Chapter 8: Special Senses

Eyes, Ears, Nose & Mouth
The Senses

• 5 senses: taste, touch, sight, smell, hear
• Touch: temperature, pressure, pain, ect are part of the postcentral gyrus of the cerebral cortex and won’t be discussed here.
• Special sense receptors:
  – Organs (like eye and ears)
  – Cluster of sense receptors (like taste buds and smell buds; I mean olfactory epithelium)
Eye & Vision

• Very complex, but easy to trick!

• **Optic Illusions**
Eye & Vision

External Anatomy of Eye

1. Eye lids:
   a. Medial and lateral canthus: corners of eye where lids meet.
   b. Eyelashes: protection
   c. Meibomian glands: eyelid edges; produce oily secretion. (sebaceous)
   d. Ciliary glands: between eyelashes. (sweat)
Eye & Vision

External Anatomy of Eye

2. Conjunctiva

a. thin membrane that lines the interior of eyelid and part of the outer surface of eyeball. Secretes mucus to lubricate and moisten the eyeball.

*Pinkeye (AKA conjunctivitis) is an infection of the conjunctiva.
Eye & Vision

External Anatomy of Eye

3. Lacrimal Apparatus

a. Lacrimal gland (AKA tear gland): above the lateral end of eye; secrete salt solution with antibodies and lysozyme.

b. Lacrimal canals: focus the tears into the …

c. Lacrimal sac: medial container that leads to the …

d. Nasolacrimal duct: empties into nasal cavity. Tears drain into the nose!

e. Watery eyes when sick = nasal backup
External Anatomy of Eye

4. Extrinsic eye muscles

- These muscles are attached to the outer surface of eyeball and allow for gross eye movement

- See Page 254
Eye & Vision

Internal Structures of the Eye

- Eyeball: made of tunics and humors, a lens and chambers.
Eye & Vision

Internal Eye: Tunics

1. Sclera: outermost tunic, thick white connective tissue, “whites of your eye”, but the central anterior portion is clear.

- Cornea: clear portion of sclera, no blood vessels, many nerve endings (pain fibers), easily repairs itself.
Eye & Vision

Internal Eye: Tunics

2. choroid: middle tunic, blood-rich, dark pigment so light doesn’t scatter inside eye.

• Ciliary body: smooth muscles attached to iris that allow it to contract and expand.
• Iris: colored part of choroid, protein pigments, circular and radial muscles control iris – close=contract, far=dilate
• Pupil: clear opening in iris
Eye & Vision

Internal Eye: Tunics

3. retina: innermost, sensory, only goes to the ciliary bodies, blood-rich, contain millions of sensory receptor cells.

- Optic disk (blind spot) where optic nerve attaches to retina. *activity page 257*
Eye & Vision

Internal Eye: Tunics

- Photoreceptors: have a two neuron chain (bipolar cell and ganglion cell) that attach to the optic nerve.
- rods (grays): mostly on the periphery of retina, allow us to see in dim light
- cones (color): mostly in the center of retina, allow us to see details and need bright light.
- Fovea centralis: pit on retina that only has cones; lateral to optic disc, sight is focused on this area (greatest visual acuity).
Eye & Vision

• Three types of cones: dependant on the wavelength of light it responds to the most.
  • 1. responds to blue
  • 2. responds to green
  • 3. responds to a range from red to green
Eye & Vision

Internal eye structures: Lens

Lens: biconcave, transparent, flexible, held by suspensory ligaments that are attached to ciliary body.

- Focuses light to the fovea centralis on the retina.
- Cataracts: hardened opaque condition of lens that can cause blindness.
Eye & Vision

Internal eye structures: Chambers

- Chambers –
  - Anterior (aqueous) segment: in front of lens; watery liquid
  - Posterior (vitreous) segment: behind the lens; gel-like liquid
Eye & Vision

Internal eye structures: Humors

• 1. aqueous humor: watery fluid between the cornea and lens; similar to plasma formed from choroid and returned to blood by scleral venous sinus (canal of Schlemm); nutrient rich, provides pressure to the eye. *Glaucoma*

• 2. vitreous humor (body): gel-like fluid that fills the eyeball and gives it support.
Eye & Vision
Eye & Vision

• **Refraction:** the bending of light waves as they pass from one media to another as a result of a change of speed. The denser the matter, the slower the light travels.

