Habituation, Sensitization, and Familiarization

Learning & Memory

Dr. Clark-Foos

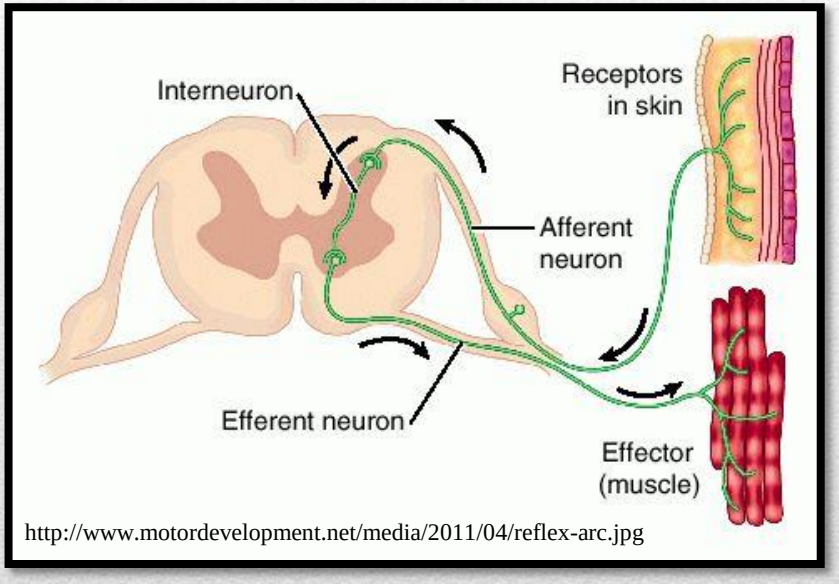
Habituation

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)



http://www.motordevelopment.net/media/2011/04/reflex-arc.jpg

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?

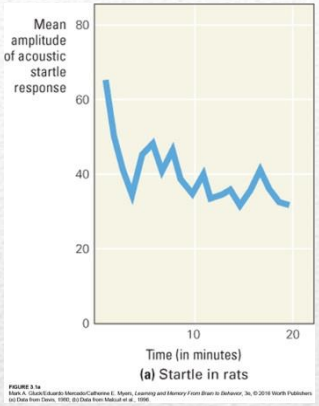
1. Decreases in sensitivity of sensory receptor (*adaptation*)
    1. Habituate jumping reflex to loud sound.
    2. Play sound in a new location.
    3. Observe dishabituation or reorienting to new location.

* 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

- Dishabituation

- 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?*

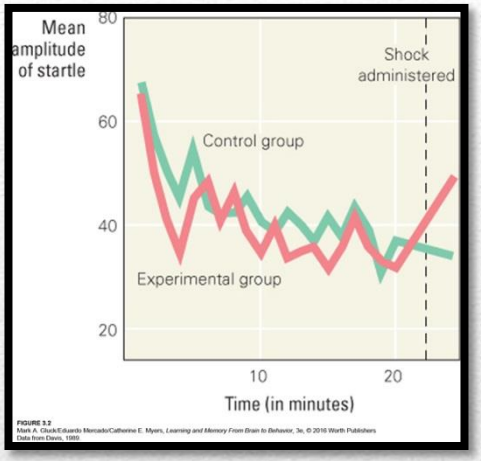
Habituation vs. Sensitization

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



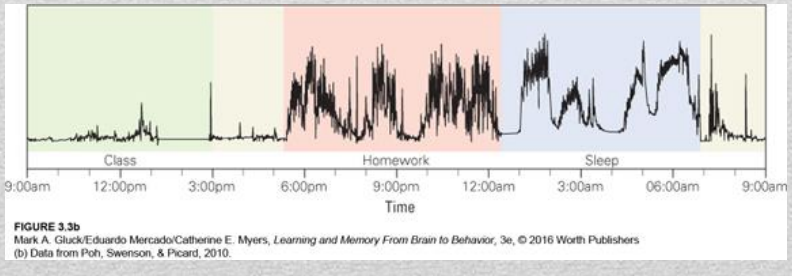


FIGURE 3.3b
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(b) Data from Poh, Swenson, & Picard, 2010.

Dual Process Theory

- Sensitization and Habituation, at the SAME time.
- Behavior is result of summation

