Announcements

- Aplia Chapter 3 due tonight
- Review session today at 5:30, room 130 ILC
- Exam 2 is Wednesday
- Study Guide posted on class website
Returning to…

Sensation and Perception
Key Concepts

- Bottom-up Vs Top-down Processing
- Brain senses only Neural Energy; physical energy can only impact brain if transduction takes place
- Vision:
  - Characteristics of Light
  - The Fascinating Eye
Bottom-up Vs Top-down Processing

- **Top Down Versus Bottom Up Processing**
  - **Bottom Up**: the sensory features create the perception
  - **Top Down**: Higher level mental processes based on our experience and expectations influence the perception
  - Example: “Hidden” messages
Key Concepts

- Bottom-up Vs Top-down Processing
- Brain senses only Neural Energy; physical energy can only impact brain if transduction takes place

Vision:
- Characteristics of Light
- The Fascinating Eye
Brain as Scientist Prisoner

The brain only senses neural energy
Key Concepts

- Bottom-up Vs Top-down Processing
- Brain senses only Neural Energy; physical energy can only impact brain if transduction takes place
- Vision:
  - Characteristics of Light
  - The Fascinating Eye
Frequency/wavelength determines hue (color)
Intensity determines perceived brightness
Frequency/wavelength determines hue (color)
Intensity determines perceived brightness

(a) Short wavelength = high frequency (bluish colors)
(b) Great amplitude (bright colors)

Long wavelength = low frequency (reddish colors)
Small amplitude (dull colors)
Key Concepts

• Bottom-up Vs Top-down Processing
• Brain senses only Neural Energy; physical energy can only impact brain if transduction takes place
• Vision:
  – Characteristics of Light
  – The Fascinating Eye
The Eye

- Fovea
- Optic disk (blind spot)
- Blood vessels
- Retina
- Pupil
- Iris
- Cornea
- Lens
- Blood vessels
The Eye

- Pupil
- Lens
- Iris
- Cornea
- Retina
- Fovea (point of central focus)
- Optic nerve to brain's visual cortex
- Blind spot
Optic Nerve, Blind Spot & Fovea

**Optic nerve:** Carries neural impulses from the eye to the brain.

**Blind Spot:** Point where the optic nerve leaves the eye because there are no receptor cells located there. This creates a blind spot.

**Fovea:** Central point in the retina around which the eye's
Distribution of Rods and Cones

Thousands of rods per square millimeter

Thousands of cones per square millimeter

Distance on retina from fovea (degrees)

Fovea
Blind spot
Rods
Cones
Vision

b. Light energy (photons) causes chemical reactions with photopigments within the rods and cones

  1. intensity is coded by rate of firing
Vision

b. Light energy (photons) causes chemical reactions with photopigments within the rods and cones
   1. intensity is coded by rate of firing

c. Rods and cones send graded potentials
   1. to next layer: bipolar cells; also send graded potentials to
   2. ganglion cells
   3. action potentials then carried to the CNS by ganglion cells.
Figure 6.8 The retina’s reaction to light

1. Light entering eye triggers photochemical reaction in rods and cones at back of retina.

2. Chemical reaction in turn activates bipolar cells.

3. Bipolar cells then activate the ganglion cells, the axons of which converge to form the optic nerve. This nerve transmits information to the visual cortex (via the thalamus) in the brain.
Vision

d. Axons from the ganglion cells leave the eye through the optic nerve
1. pass through the thalamus
2. in route to the primary visual cortex in occipital lobe (Striate cx)
Vision

5. Why all the different layers?
   a. To confuse and perplex students
   b. Data reduction
   c. Feature Detection
Vision

C. Combining information in the brain

1. The visual pathways
   Main pathway: ganglion cells … optic nerve …
   optic chiasm … thalamus … occipital cx

b. Other pathways (do not memorize):
   1. projections to hypothalamus
   2. brainstem nuclei; control oculomotor system
   3. brainstem areas; control pupil size control eye movements
   4. Blindsight
https://www.youtube.com/watch?v=4x0HXC59Huw
Vision

2. Receptive fields
3. Multiple representations of images
4. Depth Perception
   a. Size cues
   b. Obstruction of some objects by others
   c. Binocular disparity
Distance Illusion: Two objects of the same size perceived as being at different distances. The one farthest away is perceived as being larger.
Ponzo Illusion

- Converging lines indicate that top line is farther away than bottom line.
Size Constancy

- Cylinders at positions A and B perceived as the same size even though their image sizes differ.
- The depth cues such as linear perspective help the visual system judge the size accurately.
Ames Room

- The Ames room is designed so that the monocular depth cues give the illusion that the two people are equally far away
Vision