• Light is refracted as it travels through the cornea, aqueous humor, lens, then vitreous humor.

• The light refracted by the lens can change with the shape of the lens (focus).
Eye & Vision

- **Convex**: bulging shape of lens.
  - Less bulge for distance viewing.
  - More bulge for close viewing.
- **Accomodation**: bulging of lens for close vision. Ciliary bodies contract to make the lens more convex.
- **Real image**: light bending that causes the image to reverse (left to right), invert (upside down) and become smaller.
  * lenses demo*
Eye & Vision

- **Myopia**: nearsighted (can see near); images focus in front of the retina. Caused from long eyeball, strong lens, ultra curved cornea.

- **Hyperopia**: farsighted (can see far); images focus behind the retina. Caused from a short eyeball or a “lazy” lens.
Eye & Vision

- **Emmetropia**: normal vision.
- **Astigmatism**: ("not a point") misshaped eyeball causes focused *lines* of light instead of *points* of light causing all vision to be blurry.
Eye & Vision

• Steps to vision:

1. Retinal axons form the optic nerve that leave the eye.

2. The nerves split at the optic chiasma and become optic tracts—medial fibers run to the opposite side of the brain while lateral fibers stay on the same side.

3. These synapse with other neurons in the thalamus and become the optic radiation.

4. The optic radiation go to the occipital lobe and synapse with the cortex.
Eye & Vision

• Both sides of the brain “see” from both eyes producing a three dimensional image with depth perception.

• Reflexes (Autonomic system)
  1. convergence: extrinsic muscles move laterally when viewing close objects.
  2. Accommodation pupillary reflex: pupils constrict to view close objects.
  3. Photopupillary reflex: pupils constrict to protect retina from excessive light exposure.
Ear & Hearing

Functions: hearing & balance

Alexander Smirnov  
http://www.asmirnov.org
Ear & Hearing

Anatomy of the ear

Three areas of the ear:

1. Outer ear
2. Middle ear
3. Inner ear
Ear & Hearing

Anatomy of the ear

• Outer (external) ear

  1. Pinna: what we call “the ear”; AKA auricle

  2. External auditory canal: about one inch long; hole in the temporal bone; ends at the tympanic membrane (ear drum).

    a. ceruminous glands: produce ear wax (cerumen)

  3. Tempusum: transmits the sound vibrations to bones of the middle ear
Ear & Hearing

Anatomy of the ear

- **Middle Ear (tympanic cavity):** small air filled cavity in the temporal bone.

1. **Auditory (Eustachian) tube:** inferior to tympanic cavity and connecting it with the throat. Helps with maintaining correct pressure.

*Ear popping* * hearing * otitis media*
Ear & Hearing

Anatomy of the ear

• Middle Ear

2. Ossicles: the three teetiniest bones in the body

• They amplify the vibrations absorbed and transmitted by the tympanum to the fluid in the inner ear.

• Hammer (malleus), anvil (incus), stirrup (stapes) – attach to oval window on inner ear
Ear & Hearing

Anatomy of the ear

- **Inner ear (osseous labrynth)**: maze of boney chambers broken down into three areas; deep within the temporal bone behind the eye sockets.
  - Cochlea
  - Vestibule
  - Semicircular canals
Ear & Hearing

Anatomy of the ear
• Inner ear –
  1. Cochlea
    • Snail shaped organ
    • Surrounded by temporal bone, externally
    • Layered and compartmentalized by vestibular membranes.
    • Filled with fluids: endolymph & perilymph
    • Organ of Corti: centrally located; contain auditory receptors
Ear & Hearing

Cochlear duct

Bone

Auditory nerve

Vestibular canal

perilymph

Tympanic canal

Organ of Corti
Ear & Hearing
Mechanism of hearing

• Vibrations from “large” tympanum are focused onto the “smaller” oval window attached to cochlea creating amplified vibrations.

• Fluids vibrate and move the tectorial membrane that bend “hairs” on receptor cells.

• The amount of motion is transmitted as specific nerve impulses that run down the cochlear nerve to the auditory cortex in the temporal lobe.

