COGS 17 Week 6

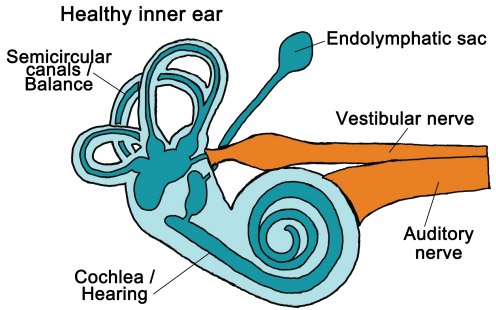
Winter 2024, A04

Slides Adapted From Previous Quarter

By: Jason Chen

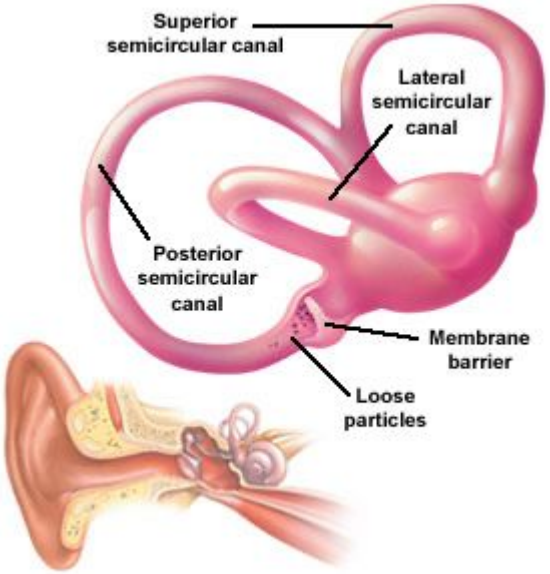
Vestibular System

Vestibular Organ



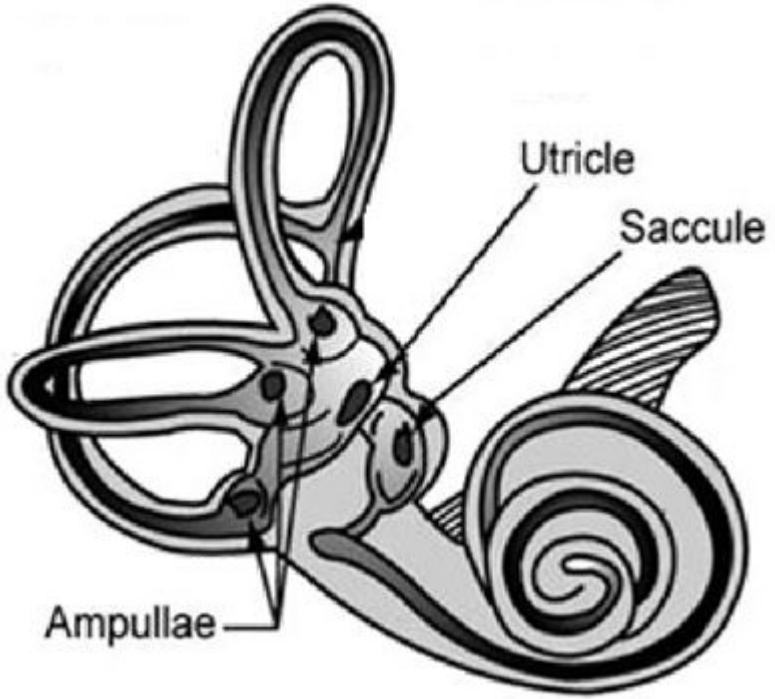
- Adjacent to Cochlea
- Consists of two complex structures that provide info for movement, balance

