260-2017-04-10-audition

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Prelude

Today's Topics

- Auditory processing

Auditory processing

- Goals
  - What's out there
  - Where is it?
- Sound
  - What is it?
- How the brain processes sound

What is sound?

- Sound = pressure waves
- Vary in frequency, amplitude
- Requires a physical medium
- Works in the dark, over long distances, out of sight lines

Alien

http://www.imamuseum.org/blog/wp-content/uploads/2012/07/movieposter-400x599.png

Detecting sound

Outer ear

- *Pinnae*
  - Filter sound
  - Channel sound
- *Ear canal*
  - Resonates to frequencies in speech

Length, diameter determine resonant frequency

Middle ear

Middle ear

- *Tympanic membrane*

- *Ossicles*
  - Malleus ('hammer')
  - Incus ('anvil')
  - Stapes ('stirrup')
- *Middle Ear Muscles*
  - Stapedius & tensor tympani

Where are we

Function of ossicles, stapedius

- Ossicles amplify
  - Air thinner than cochlear fluid
- Muscles dampen
  - *Acoustic reflex* when sound intense or speaker vocalizes

Inner ear

Inner ear

- Oval window
- *Cochlea*
  - *Organ of Corti*
- Round window

Organ of Corti

Organ of Corti

- *Basilar membrane*
- *Tectorial membrane*
- *Hair cells*
- Cochlear fluid/endolymph

Hair cells

- *Inner hair cells*
  - Transduce pressure waves
- *Outer hair cells*
  - "Fine tune" transduction
  - Alter stiffness of basilar/tectorial membranes

Otoacoustic emissions (OAE)

- Sounds made by the ear
  - Reflect integrity of hair cells
- Age of detection critical for early therapy

Standing waves

Cochlear movement

CNS projections

CNS projections

- *Auditory nerve (8th/XIII cranial)*
- Cochlear nuclei
- Superior olivary nucleus
  - L & R ear inputs mix
- *Inferior colliculus*

CNS projections

CNS projections

- Thalamus
  - *Medial geniculate nucleus (MGN)*
- Temporal lobe
  - *Auditory Cortex (AI)*

Coding frequency

- Frequency ~ pitch
- Mixture of frequencies ~ timbre (TAHMber)
- *Place code*
  - Place on basilar membrane that vibrates most strongly

Place code

Place code ~ xylophone

Tonotopy

Tonotopy in auditory cortex

Timbre

Perceiving location

Perceiving location

- Interaural (between the ears) time/phase differences
  - Low frequencies
- Interaural intensity differences
  - High frequencies

How do we perceive sound elevation?

Next time...

- Vision