Introduction to Cognitive Neuroscience
Summer 2008

Intro to Cognitive Neuroscience

Auditory perception

What is sound?

- A pattern of local increases or decreases in air pressure (usually caused by a vibrating object).
- Some terminology
  - Frequency
  - Amplitude

Ears

- Outer ear collects and amplifies sounds.
- Shape of pinna amplifies certain frequencies, in humans 2000 - 5000 Hz.
- Vibrations are transferred along the auditory canal to the eardrum

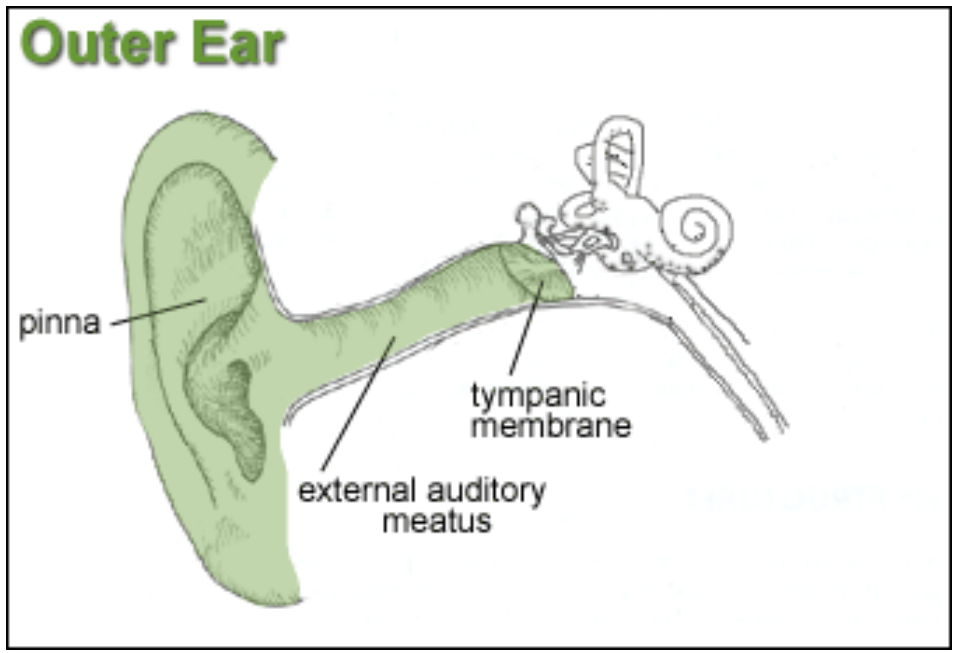
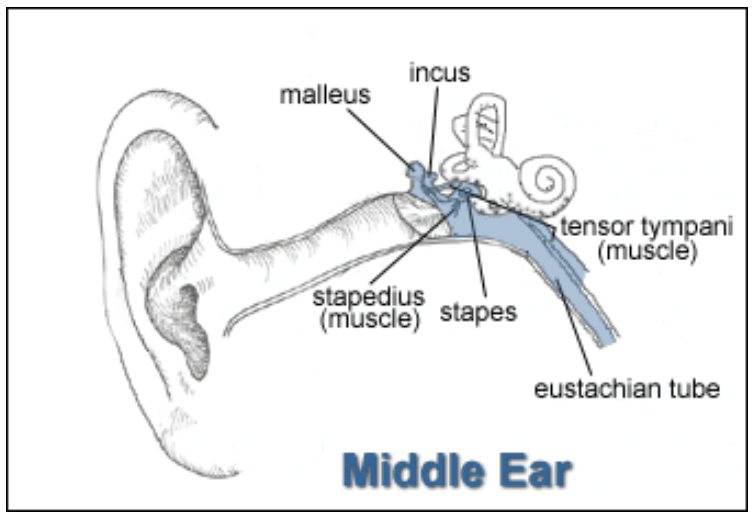


Image courtesy of U.S. Department of Labor

Ears

- Middle ear concentrates sound energy
- Changes in air pressure in the auditory canal cause the tympanic membrane to move.
- This in turn moves a chain of bones - the hammer, anvil, and stirrup.
- The movements of these bones are controlled by two muscles - the tensor tympani and the stapedus.