Vestibular System



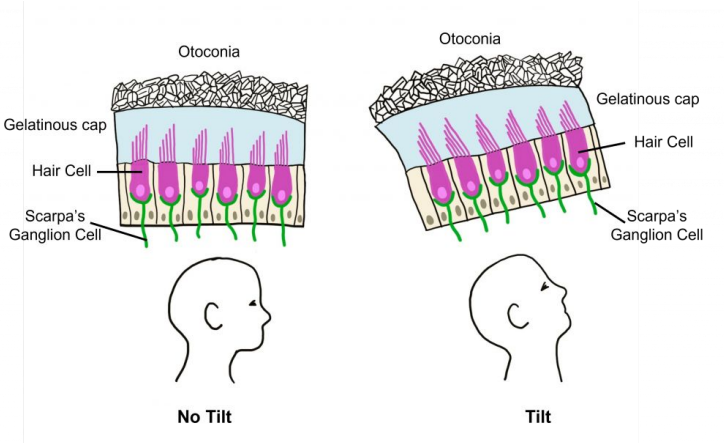
- Semicircular Canals: Detect angular ac/deceleration - i.e. Rotation
- Otolith ("Ear stone") Organs: Detect changes in head tilt relative to body
- In all of the above, deforming Hair Cells results in **graded** responses to subtle, 3D changes

Semicircular Canals



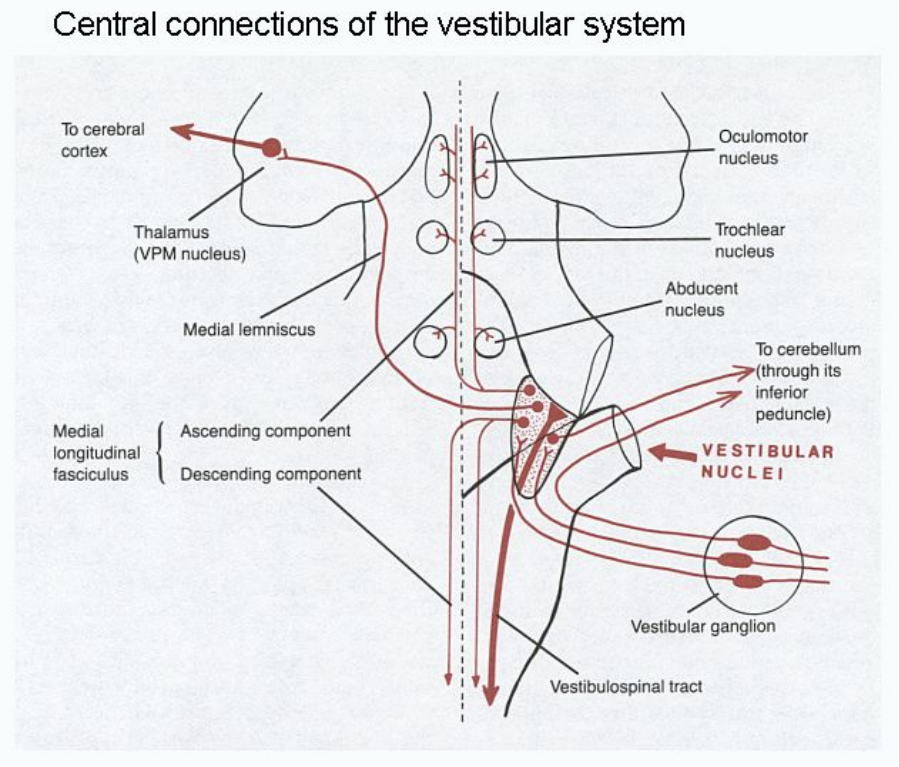
- Three looped tubes, each in a different orthogonal (X, X, Z) plane, affected by head **rotation**
- Filled with **potassium-rich (K+)** Endolymph
- Fluid dynamics inside the canals stimulate hair cell receptors, which alter NT release based on head movement.

