Notes September 27

Audition: Class 10

**Audition**

**Stimulus: Air**

- Sounds: from simple (none), complicated (voice)
- Sounds = Air pressure waves. 700 miles/hour

**Qualifying sound**

- Amplitude (intensity)
- Pitch (frequency)
- Timbre (complexity)

**Sensing: The Ear**

- For just audible sounds, tympanic membrane traveling distance is comparable to the diameter of a hydrogen atom!

**The Cochlea: sound transduction**

- Diameter cells: Support
- Basilar membrane moves relative to tectorial membrane
- Hair cells transduce sounds into electrical impulses. Their axons form the auditory nerve.

**The ear: anatomy**

- How does sound transduction work?
- Sound
- air
- Middle ear: tympanic membrane, malleus, incus, stapes. The smallest bones of your body
- Inner ear: Oval window, round window

The Hair Cells are transducers

Mechanical→ electrical (receptors potentials)→ action potentials

- Tip links physically open a single ion channel (very precise)

Tip links mechanically open ion channels

- A sound of a particular frequency flexes a particular section of the basilar membrane

**Audition: sensing**

- Stretch of tip links → opening of ion channels; loudness
- position of hair cells along basilar membrane: frequency high frequencies near the windows
- cochlear nerve contains axons from:
  - inner cells (95%): responsible for auditory info
  - outer cells (5%) motor cells preamplifiers
  - tinnitus: perception of the backgrounds

**Auditory Pathway**

Most of the auditory information crosses the midline

Auditory nerve→ superior olivary complex cochlear nucleus→ inferior colliculs → medial

**Audition: Perceiving**

- medulla
- midbrain
- medial geniculate nucleus
- auditory cortex

**Implants**

- tonotopic organization (map of frequencies)
- high frequencies: place code
- cochlear implants (brain machine interface) use the place to restore auditory perception

**Auditory Cortex**

- 2 streams of auditory info processing: Anterior/Posterior
- What vs Where from

  MGN(Thalamus) → Core(primary auditory complex)→ Belt→ Parabelt→sound

  localization and complex sounds

**Audition: Perceiving**

- Perception of low frequencies: Synchronous apical firing
  Rate code: the firing rate is proportional to the (low) frequency
- Perception of timbre: Any sounds can e decomposed into a subset of pure tones.
  Fundamental frequency= perceived note
  Timbre= mixture of overtones

**Audition Perceiving**

- Perception of spatial location: right-left
  Use difference in the timing of vibrations to infer sound source location. Coding spatial location with “phase differences”
- Perception pf spatial location: up-down
  The timbre of sounds is different depending on its up-down location (shape of the ear).
Auditory Cortices: Sound processing

Pattern Recognition: Learning to associate a complex sound with something else

Amusia: deficit in perceiving/remembering music

The cocktail party problem: One voice at a time… Limited attention

The Mozart effect: Music and IQ

Vestibular System

Stimulus=Gravity

Inner ear: Cochlea + Vestibular Sacks + Semicircular Canals

(Vestibular System)

- Vestibular sac: head orientation
- Semicircular canals: head acceleration
- Functions of the vestibular system: balance eye movements (correction for head movement)

Vestibular System: acceleration

- 3 Ampulla: Contains hair cells
- detect acceleration (how fast fluid moves).
- Hair cells: K+ channel coupled

Vestibular sacs: tilt detection

- 2 vestibular sacs: utricle, saccule. Sense gravity.
- Head orientation (how tilted are the otoconia)

Vestibulo-Ocular Reflex

- Test brainstorm function. Used in unconscious (comatose) patients
Warm/cold water→ fluid movement in canals→ eye movements

Note: The VOR does not involve the thalamus!

**Vestibulo-ocular reflex**

- Eye movements are used to test the integrity of the brain stem. In normal patients, both eyes move together

**Vestibular pathways**

- Vestibular information reaches the vestibular cortex through cortex through the thalamus.