Habituation, Sensitization, and Familiarization

Learning & Memory
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Habituation
the ability to ignore irrelevant, repetitive stimuli

- What else are you habituated to right now?
- My first experience with snow

Where does habituation occur?
- The case of the simple reflex (3 neurons)

Non-Learning Explanations
1. Decreases in sensitivity of sensory receptor (adaptation)
2. Fatigue of motor response

Where does habituation occur?
- The case of the reflex

Sensory Neuron?
1. Decreases in sensitivity of sensory receptor (adaptation)
2. Play sound in a new location.
3. Observe dishabituation or reorienting to new location.
* Alternatively, observe other (non-habituated) behaviors.

Muscle?
2. Decreases in the responsiveness of motor neuron or muscle (fatigue)
1. Habituate jumping reflex to loud sound.
2. Play new sound or new stimulus.
3. Observe dishabituation/spontaneous recovery.
• A brief video demonstrating habituation of an acoustic startle reflex in a rat.

https://www.youtube.com/watch?v=Kfu0FAAn-10

• Other measures: orienting responses, fixation time, etc.

• Not always advantageous
  • e.g., Deer and gamblers

Utility of Habituation: Recognition Memory

• Novelty preference/preferential viewing
  • Length and content of memory
  • Rats & Monkeys look 2x as long at novel stimuli

Influences on Habituation

• Interstimulus Interval (ISI)
  • Short-term and Long-term Habituation
    • Massed Exposure
      • Faster habituation in short-term
    • Spaced Exposure
      • Longer habituation, less spontaneous recovery

• Stimulus Specificity and Generalization

• Dishabituation

• Coolidge Effect
  • “Ha. Tell that to [Mr./Mrs.] Coolidge.”
**Sensitization**  
*heightened awareness/responsiveness to a stimulus or class of stimuli for a period of time.*

- Can you think of other things you have been sensitized to?

**Habituation vs. Sensitization**

<table>
<thead>
<tr>
<th>Habituation</th>
<th>Sensitization</th>
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<tbody>
<tr>
<td>Specific to a particular stimulus and response</td>
<td>General to a variety of stimuli and response</td>
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<tr>
<td>Results in decreased response magnitude</td>
<td>Results in increased response magnitude</td>
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<tr>
<td>Specific to a particular brain circuit</td>
<td>Represents responses in many circuits</td>
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<tr>
<td>Occurs after repetition of a variety of types of stimuli</td>
<td>Occurs only after emotional stimuli</td>
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<tr>
<td>Exhibited in both the short term and long term</td>
<td>Normally lasts only for a short period</td>
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**Dual Process Theory**
- Sensitization and Habituation, at the SAME time.
- Behavior is result of summation

**Opponent Process Theory**
- Take the good with the bad.
Experience-based learning
Object Recognition

- Neophobia
  - Dolphins

Familiarity
- “sense of sameness” (James, 1890)
- Priming, word-stem completion task
- Moth detection in blue jays (Bond & Kamil, 1999)

Recognition of Individuals?
Johnston (1993): Flank scent memory in golden hamsters
- Habituation to Hamster A’s scent can last up to 30 min.

More Golden Hamsters
Can they distinguish between two female hamsters with similar scents?

Perceptual Learning
increased ability to detect and classify particular sensory stimuli after exposure

- Chicken Sexers
- Coke vs. Pepsi
- Rats in Fancy Houses learn faster (Gibson & Walk, 1956)
- Mere Exposure (Gibson & Gibson, 1955)

- Other-race effect (Malpass & Kravitz, 1969) and improvement
Spatial Learning

Memory for turns, Visual Cues

Messing with Wasps
(Tinbergen & Kruyt, 1972)

Biology of Habituation: Why Sea Snails?

Aplysia (invertebrates) are simple, with large unique neurons
- Gill/siphon withdrawal reflex

Kandel’s Aplysia research (e.g., Squire & Kandel, 1999)
- Habituation of a gill withdrawal reflex
- Repeated stimulation results in long-lasting (long-term memory?) habituation for several weeks.
- Synaptic Depression (dual process theory)
• **Kandel’s Aplysia research** (e.g., Squire & Kandel, 1999)
  • Neuronal mechanism of habituation
    • Sensory-Motor Synapse
    • Sensory neurons still fire AP
    • Motor neurons still sensitive to neurotransmitter, just less of it
    • Homosynaptic

  • Fewer synaptic connections and fewer vesicles being released presynaptically
  • Crayfish and cat

• **Kandel’s Aplysia research** (e.g., Squire & Kandel, 1999)
  • Neuronal mechanism of sensitization
    • Electric shock to tail results in sensitization of gill withdrawal

• **Kandel’s Aplysia research** (e.g., Squire & Kandel, 1999)
  • Neuronal mechanism of sensitization
    • **Modulatory Interneurons** (heterosynaptic)

  1. Modulatory interneuron releases serotonin
  2. Presynaptic K⁺ channel blocked, Action Potential prolonged
  3. Ca⁺⁺ channels open, more Ca⁺⁺ in presynaptic
  4. More Ca⁺⁺ docking with vesicles, more neurotransmitter
  5. More neurotransmitter, more AP from motor neuron
Perceptual Learning and Cortical Plasticity

- Somatosensory cortex
- Receptive Fields
- Topographic map
- Development
  - Blind kittens and opossums
  - Specific and multimodal and new?
- Exposure

Spatial Memory

- Hippocampus size and importance
- Place cells (O’Keefe & Dostrovsky, 1971)
- Nobel Prize in 2014
- Shrinkage or blocking, decreased abilities

Damage and Rehabilitation after Stroke

- Use it or Lose it and Learned non-use
- Constraint-induced movement therapy
  - Possibly a form of perceptual learning

Human-Machine Interfaces

- Cochlear implants
- Rats with night vision