Otolith Organs



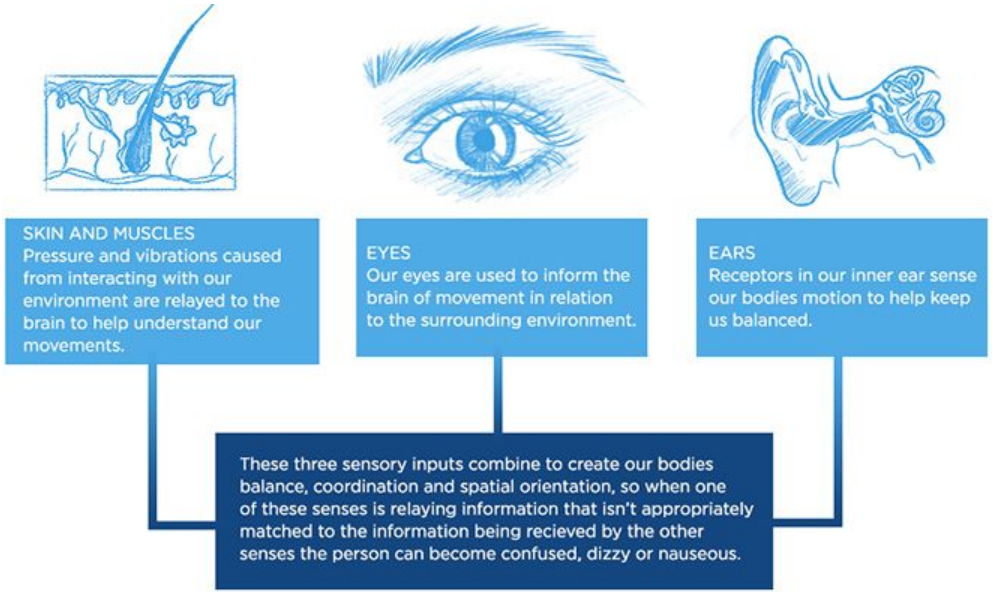
- Saccule and utricle detect **head tilt** via calcium carbonate crystals that shift and deform hair cells.
- Important for understanding orientation in 3D space

Vestibular Pathways



- From hair cells to vestibular ganglions, integrated within the 8th cranial nerve.
- Signals processed in the vestibular nuclei, cerebellum, and other brainstem nuclei, crucial for posture regulation and eye movement compensation.

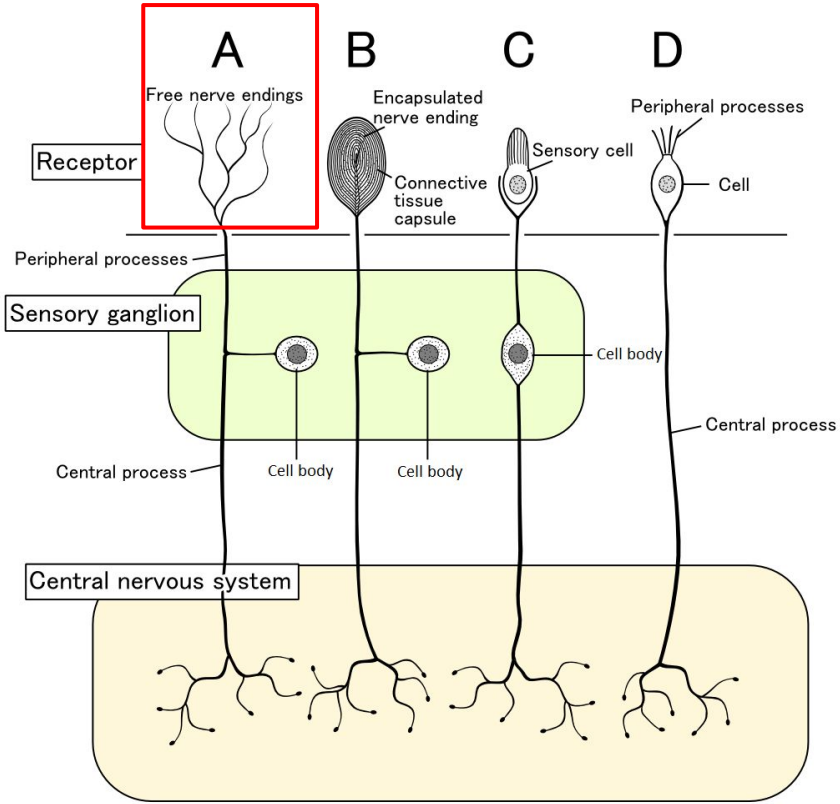
Motion Sickness



- A Vestibular Phenomenon
- When visual and/or motor feedback inconsistent with vestibular info, Medulla connections cause nausea