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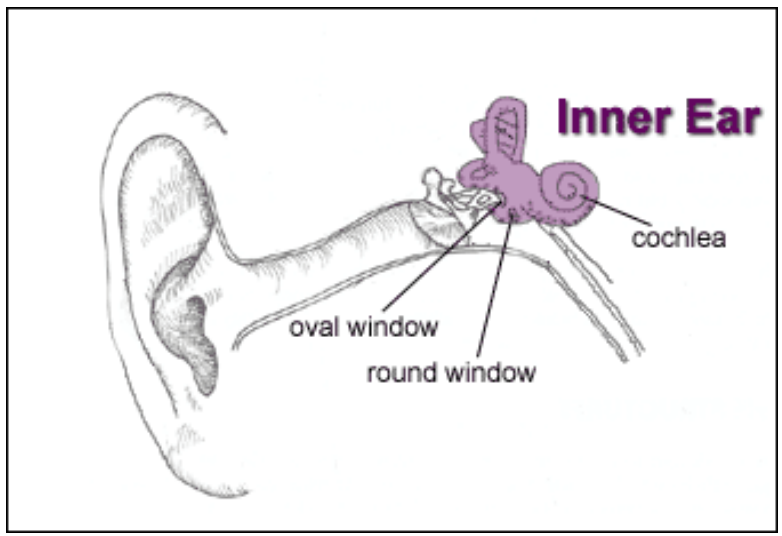
Ears

- Inner ear converts air pressure into neural signals.
- Stirrup bone presses on oval window in cochlea, creating waves in fluid within cochlea.
- Cochlea is a coil of three parallel canals.
  - Vestibular canal
  - Middle canal
  - Tympanic canal



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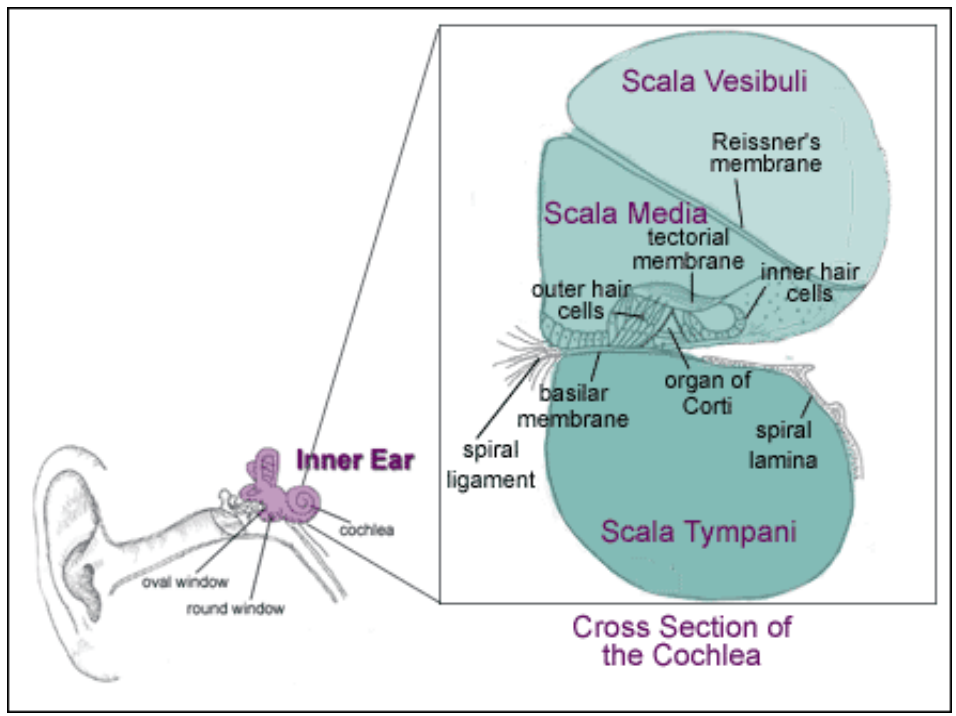
Inner ear

- Membrane between middle and tympanic canal is the basilar membrane; base for transduction mechanism.
- Basilar membrane is narrow near base of cochlea; wide near its apex.
- Basilar membrane moves when waves are created in surrounding fluid.
- Basilar membrane is tuned to frequency of waves.