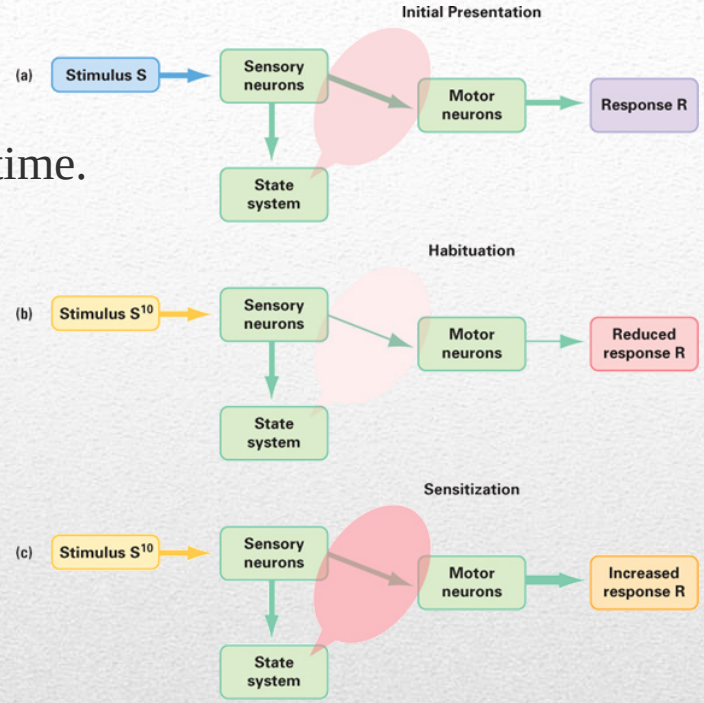

FIGURE 3.4
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(a) Information from Groves and Thompson, 1970.

Opponent Process Theory

- Take the good with the bad.

Experience-based learning

Object Recognition

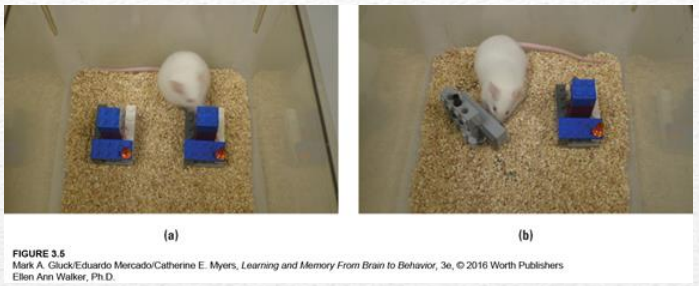

FIGURE 3.5
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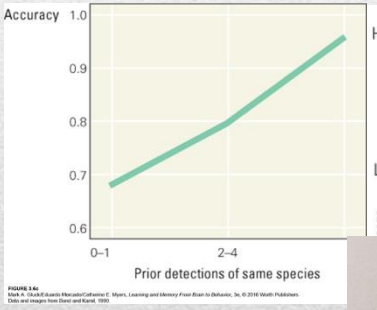
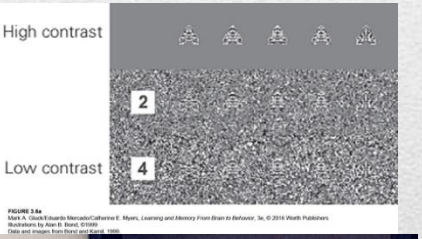
Ellen Ann Walker, Ph.D.

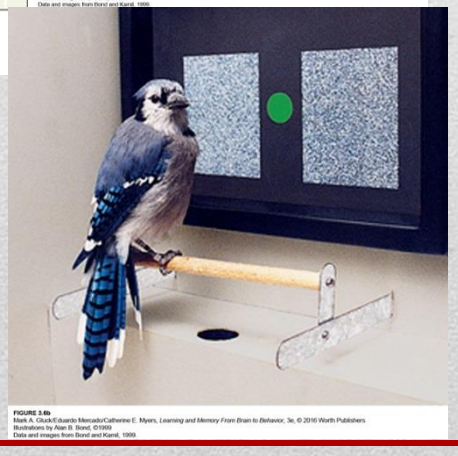
- *Neophobia*
  - Dolphins

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.

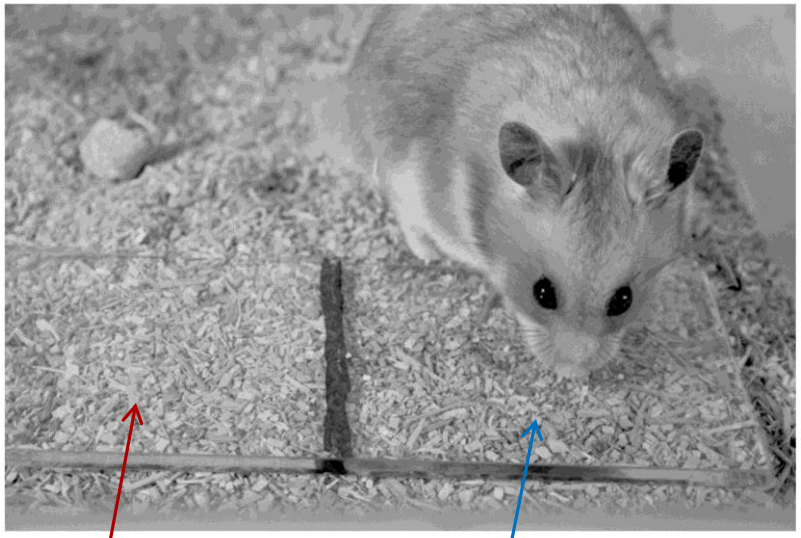


FIGURE 3.3A Individual scent recognition by hamsters.