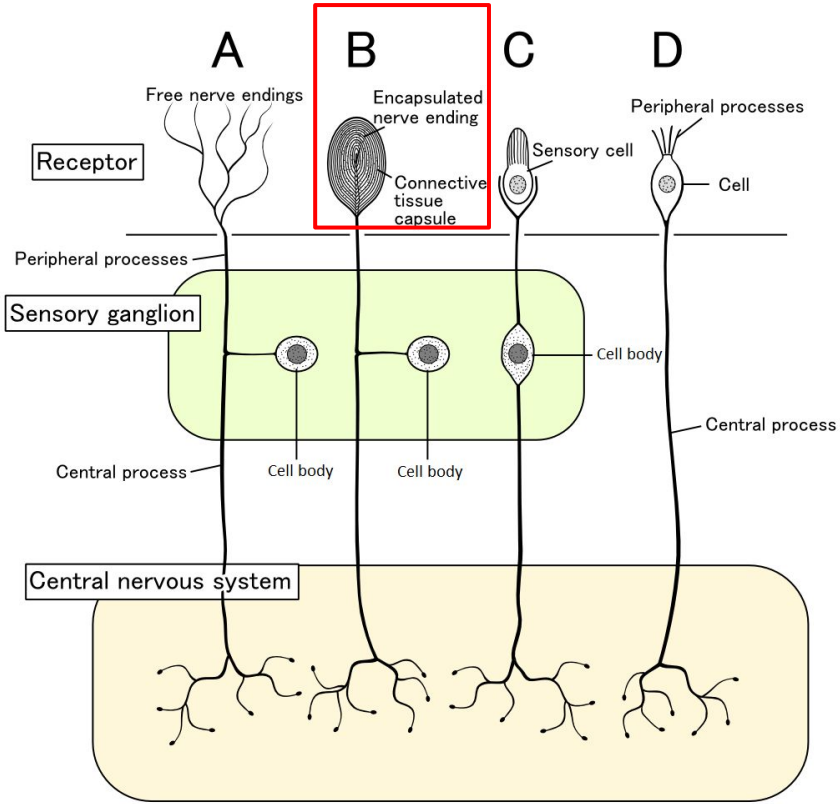
Somatosensory System

Free Nerve Endings



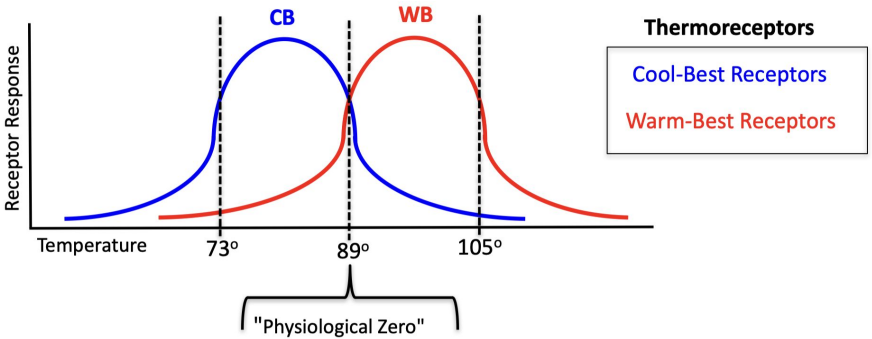
- respond to change in Temperature (Thermoreceptors) and pain & itch (Nociceptors)

