Habituation, Sensitization, and Familiarization

Learning & Memory
Dr. Clark-Foos

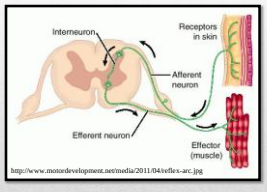
Habituation

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?

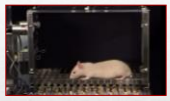
1. Decreases in sensitivity of sensory receptor (*adaptation*)
   1. Habituate jumping reflex to loud sound.
   2. Play sound in a new location.
   3. Observe dishabituation or reorienting to new location.

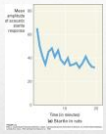
* Alternatively, observe other (non-habituated) behaviors.

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.



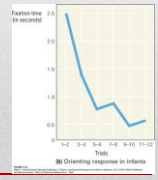


https://www.youtube.com/watch?v=Kfu0FAAu-10

- 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



- Stimulus Specificity and Generalization
- Dishhabituation

- Coolidge Effect
  - "Ha. Tell that to [Mr./Mrs] Coolidge."

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

Sensitization

heightened awareness/responsiveness to a stimulus or class of stimuli for a period of time.

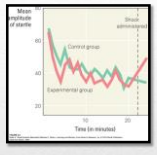
- *Can you think of other things you have been sensitized to?*

Habituation vs. Sensitization

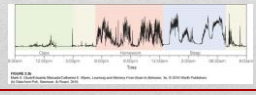
Habituation	Sensitization
Specific to particular stimulus and response	General to a variety of stimuli and responses
Results in decreased response magnitude	Results in increased response magnitude
Specific to a particular brain circuit	Heightens responses in many circuits
Occurs after repetition of a variety of types of stimuli	Occurs only after emotional stimuli
Exhibited in both the short term and long term	Normally lasts only for a short period

Sensitization

- Dishabituation and Sensitization
- Fear-potentiated startle reflex
- Desensitization

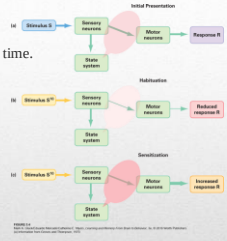


- Skin conductance response (SCR)
  - *Prepulse inhibition*
    - Quiet tone → Startling Tone → Less response
    - Less response, Habituation
    - Not Stimulus Specific, Sensitization



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

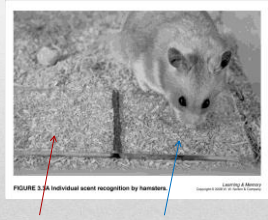
- *Neophobia*
  - Dolphins

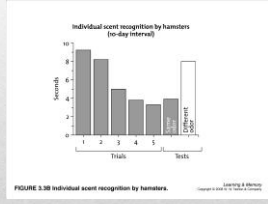
Familiarity

- "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.



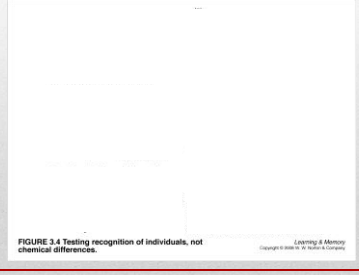


Hamster A flank scent

Hamster B flank scent

- More Golden Hamsters

  Can they distinguish between two female hamsters with similar scents?

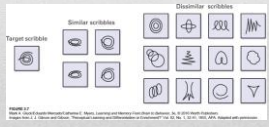


Perceptual Learning

increased ability to detect and classify particular sensory stimuli after exposure

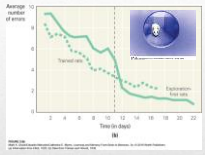
- Chicken Sexers
- Coke vs. Pepsi

- Rats in Fancy Houses learn faster* (Gibson & Walk, 1956)
- Mere Exposure (Gibson & Gibson, 1955)



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

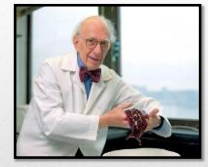
Spatial Learning



Memory for turns, Visual Cues

Messing with Wasps
(Tinbergen & Kruyt, 1972)

• Biology of Habituation: *Why Sea Snails?*

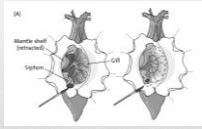


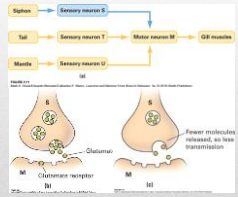
Aplysia (invertebrates) are simple, with large unique neurons

- *Gill/siphon withdrawal reflex*

• Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)

- Habituation of a gill withdrawal reflex

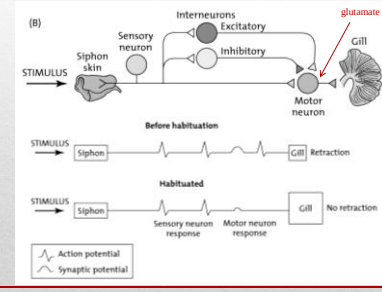




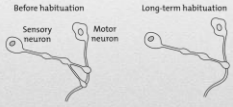
- Repeated stimulation results in long-lasting (long-term memory?) habituation for several weeks.
  - Synaptic Depression (dual process theory)

• Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)

- Neuronal mechanism of habituation

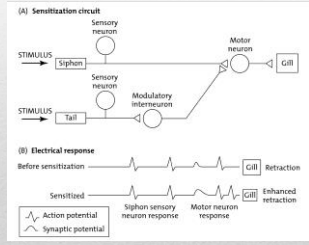


- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Neuronal mechanism of habituation
    - Sensory-Motor Synapse
      - Sensory neurons still fire AP
      - Motor neurons still sensitive to neurotransmitter, just less of it.
      - Homosynaptic

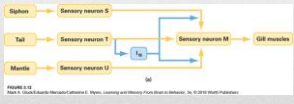


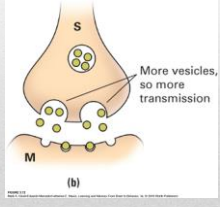
      - Fewer synaptic connections and fewer vesicles being released presynaptically
        - Crayfish and cats

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



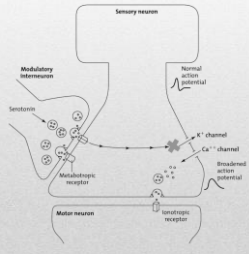
- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Neuronal mechanism of sensitization
    - *Modulatory Interneurons* (heterosynaptic)





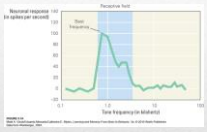
- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Neuronal mechanism of sensitization
    - *Ionotropic vs. Metabotropic receptors*

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

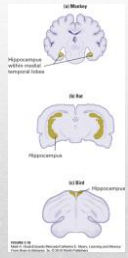
- Somatosensory cortex
- Receptive Fields
  - Topographic map



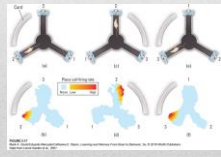
- Development
  - Blind kittens and opossums
  - Specific and multimodal and new?

- Exposure

Spatial Memory



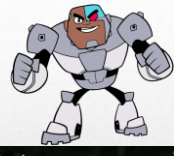
- Hippocampus size and importance
- Place cells (O'Keefe & Dostrovsky, 1971)
  - Nobel Prize in 2014
  - Shrinkage or blocking, decreased abilities



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