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Hamster A flank scent

Hamster B flank scent

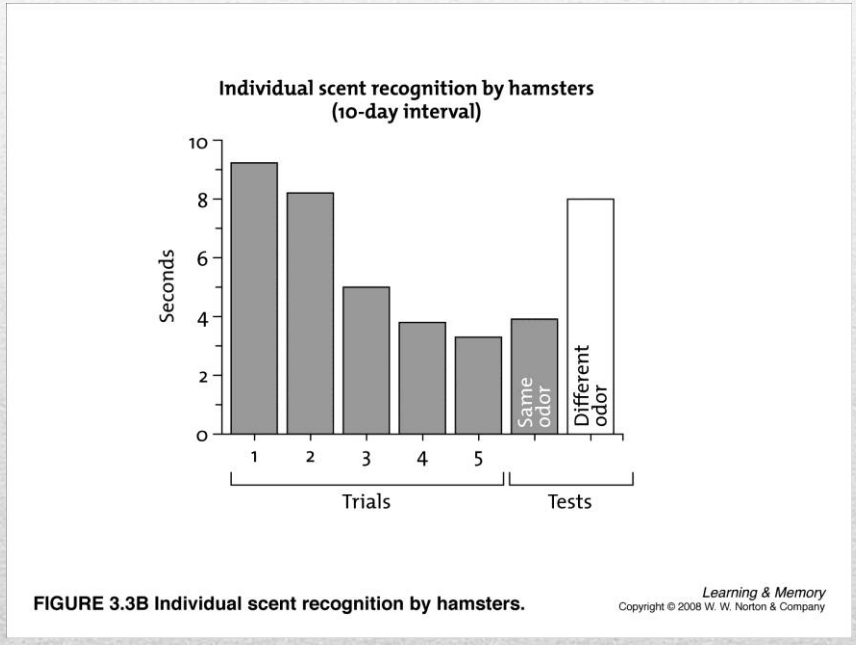

FIGURE 3.3B Individual scent recognition by hamsters.

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- More Golden Hamsters

  Can they distinguish between two female hamsters with similar scents?

FIGURE 3.4 Testing recognition of individuals, not chemical differences.

Learning & Memory

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)

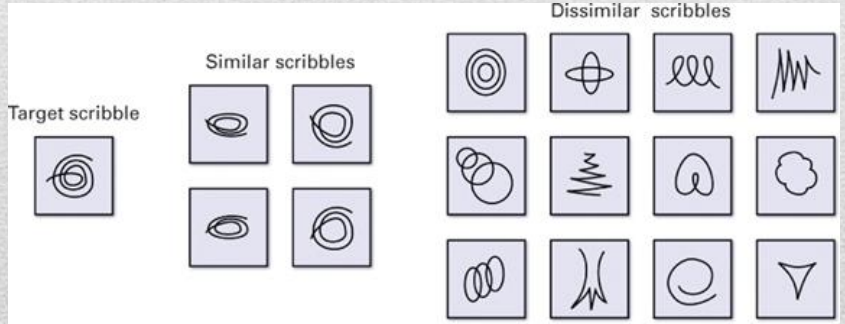

FIGURE 3.7
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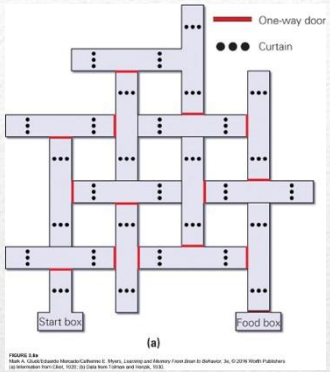
Images from J. J. Gibson and Gibson, "Perceptual Learning and Differentiation or Enrichment?" Vol. 62, No. 1, 32-41, 1955, APA. Adapted with permission.

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

Spatial Learning



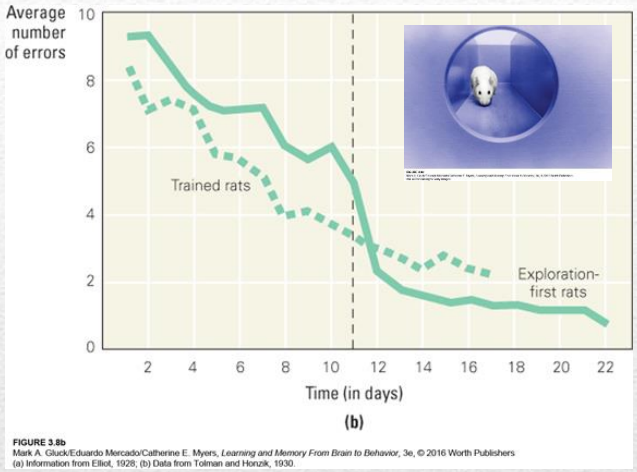


FIGURE 3.8b
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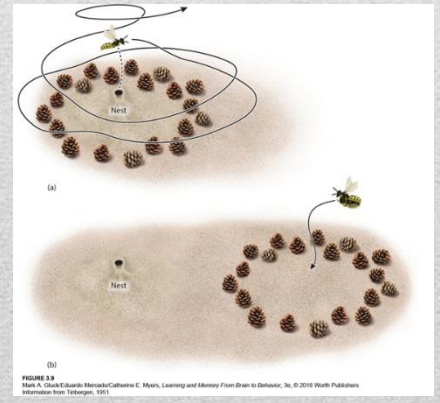
(a) Information from Elliot, 1928; (b) Data from Tolman and Honzik, 1930.

