Learning: Part 2

Outline

- Last week
  - Habituation
  - Sensitization
  - Classical conditioning
- Tonight
  - Instrumental conditioning
  - Cognitive (and other forms of) learning
  - Basic memory processes

Implicit Learning Summary

- Habituation
  - a decrease in the strength of a response after repeated presentation of a stimulus
- Sensitization
  - an increase in response strength to repeated dangerous, irritating, or both stimuli
- Classical conditioning
  - Pairing a neutral stimulus with a stimulus (US) that elicits a reflexive response (UR). Once paired, the neutral stimulus becomes a conditioned stimulus that leads to a conditioned response
But

- Not all learning involves reflexive (automatic) behaviors
- Some learning involves intentional or non-pre-programmed behaviors
- Some behaviors are learned
- Sometimes we learn without direct involvement

Learned Behavior?

http://www.youtube.com/watch?v=o5arXGwaP7c

Instrumental (or Operant) Conditioning

Edward Thorndike, 1874-1949
What is learned?

- An association between a behavior and a response

- Learning is a trial and error process in which the animal gradually becomes more likely to make those responses that produce desirable effects

Thorndike’s Law of Effect

- If behavior followed by pleasant state, behavior’s likelihood of occurring again increases.
- If behavior followed by aversive state, behavior’s likelihood of occurring again decreases.
Instrumental Conditioning

Burrhus Frederic (B.F.) Skinner, 1904-1990

Developed the “Skinner Box” (formal name: Operant Chamber)

- contains bar or key that an animal manipulates to obtain food reinforcer
- contains device to record responses
- Most famous, rat pressing lever
Instrumental Conditioning: Two Basic components

- Reinforcement
  - Increases likelihood of behavior recurring
- Punishment
  - Decreases likelihood of behavior recurring

Types of Reinforcement & Punishment

<table>
<thead>
<tr>
<th></th>
<th>POSITIVE (give something)</th>
<th>NEGATIVE (take something away)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcement</td>
<td>press lever → give food</td>
<td>press lever → take away shock</td>
</tr>
<tr>
<td>Punishment</td>
<td>press lever → give shock</td>
<td>press lever → remove food</td>
</tr>
</tbody>
</table>

Getting to the desired behavior

- Because all behaviors may not occur automatically, need some way of guiding behaviors to desired one
Getting to the desired behavior

- **SHAPING**: Reinforcing closer and closer approximations to the desired behavior

How often should reinforcement/punishment be delivered?

- Continuous
- Partial

Schedules of Reinforcement

- **Continuous Reinforcement**: reinforce the desired response each time it occurs
Schedules of Reinforcement

- **Partial reinforcement: Interval**
  - **Fixed interval**: Reinforced after a particular interval of time passes
  - **Variable interval**: Reinforced after an interval of time on average (e.g., rat gets food pellet after pressing lever for 10 minutes on average)

Schedules of Reinforcement

- **Intermittent or partial reinforcement: Ratio**
  - **Fixed ratio**: Reinforced after a specific number of responses (e.g., 1 comment every 5th smile)
  - **Variable ratio**: Reinforced after a number of responses that averages to a particular value (e.g., on average after every 5th smile, but sometimes reinforcement will come after the 4th, sometimes after the 7th; gambling)

If you want to change behavior as quickly as possible, immediate and continuous reinforcement or punishment is best

- example: running across street
- example: Summer got an A+ on her test, she got to go to treasure chest
If you want a behavior to last as long as possible (i.e., be resistant to extinction), variable ratio reinforcement or punishment is best.

Example: whining to get a toy.

**Schedules of Reinforcement**

- **Continuous Reinforcement:** Reinforce the desired response each time it occurs.

Gambling is:

- Reinforced after a variable number of responses.
- Leads to fast, steady responding.
- Very difficult to stop, rewards unpredictable.
Does punishment work?
- Yes, if immediate, clearly paired, and continuous
- but…
  - Only tells what not to do
  - Creates heightened anxiety, which can impair future learning
  - May lead to subversive behavior

Some types of punishment may be reinforcements instead

Attention to bad behavior can serve as positive reinforcement
- [http://youtube.com/watch?v=KpSfThUv_pc](http://youtube.com/watch?v=KpSfThUv_pc)
Discipline techniques that work

- Notice and pay attention to good behavior
- Reinforce good behavior
- Ignore minor bad behavior such as fussiness or whining
- If necessary, give simple clear commands and enforce them immediately by intervening

http://www.youtube.com/watch?v=qy_miEnniF4
2:45 minutes

Some claims of “behaviorism”

- Behaviors are the result of environment pairings (CS-US), or stimulus-response
- Basic principles explain learning within and across species
- Thoughts and cognitions are not required for learning
- Learning expressed via behavior
- Big “names:” Skinner, Watson, Pavlov, Thorndike
Limitations to general learning principles