Encapsulated Nerve Endings



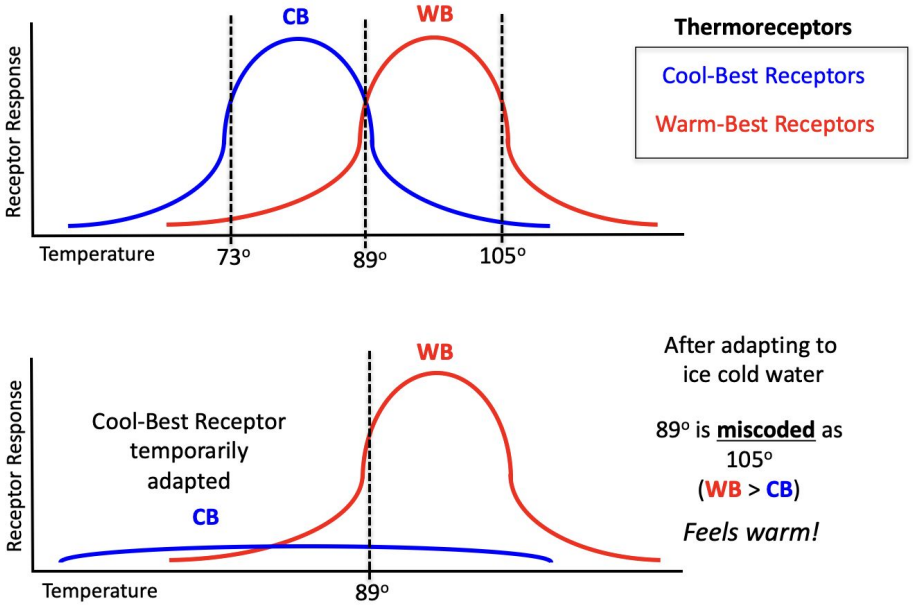
- respond to 1) various types of Touch and 2) Proprioception = internal muscle & organ movement
- Meissner's have small Receptive Fields & are fast adapting - respond to rapid change
- Merkel's have small Receptive Fields & are slow adapting - for detail discrimination
- Pacinians have large Receptive Fields & are fast adapting - respond to large scale changes
- Ruffinni's have large Receptive Fields & are slow adapting - respond to sustained, large-scale events

Across-fiber Coding



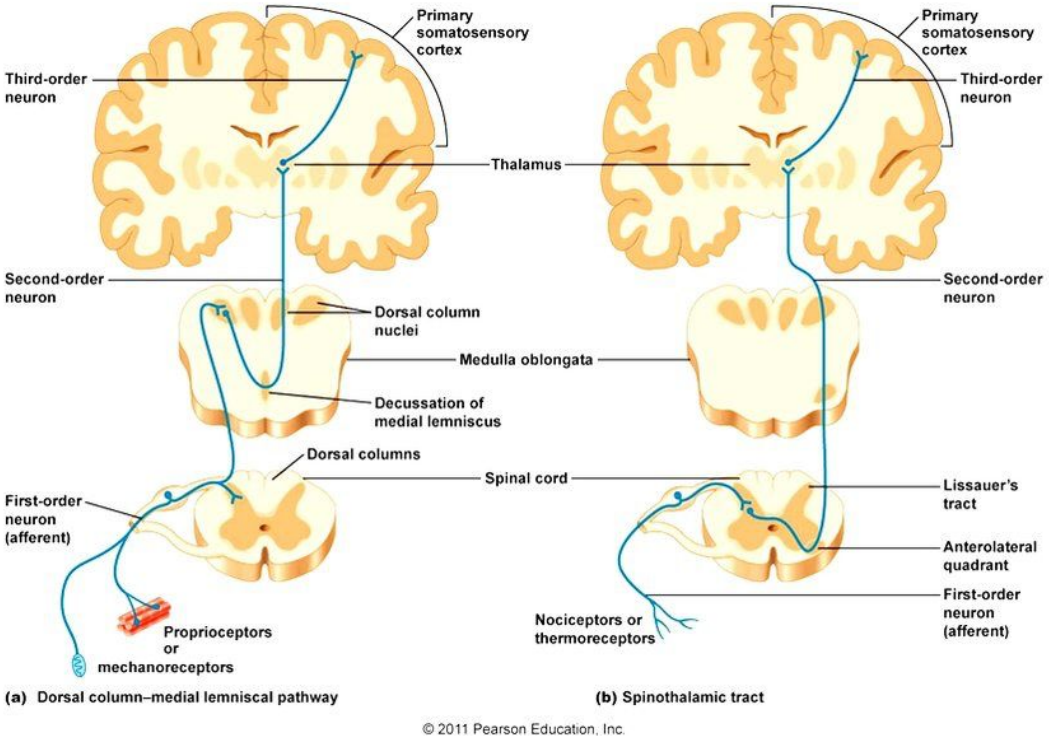
- Two types of temperature receptors: Warm Best & Cool Best
- Temperature coded by the distribution of activity across both types of receptors
- 89 ℉ -- physiological zero" (does not feel either cold or hot) = Produces equal response from Warm Best (WB) and Cool Best (CB) receptors (WB = CB)