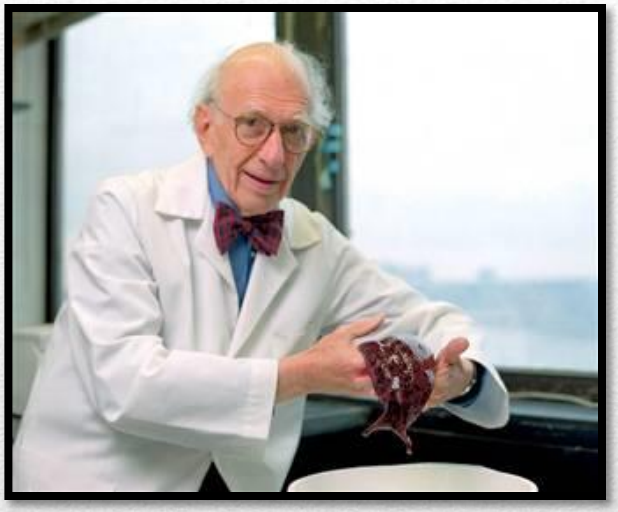
Memory for turns, Visual Cues

Messing with Wasps

(Tinbergen & Kruyt, 1972)



- Biology of Habituation: *Why Sea Snails?*



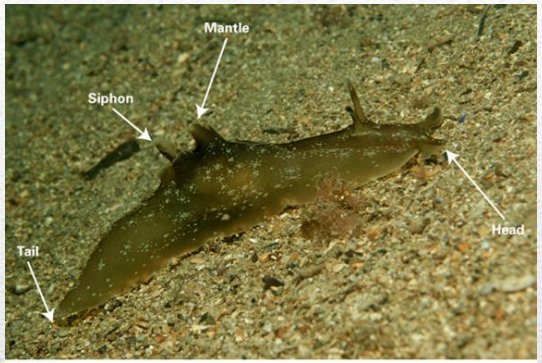


FIGURE 3.10
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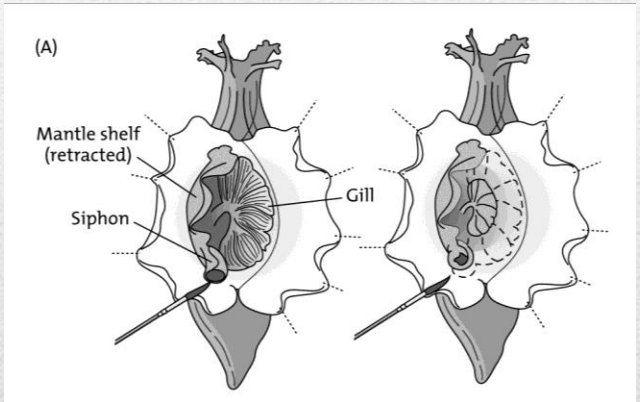
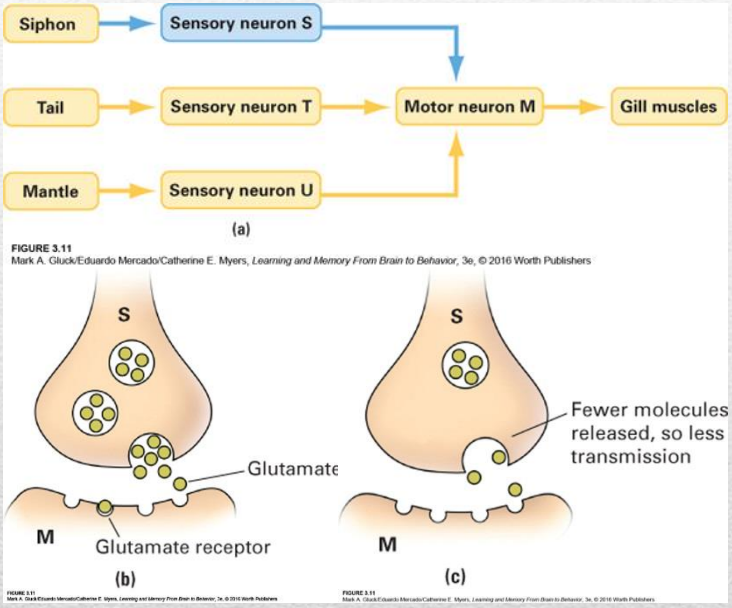
Borut Furlan/Getty Images
Information from Squire and Kandel, 2000.

Aplysia (invertebrates) are simple, with large unique neurons

- *Gill/siphon withdrawal reflex*

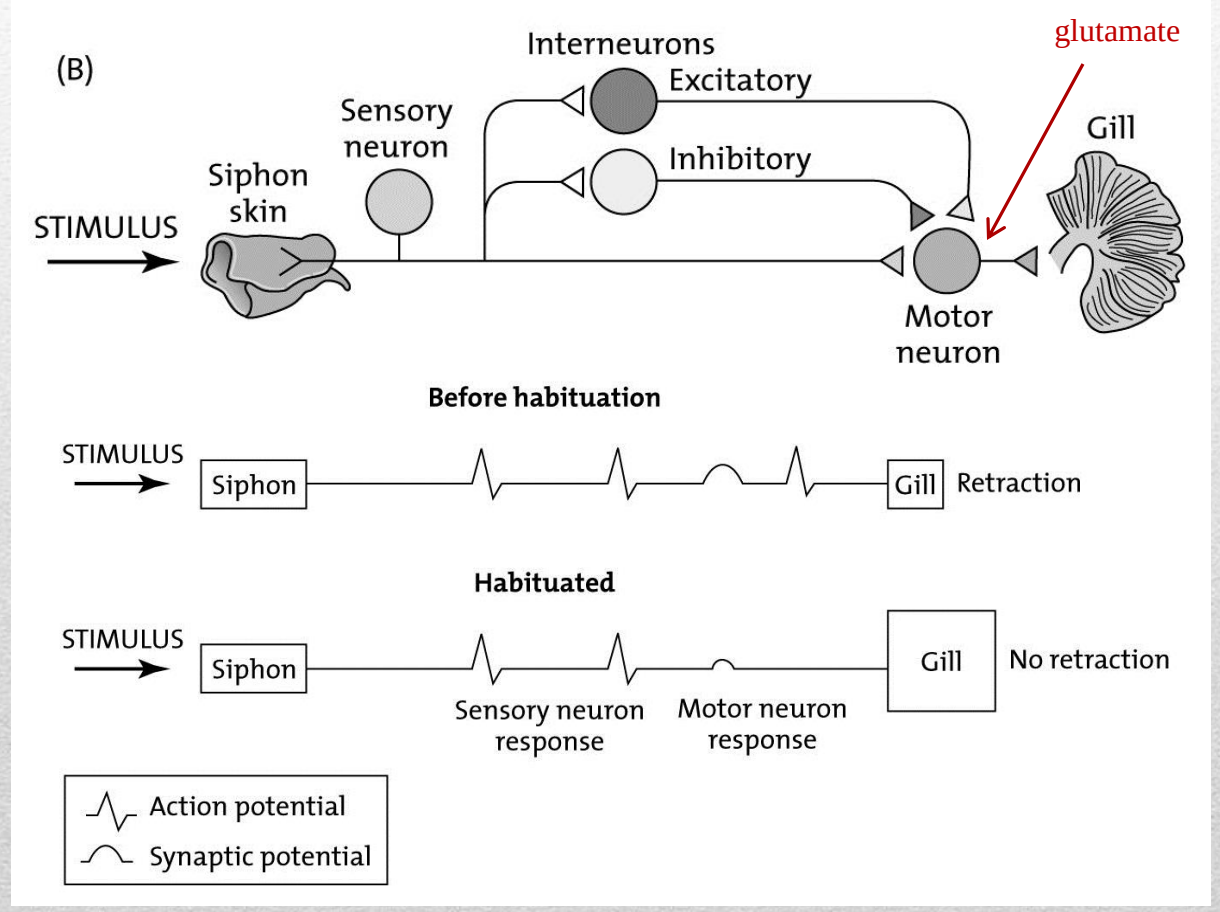
- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Habituation of a gill withdrawal reflex



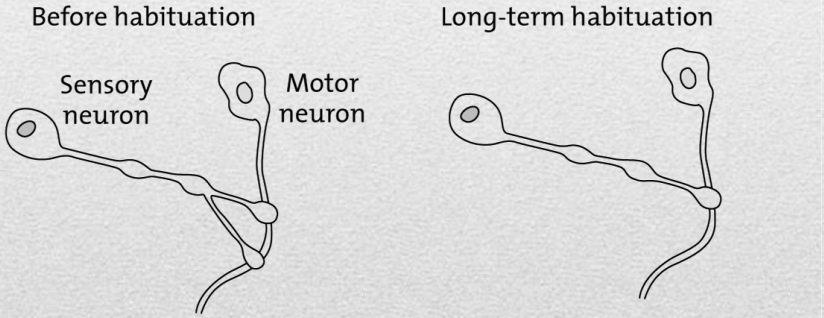


  - Repeated stimulation results in long-lasting (long-term memory?) habituation for several weeks.
    - Synaptic Depression (dual process theory)

- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Neuronal mechanism of habituation

