without requiring subjective reports. Our new methods permit us to examine the questions of "How does a person interpret sound?", "To what extent a person is paying attention to a sound?", and "Is a person really not hearing a sound or just pretending not to hear?" We also probe functions of the inner ear in order to study how the ear protects itself from damage by loud sounds. We hope that our new findings and methods will lead to new technologies to customize sounds for individuals to perceive sound more easily and pleasantly.

Eye responses

"Ear-catching" sounds

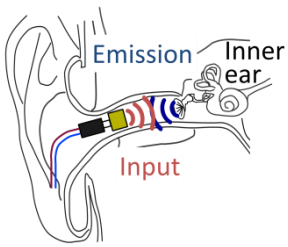
We found that the **diameter of the pupil**, which is known to reflect activities of the locus coeruleus-norepinephrine (LC-NE) system of the brain that is involved in attention and alertness, increases when salient (or ear-catching) sounds are presented.



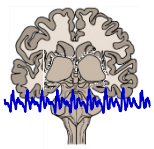
Sounds emitted by the ear itself

Protection from loud noise

We used **oto-acoustic emissions** to probe the ear's functions that protect sensory cells from damages by loud sounds. We found that the efficiency of the protection mechanism can predict the amount of noise-induced hearing loss.

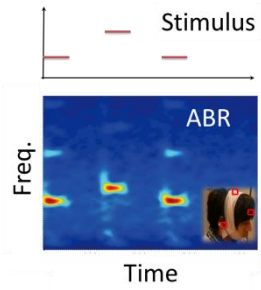


Brainwaves



Interpretation of ambiguous sounds

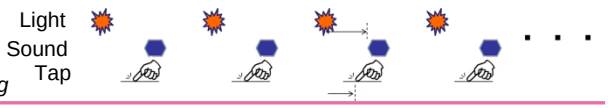
It is possible that one instance of the same sound can be interpreted differently from another instance of the same sound. We measured **auditory brainstem responses** and found that the brainstem, which is considered to be an early processing stage, is involved in this variation in interpretation.



Finger tapping

"Feigning-proof" hearing test

Synchronous **finger-tapping** to rhythmic light flashes is disturbed when asynchronous sounds are simultaneously presented with the rhythmic ones. Making use of this phenomenon, we devised a novel objective measure of the auditory detection threshold.



Light-synchronized tapping

Related works

[1] S. Furukawa, H. I. Liao, S. Kidani, M. Yoneya, M. Kashino, "Evaluating the salience of auditory events through eyes, " in *Proc. 7th Forum Acusticum*, 2014.

[2] S. Otsuka, M. Tsuzaki, J. Sonoda, S. Furukawa, "Effects of short-duration instrument practice on the auditory peripheral functions of violin players," 38th ARO Midwinter Meeting, 2015.

[3] S. Furukawa, K. Onikura, S. Kidani, H. Liao, M. Kato, N. Kitagawa,, " An objective measure of auditory detection threshold based on a light-synchronized tapping task," 38th ARO Midwinter Meeting, 2015.

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