Across-fiber Coding



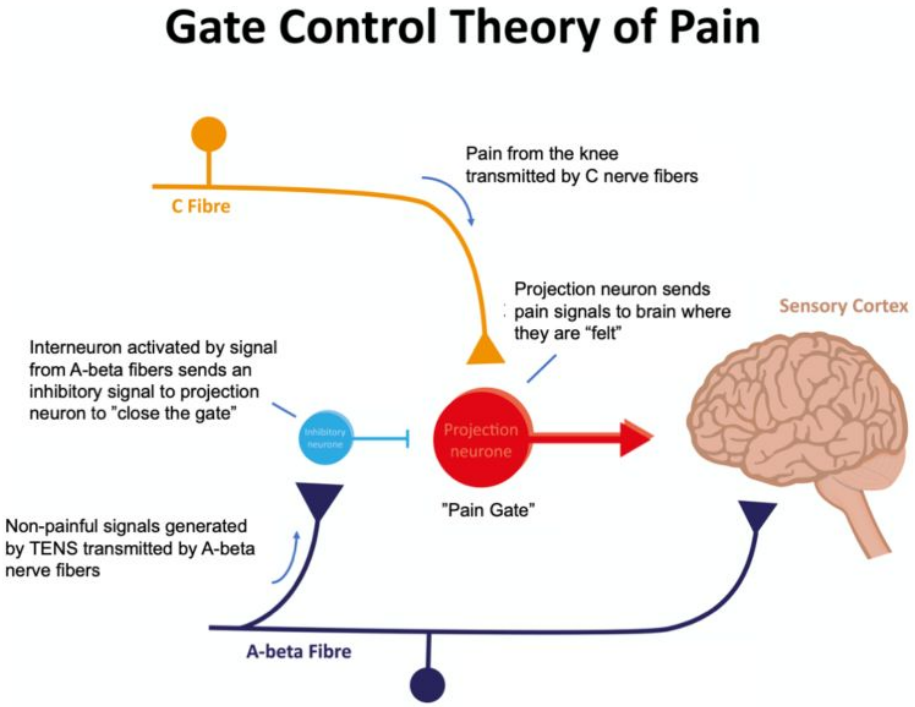
- Exposing the skin to a warmer temperature (such as 105 ℉) produces a different code: “WB > CB”
- Chilling the hand (as by putting it in ice water) will selectively adapt the CB receptors more than the WB receptors, producing an aftereffect such that tepid water (89 ℉) will now feel warmer (more like 105 ℉) (Now CB < WB instead of CB = WB)

Somatosensory Pathways



- Medial Lemniscal pathway -- “Second-order” cells cross over in Brain Stem (tract called “Medial Lemniscus”) to synapse in contralateral VPN (Ventral Posterior Nucleus of the Thalamus)
- Spinothalamic pathway -- “Second-order” neurons cross over in Spinal Cord, ascend on contralateral side to synapse in contralateral VPN

Gate Theory



- Touch Receptors near source of pain are stimulated
- Periaqueductal Grey Area (PAG in Midbrain) releases Inhibitory Endorphins
- Within brain, some cells that release Substance P have NT receptor sites on their Terminals that respond to inhibiting Endorphins

Questions?

Office Hours: Mon 5-6 pm

To get the section slides:
https://github.com/JasonC1217/COGS17_A04_Wi24

OR: