Chapter 4: Sensation and Perception

Lecture Preview

- Identify the basic principles applied to all senses
- Explore how our minds construct our perceptions
- Discuss the ways we sense and perceive visual, auditory, somatosensory, olfactory, and gustatory information

Sensation

- Conversion of external energies or substances into a nervous system signal (inhibition or excitation)
- Sense receptors - specific stimuli

Psychophysics: Measuring the Barely Detectable

- Absolute threshold - stimulus energy needed for the nervous system to detect
  - Human error increases as stimuli get weaker

Psychophysics: Measuring the Barely Detectable

- Just noticeable difference - smallest change in intensity of a stimulus that we can detect 50% of the time
  (Also called threshold)
- Signal detection theory - provides a way to detect and account for subjects’ biases

Distinguishing Signals from Noise

<table>
<thead>
<tr>
<th>Stimulus present</th>
<th>Stimulus absent</th>
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</thead>
<tbody>
<tr>
<td>Hit</td>
<td>Miss</td>
</tr>
<tr>
<td>False alarm</td>
<td>Correct rejection</td>
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Respond "Yes" | Respond "No"
With all our sensory inputs, how do we focus?

- process of focusing on one sensory channel and ignoring others
  - Filter theory of attention and the dichotic listening task
  - Cocktail party effect

Seeing: The Visual System

- Light (measured in wavelengths):
  - Human visible spectrum
  - Brightness - intensity
  - Hue - color

Structure of the Human Eye

- Fovea (point of central focus)
- Optic nerve to brain's visual cortex
- Pupil
- Cornea
- Blind spot

Vision

- the light-sensitive inner surface of the eye, containing receptor rods and cones plus layers of neurons that begin the processing of visual information

The Retina

- Hubel and Wiesel (1960s) - recorded from cat visual cortex
  - Different cortical cells respond maximally to different types of stimuli
  - Detecting lines and edges:
    - Simple cells - orientation-specific slits of light in a particular location
    - Complex cells - orientation-specific but less dependent on location

Visual Perception: Shape and Contour
Visual Perception: Shape and Contour

- **Detection** - using minimal patterns to identify objects
- Hierarchical model of processing: Feature detector cells respond to increasing shape complexity with higher levels of cortical processing, from lines and edges to complex shapes and moving objects.

Hubel & Wiesel

- Discovered that the organization of the visual cortex can be changed by visual experience.
- **Critical period** – if optical defects in vision are not corrected early in development, the visual cortex can lose the ability to process information from the submissive eye.
- _______________ – an impairment in visual acuity not due to an optical defect. The cure is to patch the dominant eye.

PRS

- **Amblyopia**
  - A. Is due to an imbalance in the left-eye and right-eye representation in the visual cortex.
  - B. Can be cured by patching the dominant eye.
  - C. Both of the above.

Visual Perception: Shape and Contour

- **Face recognition**
  - Extract key features, fill-in from context and memory
  - Cells in the lower temporal lobe fire in response to particular faces

Hearing: The Auditory System

- **Sound** - mechanical vibration
  - **Pitch** - wave frequency (Hz)
  - **Loudness** - amplitude of the sound wave (dB)
  - **Timbre** - complexity of sound

How the Ear Works

- **Outer Ear** - funnels sound
  - Pinna
  - Ear canal
- **Tympanic Membrane**
- **Middle Ear** - transmits sound
  - Ossicles - hammer, anvil, stirrup
- **Inner Ear** - converts vibration to neural signal
  - **Cochlea**
    - Basilar membrane
    - Organ of Corti
    - Hair cells
The Ear and its Parts

**Audition - The Ear**

- **Eardrum** - chamber between eardrum and cochlea containing three tiny bones (hammer, anvil, stirrup) that concentrate the vibrations of the eardrum on the cochlea's oval window
- **Inner Ear** - innermost part of the ear, containing the cochlea, semicircular canals, and vestibular sacs
- **Cochlea** - coiled, bony, fluid-filled tube in the inner ear through which

Different Types of Auditory Perception

- **Pitch Perception** - different tones excite different areas of the basilar membrane and primary auditory cortex
  - High tones - place theory
  - Low tones - frequency theory, volley theory

Hearing Disabilities

- **Conductive Hearing Loss** - hearing loss caused by damage to the mechanical system that conducts sound waves to the cochlea (damage to the eardrum or bones in the middle ear.)

- **Nerve Hearing Loss**
  - hearing loss caused by damage to the cochlea's receptor cells or to the auditory nerve (damage to structures of the inner ear)

Noise Exposure

- May fracture the middle ear bones (ossicles).
- May rip holes in the ear drum.
- May kill the auditory receptors (inner hair cells).
  - Only 4,000 receptors per ear.
- May induce _______ in immature organisms (SIDS).

PRS

- A conductive hearing loss can potentially be cured by surgery, while at present there is no cure for nerve deafness.
  - A. True
  - B. False
Ear Infections
- Fluids in the middle ear block the transmission of sound to the inner ear.
- Fluid pressure may rupture the ear drum.
- Ear tubes reduce the frequency and severity of ear infections.
- Chronic ear infections may potentially lead to deficits in the organization of the auditory cortex (like amblyopia). Potential link with learning disabilities.

Smell and Taste: The Sensual Senses
- Odors are airborne chemicals that interact with receptors in our nasal passages
- We detect certain tastes: sweet, sour, salty, bitter, umami (“savory”), and perhaps fat
- Papillae on the tongue contain taste buds, which are sense receptors

Smell and Taste Pathways

Age, Sex and Sense of Smell

Taste, Smell, and Emotion
- Distinguishing pleasant vs. disgusting smells - limbic system (amygdala, orbitofrontal cortex)
- Tasting disgusting food and viewing facial expressions of disgust activate gustatory cortex
- ___ - odorless chemicals that serve as social signals to members of one’s species
- Loss of taste and smell - occurs during normal aging, and as a symptom of diabetes, high blood pressure, or other disease process
- Some may eat less, die sooner

Body Senses: Touch, Body Position, Balance
- Somatosensory System - touch and pain
- Mechanoreceptors - specialized nerve endings in skin; detect light touch, deep pressure, temperature
- Free nerve endings - in skin; detect pain, touch, temperature
Pain

- Psychological Control
  - Mind over sensation, distraction
- Gate-Control Theory
  - Theory that the spinal cord contains a neurological “gate” that blocks pain signals or allows them to pass on to the brain
  - “Gate” opened by the activity of pain signals traveling up small nerve fibers
  - “Gate” closed by activity in larger fibers or by information coming from the brain

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Pain

- Transduction – the biochemical pain stimulus may be potassium ions (K+) leaking out of ruptured cells, it may be substance P or some unknown molecule.
- Pain receptors – may be free nerve endings.
- CNS – pain is probably experienced in the thalamus.

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Pain

- ________ pain – sharp, localized, rapidly adapting. Transmitted by large diameter myelinated axons.
- ________ pain – diffuse, burning, slowly adapting, not localized. Transmitted by small diameter, unmyelinated axons. The axons are short and many synapses are involved in transmitting the signal to the thalamus.
  - Pain medications are used to control protopathic pain.

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Pain

- The magnitude of pain ________ equal the severity of tissue damage.
- Neural gate – located in the spinal cord.
- Cognitive expectations – may produce the release of endorphins.
- ________ – may produce the release of endorphins.
- Acupuncture – may produce the release of endorphins.
- Endorphins act to close the neural gate, and reduce the level of discomfort.

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Pain

- ________ mimics the endorphine molecule, and closes the neural gate.
- Morphine has a systemic effect and may stimulate receptor sites not involved in the pain pathway (may produce hallucinations).
- Morphine causes a reduction in the synthesis of endorphins, and this leads to dependency, addiction and withdrawal.
**PRS**

- Pain medications are used to control protopathic pain.
- T/F

**Subliminal Thresholds**

- Subliminal
  - When stimuli are below one’s absolute threshold for conscious awareness

<table>
<thead>
<tr>
<th>Intensity of stimulus</th>
<th>Low</th>
<th>Absolute threshold</th>
<th>Medium</th>
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<tbody>
<tr>
<td>Percentage of correct detections</td>
<td>0</td>
<td>25</td>
<td>50</td>
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**Subliminal Perception**

- Can exposure to faint, brief or “reversed” stimuli influence behavior?
- Social concern for ‘backwards’ masking in music influencing today’s youth, or hidden advertising influencing consumer behavior.
- Strongest data show that “subliminal” exposure to a simple picture is processed to the level that it can be identified as “familiar” compared to a control picture 60-65% of the time. This effect may last for a week or longer.

**Cooperative Group Challenge**

1. transduction
2. depth perception
3. trichromatic theory
4. sensation
5. perception
6. absolute threshold
7. just noticeable difference
8. cones

**Q1**

1. ____ are receptors that allow us to see in color.

**Q2**

2. The process of converting external energy into neural activity is called ____.
Q3
3. The _____ is the lowest level of a stimulus needed for the subject to detect it 50% of the time.

Q4
4. _____ is the interpretation of raw sensory inputs.

Q5.
5. The idea that color vision is based on our sensitivity to three different colors is called the _____.

Q6.
6. The _____ tells us how easily we can detect changes in stimulus intensity.

Q7.
7. _____ refers to the detection of physical energy by our sense organs.

Q8.
8. Our ability to see spatial relations in three dimensions is called _____.