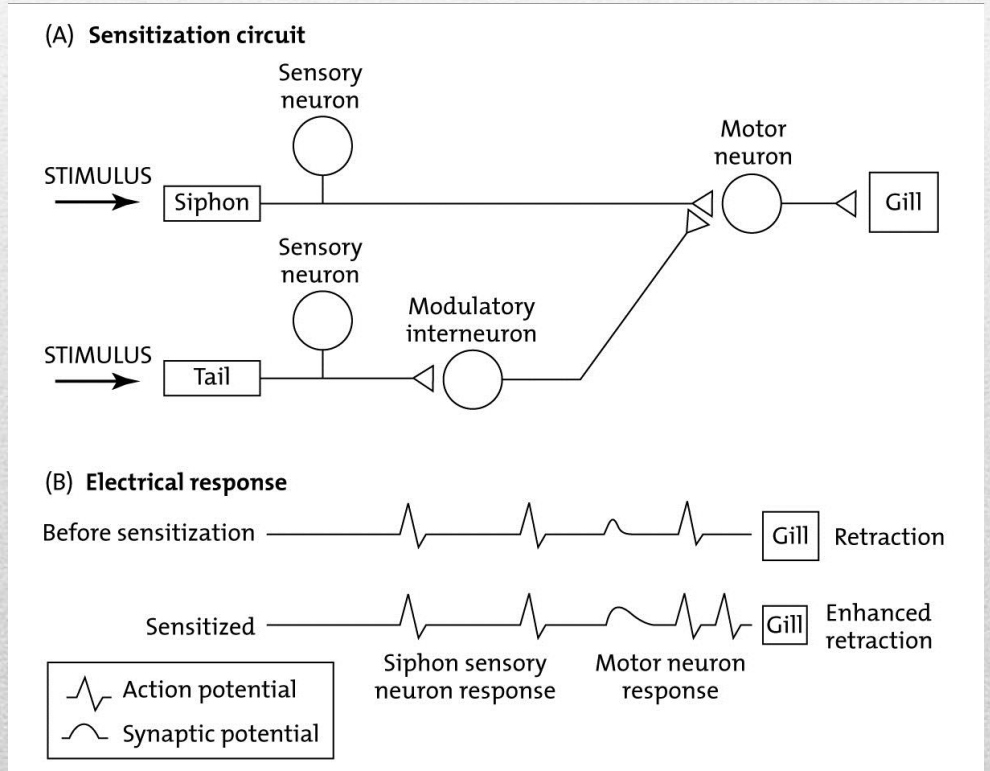


- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Neuronal mechanism of habituation
    - Sensory-Motor Synapse
      - Sensory neurons still fire AP
      - Motor neurons still sensitive to neurotransmitter, just less of it.
      - Homosynaptic



      - 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)

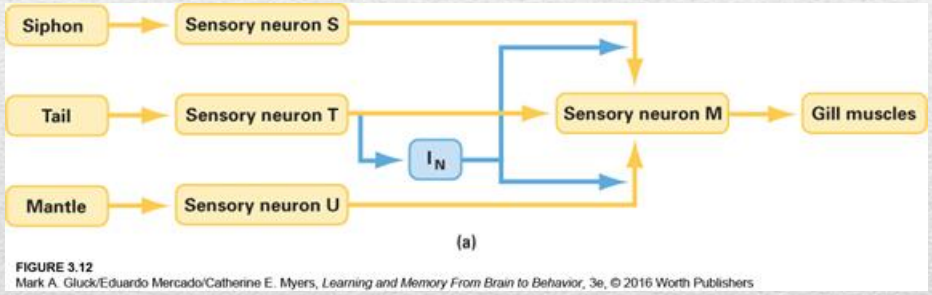


FIGURE 3.12
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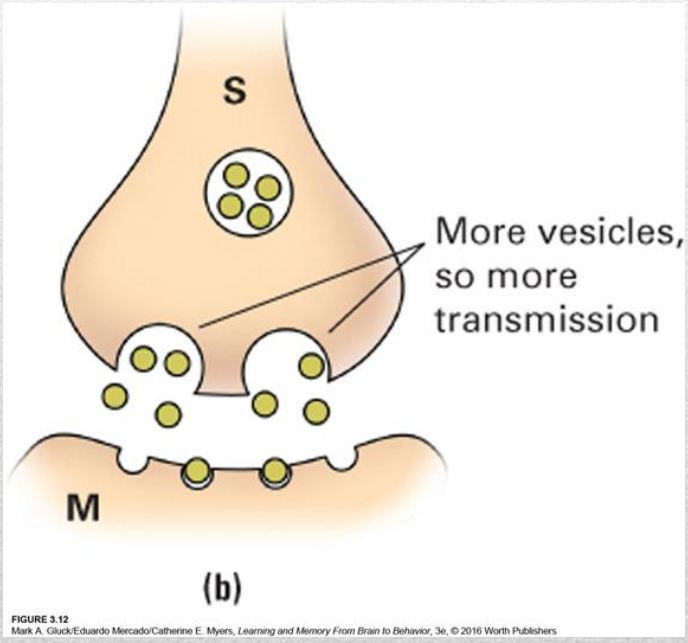

FIGURE 3.12
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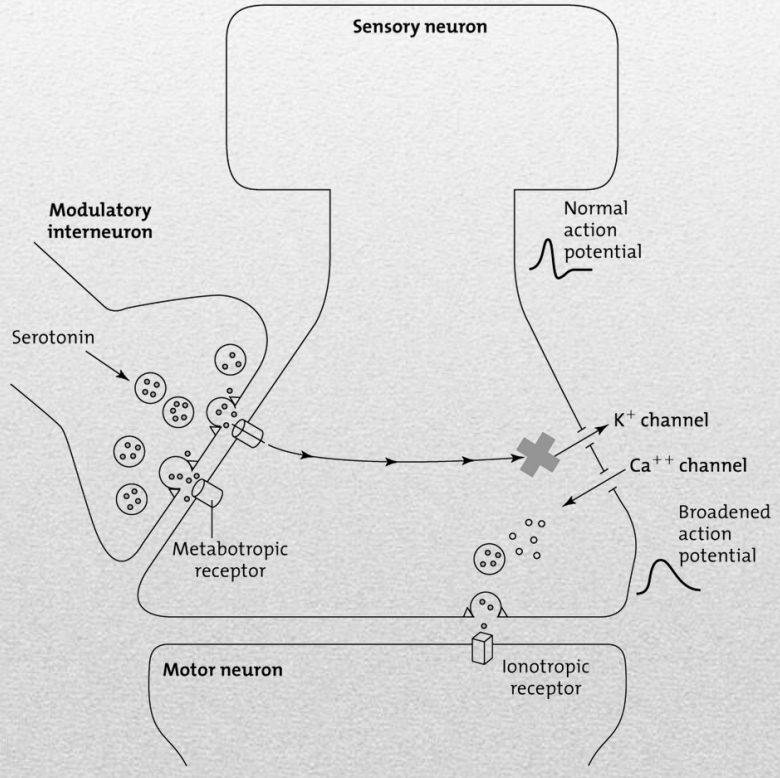
- Kandel's *Aplysia* research (e.g., Squire & Kandel, 1999)
  - Neuronal mechanism of sensitization
    - *Ionotropic vs. Metabotropic receptors*

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

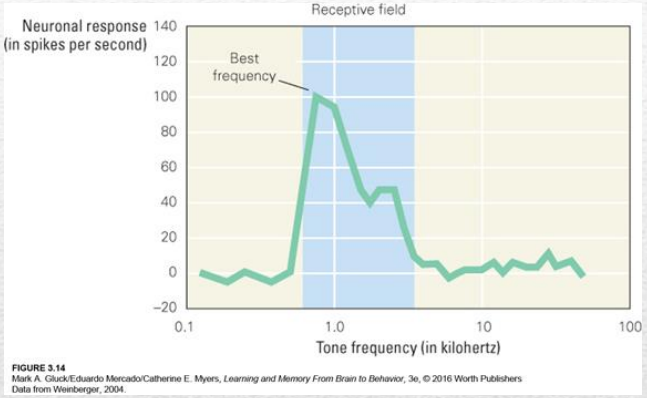


FIGURE 3.14
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Data from Weinberger, 2004.

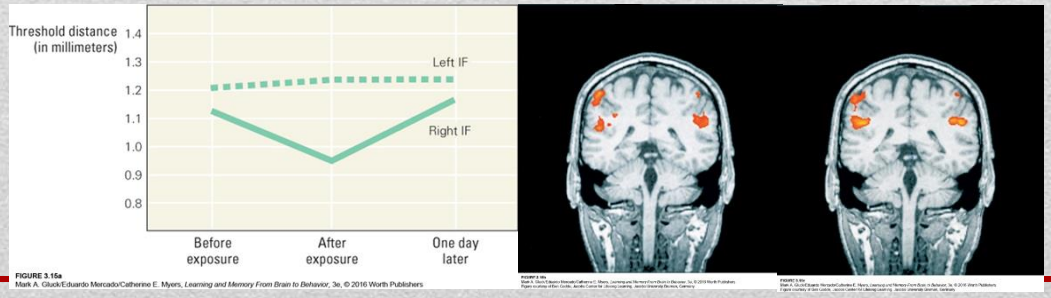

FIGURE 3.15a
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Spatial Memory

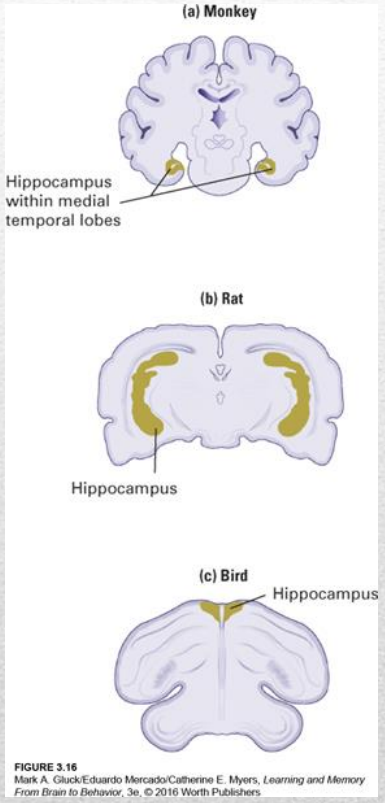

FIGURE 3.16
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- Hippocampus size and importance
- Place cells (O'Keefe & Dostrovsky, 1971)
  - Nobel Prize in 2014
  - Shrinkage or blocking, decreased abilities