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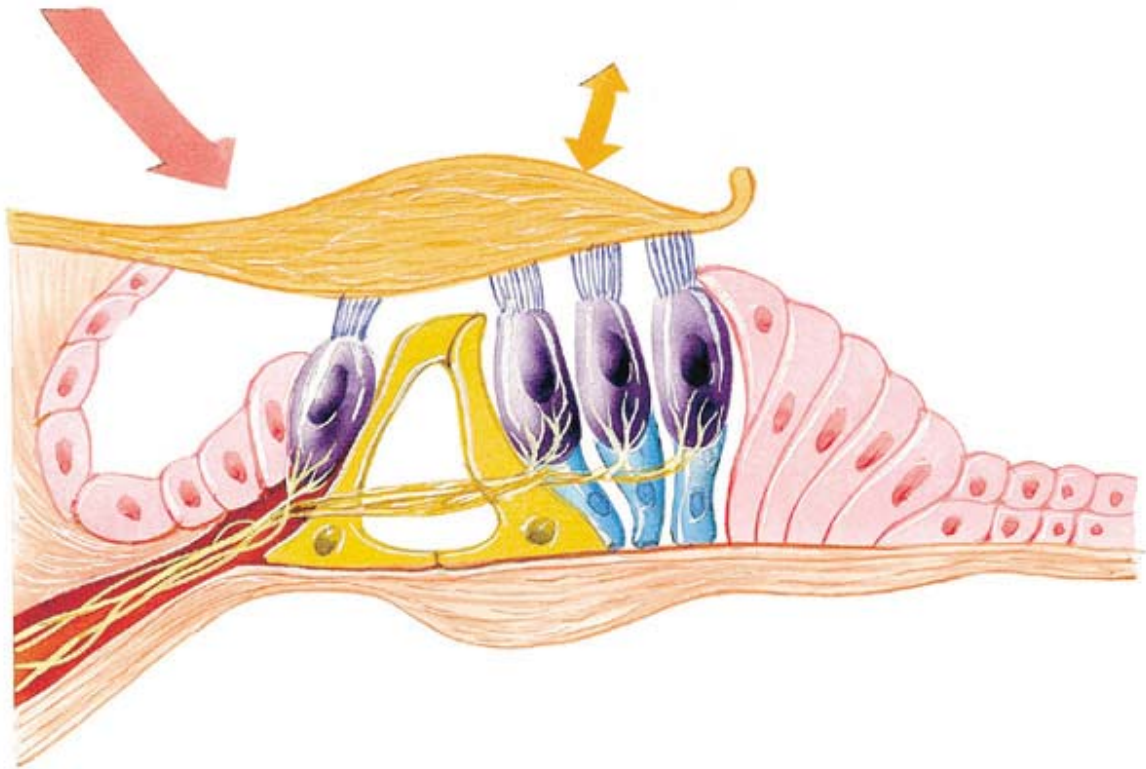
Inner ear

- On the basilar membrane is the organ of Corti - all the stuff that converts sounds into neural activity.

- Most important are the hair cells.
  - One row of inner hair cells, three rows of outer hair cells.
  - Their hairs are what allow them to detect sounds.



Inner ear

- Each hair cell has both afferent (to the brain) and efferent (from the brain) nerves.
- Most auditory info comes from the inner hair cells.
- Outer hair cells can influence stiffness of basilar membrane, tuning cochlea to different sounds.

Auditory pathways

- Vestibulocochlear nerve runs from cochlea to the cochlear nuclei in the brainstem.
- Cochlear nucleus projects (mostly) to opposite superior olivary nucleus.
- Superior olivary nucleus projects to medial geniculate nucleus (in the thalamus).
- MGN projects to auditory cortex, in the temporal lobe.
- Auditory system is tonotopically organized.

Discriminating pitch

- Theory 1: Place theory - we ID pitches by the location of the hair cells that are most stimulated.

- Theory 2: Volley theory - we ID pitches by the timing of action potentials, which is related to the frequency of the sound.

Discriminating pitch

- Current theory: some of both!
- Volley coding is used for lower pitches, up to about 4000 Hz.
- Place coding is also used. Complex sounds are ID’d by a sort of Fourier analysis.