- Learning doesn’t always require behavior
- Organisms predisposed to pick up on some pairings not others
- Learning can occur without reinforcement or pairing

Different animals are biologically predisposed to associate different types of stimuli

- Birds easily associate illness with visual cues (e.g., color of food), but not with taste
- Rats easily associate illness with taste, but not with visual cues

Garcia & Koelling’s (1966) sweet, bright, noisy water study

- Group 1: Drinking ‘sweet, bright, noisy water’ was followed by shock
- Group 2: Drinking ‘sweet, bright, noisy water’ was followed by nausea
- Rats later exposed to a subset of these three cues, which cues would cause the rats in each group to avoid drinking the water?
Garcia & Koelling's (1966) bright noisy water study

Results

Rats formed an association:
- between audio-visual cues ('bright noisy water') and shock
- between taste and nausea

Rats did not form an association:
- between audio-visual cues and nausea
- Between taste and shock

Implications

- Behaviorists: general laws of learning shape the behavior of all animals
- Garcia: animals "biased learning machines" designed by evolutionary forces to forge meaningful links between some stimuli but not others
Learning without reinforcement

Edward Chase Tolman
- Rat group A: ran maze for 10 days, reinforced for finding way out.
- Rat group B: ran through maze for 7 days, no reinforcement. Day 8-10, reinforcement
- Rat group C: rode in trolley through maze for several days. Let out on day 8.

Tolman study

![Graph showing learning without reinforcement](image)
Rats make cognitive maps of mazes without reinforcement

Rats made cognitive maps without even moving behaviorally through maze

Children learn through observation after one exposure (not gradual) and without reinforcement (Albert Bandura)

Summary

All animals can learn associations between CS and US, and between actions and their consequences

Behaviorists neglected:
- biological predispositions
- The role of “thought/cognition” in pairing
- learning without reinforcement
Memory

- Maintaining information over time
- Changes in the brain that result from past experience and influence the way we think, feel, or behave
- Critical/influences almost every aspect of our lives

In order to remember information, need to:

- Acquire information
- Store information
- Retrieve information

How all of this occurs often thought of by distinguishing three “systems” of memory

Memory Systems
Properties Of Memory Systems

- Serve different functions
- Vary in
  - capacity: how much information can be maintained
  - duration: how long information stays there

Memory systems

Sensory Memory

Impressions of sensory information that persist after the original stimulus has ended
## Sensory Memory Trace

<table>
<thead>
<tr>
<th>Source</th>
<th>Memory trace</th>
<th>Duration</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual</td>
<td>“icon”</td>
<td>&lt; 1 sec</td>
<td>large</td>
</tr>
<tr>
<td>Auditory</td>
<td>“echo”</td>
<td>&lt; 4 sec</td>
<td>large</td>
</tr>
</tbody>
</table>

Tachistoscope: presents images briefly

### ICONIC MEMORY

Full report condition:
Participants report @ 3
- 4 letters … but know they saw more letters than that
Partial report condition:

- Array flushed for 50 msec.
- Auditory tone indicates line to be remembered (e.g., top line).
- Subject repeats correct line.

Ability to Remember Letters

<table>
<thead>
<tr>
<th>Category 1</th>
<th>Full</th>
<th>Partial</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
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<td>4</td>
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<tr>
<td>12</td>
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</tbody>
</table>
Implications

Participants retain most or all of the items displayed very briefly in a visual sensory register.

How long is visual information stored in iconic memory?

- Tone cues participant about which row to report
- Participant must wait for tone to recall letters
- Vary length of time between turning off the display and sounding the tone

Result: memory of display decays rapidly and is gone within one second.

Memory Stages and Processes

Adapted from Fig 5.1 Leahey & Harris, 2001
Working Memory

- Consciously holding of information in storage or current awareness
- Information with which you are working right now
- Originally called “short-term memory”

Working Memory

- Magic number ± 7

How big is working memory?

- Magic number is still ± 7
- But, how that 7 defined can vary
  - Chunking: Grouping information in meaningful ways to hold more in working memory
How big is working memory?

- **Chunking**
  - Grouping information in meaningful ways allows one to hold more in working memory
  - With greater expertise, can group information meaningfully more easily

**Working Memory**

- **Capacity:** Very limited
  - Unrelated information: 7 ± 2
  - Related information: Amount held in working memory depends on how information organized

**Memory Stages and Processes**

Adapted from Fig 5.1 Leahey & Harris, 2001
Working Memory

- **Capacity:** Very limited
  - Unrelated information: $7 \pm 2$
  - Related information: Amount held in working memory depends on how information organized

- **Duration:** As long as you pay attention to (rehearse) the information