2. Receptive fields
3. Multiple representations of images
4. Depth Perception
   a. Size cues
   b. Obstruction of some objects by others
   c. Binocular disparity
Vision

2. Receptive fields
3. Multiple representations of images
4. Depth Perception
   a. Size cues
   b. Obstruction of some objects by others
   c. Binocular disparity
Binocular Cues

**Binocular (retinal) disparity:** Images from the two eyes differ. Try looking at your two index fingers when pointing them towards each other half an inch apart and about 5 inches directly in front of your eyes. You will see a “finger sausage” as shown in the inset.
Another cool feature of binocular disparity

RANDOM-DOT STEREOSCOPIC IMAGES
IV. Audition

A. Characteristics of sound

1. Frequency determines pitch
   a. Humans range 20-20,000 Hz (cycles per second)
   b. Other animals can hear much higher frequencies
   c. Most sounds are not pure

2. Amplitude determines loudness
   a. Sound measured in decibels (dB's)
   b. Logarithmic, not linear scale
   c. Humans have an immense range of intensities they can perceive
The Stimulus Input: Sound Waves
Sound waves are composed of compression and rarefaction of air molecules.

Acoustical transduction: Conversion of sound waves into neural impulses in the hair cells of the inner ear.
Frequency (pitch): The dimension of frequency determined by the wavelength of sound.

Wavelength: The distance from the peak of one wave to the peak of the next.

Short wavelength = high frequency (bluish colors, high-pitched sounds)

Long wavelength = low frequency (reddish colors, low-pitched sounds)
Intensity (Loudness):
Amount of energy in a wave, determined by the amplitude, relates to the perceived loudness.

Great amplitude (bright colors, loud sounds)

Small amplitude (dull colors, soft sounds)
Loudness of Sound

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>Rock band (amplified) at close range</td>
</tr>
<tr>
<td>130</td>
<td>Loud thunder</td>
</tr>
<tr>
<td>120</td>
<td>Jet plane at 500 feet</td>
</tr>
<tr>
<td>110</td>
<td>Subway train at 20 feet</td>
</tr>
<tr>
<td>100</td>
<td>Busy street corner</td>
</tr>
<tr>
<td>90</td>
<td>Normal conversation</td>
</tr>
<tr>
<td>80</td>
<td>Typical room</td>
</tr>
<tr>
<td>70</td>
<td>Whisper</td>
</tr>
<tr>
<td>60</td>
<td>Threshold of hearing</td>
</tr>
</tbody>
</table>

Prolonged exposure above 85 decibels produces hearing loss.
Audition

B. The ear
1. Outer ear
2. Auditory canal
Audition

B. The ear

1. Outer ear
2. Auditory canal
3. Eardrum
4. Bones of middle ear
   a. hammer, anvil, stirrup
   b. transducing mechanism with 99.9% efficiency
B. The ear

1. Outer ear
2. Auditory canal
3. Eardrum
4. Bones of middle ear
   a. hammer, anvil, stirrup
   b. transducing mechanism with 99.9% efficiency
5. Oval window
6. Cochlea (this is the place!!)
Audition

B. The ear

1. Outer ear
2. Auditory canal
3. Eardrum
4. Bones of middle ear
   a. hammer, anvil, stirrup
   b. transducing mechanism with 99.9% efficiency
5. Oval window
6. Cochlea (this is the place!!)
7. Semicircular (vestibular) canals
C. The cochlea

1. Three fluid filled sections
2. Two membranes
   a. basilar vibrates
   b. preferential vibration for frequencies
3. Hair cells between two membranes are displaced as basilar membrane vibrates
4. Each hair cell gives one neuron in the auditory nerve
Audition

D. So, how do we hear?

1. Pitch perception
   a. Place
   b. And for lowest sounds… vibration in synchrony with waveform

2. Sound localization
   a. Arrival time differences for lower tones
   b. Intensity differences for higher frequencies

3. The auditory system has excellent temporal resolution!
Coding Sounds

- **Low frequency sounds** cause more vibration near distal end of Basilar Membrane.
- **High frequency sounds** cause more vibration near proximal end of Basilar Membrane.

**Distance along basilar membrane**

(a) Effect of bassoon on basilar membrane

(b) Effect of piccolo on basilar membrane
Audition

D. So, how do we hear?

1. Pitch perception
   a. Place
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2. Sound localization
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   b. Intensity differences for higher frequencies

3. The auditory system has excellent temporal resolution!
Other cues to localize sound
Hearing loss by age...
Exam 2

- 50 Multiple Choice Questions
- 75 Minutes beginning at 4:00
- Half from Book
- Half from Lecture
- Bring your clicker. You will click at start, and click at end.