• Pitches and loudnesses are interpreted in that part of the brain based on “hair” movements.
Ear & Hearing
Anatomy of the ear

- **Inner ear – Vestibule**
- Fluid filled membranous sac between cochlea and semicircular canals.
- Otolithic membrane filled with otoliths (calcium salts) that move with head.
- This movement moves “hairs” on receptor cells that send impulses to the vestibular nerve and on to the cortex.
Ear & Hearing

Mechanisms of equilibrium: working together!

- **Static equilibrium**: when the body is not moving (aka static), responds to the position of the head in relationship to gravity; senses up from down.

- **Dynamic equilibrium**: when body is moving, responds to angular or rotary movements of the head; senses twirling, roller coaster bumps and dips for example.
Figure 10-23
Anatomy of the ear

- **Inner ear – Semicircular Canal**
- **Crista ampullaris**: receptor areas of semicircular canal
- **Cupula**: gel-like area surrounding “hair” receptor cells. As the fluid in the canals moves with inertia the motion is relayed as impulses to the vestibular nerve and on to the cortex.
Deafness: any amount of hearing loss

- 1. conduction deafness: mishap with the vibratory structures of the ear; eardrum, ossicle fusion, ear wax buildup (can use hearing aids)

- 2. sensorineural deafness: any damage to receptors, nerves or brain areas that interpret sound (hearing aids do not help).
Taste & Smell

- Chemoreceptors: receptors that respond to chemical solutions.
- Smell: olfactory receptors have multiple chemical sensitivities.
- Taste: taste receptors have four chemical sensitivities; sweet, sour, bitter, and salty.
- The two senses complement each other.
The Sense of Smell

- Olfactory receptor cells: positioned superiorly in the nasal cavity (sniffing); neurons with….
- “hairs”!
- Bathed in mucous that dissolves chemicals in the air.
- Olfactory filaments make the olfactory nerve to olfactory cortex.
Taste & Smell

- Olfactory receptor cell
- Olfactory neuroepithelium
- Piriform cortex
- Amygdaloid complex
- Entorhinal cortex
- Hippocampus
- Thalamus
- To contralateral side via the anterior commissure
Taste & Smell

• Olfactory cortex is tied to the limbic (emotional visceral) system.
• Smells help us recall memories better than any other sense.
• Only need a few molecules to smell, but adapts to unchanging stimuli quickly.
• Imbalances: head injury, nasal passage irritations, zinc deficiency, epileptics.
Taste & Smell

The Sense of Taste

• Do you “eat to live” or “live to eat”?
Taste & Smell
Taste & Smell

- Taste receptors (aka taste buds): about 10,000 mainly on dorsal tongue.
- Papillae: projections on dorsal tongue
  - Filiform: sharp projection
  - Fungiform: rounded projections w/taste buds
  - Circumvallate: circular projections w/taste buds
- Gustatory cells: specific epithelia that respond to chemicals dissolved in saliva.
Taste & Smell

• Sensory nerve fibers form parts of three cranial nerves that run to the gustatory cortex. (facial nerve, glossopharyngeal, and vega nerves)
• Sweet responds to sugar and some amino acids (maybe the hydroxyl group)
• Sour responds to hydrogen ions in acids.
• Bitter responds to alkaloids.
• Salt responds to metal ions.
Development

- Eye develop at 4 weeks gestation.
- All senses are fully developed at birth except vision.
- Eyeball grows to about 8 years old; lenses keep growing.
- Infants are hyperopic (farsighted), see in grays, don’t have functioning lacrimal glands and not much depth perception.
Development

• Ears hear at birth, but are mainly reflexes. By 4 months they specify sounds and respond to them with head movements and facial expressions.
• Hearing and speech are directly related.
• Taste and smell are sharp at birth so bland food tastes great to infants, but toddlers will play with their own feces.
Imbalances

- Presbyopia: “old” eyes, less tears, lens cloudy and harder, photoreceptor damage
- Strabismus: cross eyed baby
- Maternal infections: rubella, gonorrhea
- Presbycusis: “old” hearing, organ of Corti atrophies, can’t hear high pitches and specific speech.