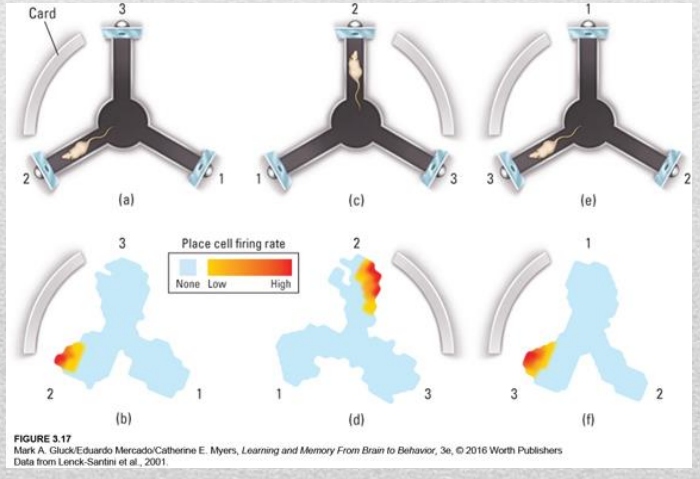

FIGURE 3.17
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Data from Lenck-Santini et al., 2001.

Damage and Rehabilitation after Stroke

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

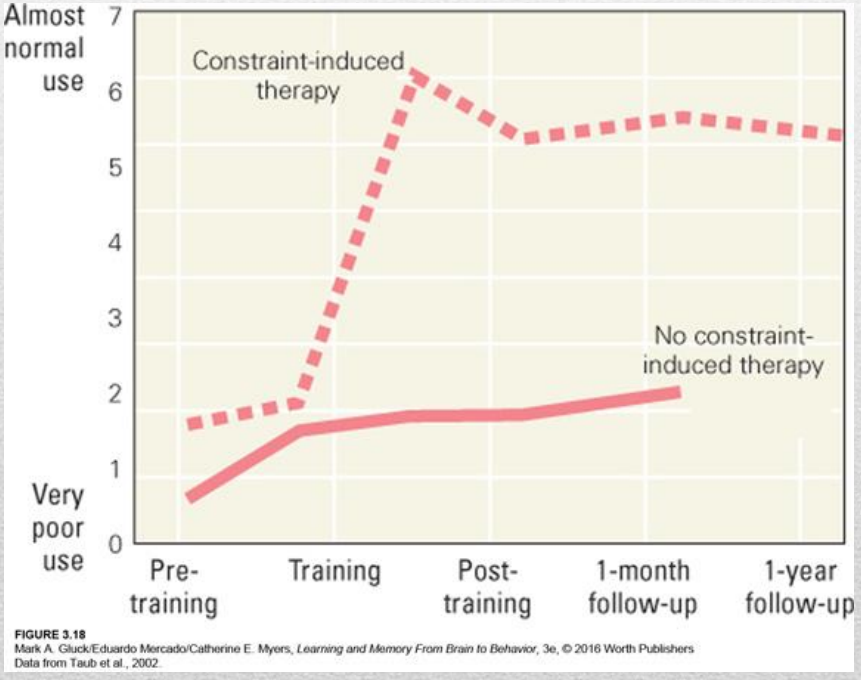

FIGURE 3.18
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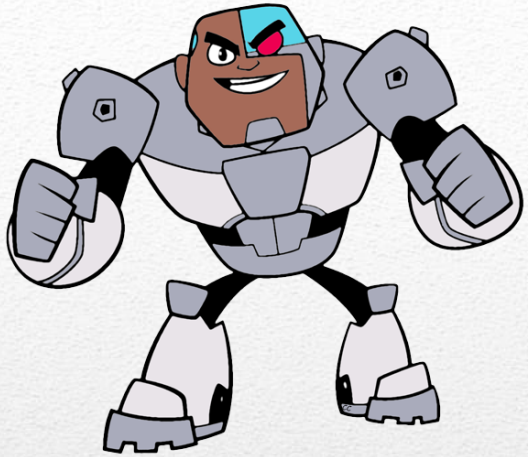
Data from Taub et al., 2002.

Human-Machine Interfaces



- Cochlear implants
- Rats with night vision

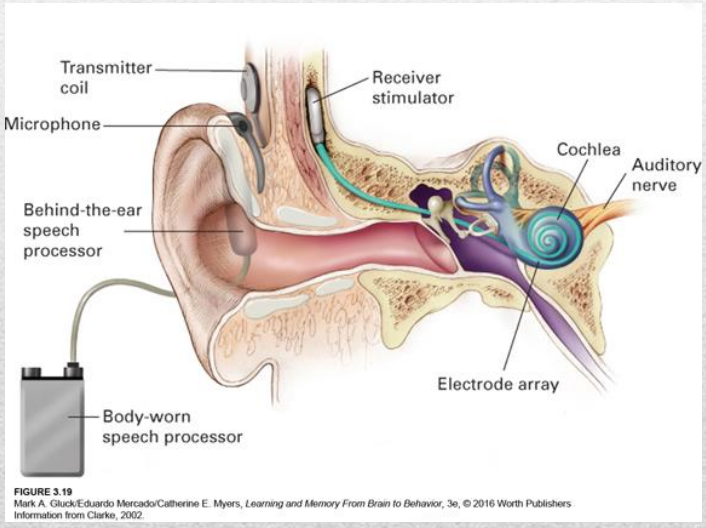


FIGURE 3.19
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Information from Clarke, 2002.