Lecture 18 (Nov 24th): LEARNING & MEMORY #1
Lecture Outline

This Lecture: Psychology of Memory and Brain Areas Involved

Next lecture: Neural Mechanisms for Memory

1) Psychology of Memory:
   - Short Term Memory vs. Long Term Memory
   - Explicit Memory vs. Implicit Memory

2) Conditioned Responses (a type of Implicit Memory):
   - Operant Conditioning
   - Classical Conditioning

3) Brain Areas Involved in Implicit Memory: Classical Conditioning

4) Role of Hippocampus in Memory (and, if there is time, “Place cells”)
PSYCHOLOGY of Memory

Some Memory Terms:

Retention: maintaining a memory
Recall: to bring back to mind, to retrieve
Recognize: to perceive something as previously known, it is “familiar”

Short Term Memory (STM) vs. Long Term Memory (LTM)

STM: memory for things that just happened
limited storage 7 items (+/- 2)

LTM: memory for things that do not currently occupy your attention;
they must be recalled or recognized

Permanent memories require:
STM -> consolidated -> LTM
How best to consolidate STM -> LTM? i.e., how best to retain?

1) You need **GLUCOSE** (brain’s energy source)
   a) get it from food
   b) get it from Adrenaline and Cortisol (remember from last lecture?)

In response to stress,…

- **Adrenaline** is released from *Adrenal Medulla*
- **Cortisol** is released from the *Adrenal Cortex*
  … which results in Glycogen -> **Glucose**

(also, happens when *aroused in general*, from an emotional/meaningful event)

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Do not study when you’re feeling bored!
Do not study in a panic!
So, it’s ok (even good) to be a little stressed!

Turning the knots in your stomach into bows: Reappraising arousal improves performance on the GRE

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Maybe a little nervousness just means we care!
How best to consolidate STM -> LTM (con’t)?

2) Study From Different Angles.
   And, make links with other known things.
   (It’s easier to recall a story as a whole rather
   than a bunch of unrelated facts).
   Don’t “commit to memory”, do “commit to understanding”

3) Sleep / Alcohol / Midazolam
   Stops new memories from being formed, which would otherwise
   interfere with the memory consolidation of items just learned
LTM: Explicit Memory vs. Implicit Memory

Explicit: memory for events or facts (sometimes called “semantic”)
“episodic” memory (i.e., events), “remember”
“declarative” (i.e., facts that can be stated), “know”

Implicit: memory that does not require memory of specific events or facts, yet affects our behavior

1) Learned Motor Skills (“procedural memory” or “motor memory”)

Mirror Drawing

Tower of Hanoi
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1) Learned Motor Skills (“procedural memory” or “motor memory”)
2) Priming Effects
   A) Word priming: word or non-word?
      Test = “doctor” vs. “pwnig”
      Prime = “nurse” vs. “car” (... the prime is implicitly put in memory)
   B) “Subliminal” Advertising: ALL OVER THE PLACE!

NOTE: (B) is a little complicated because advertising effects vary in how much we are “aware” of (i.e., able to recollect) the manipulation
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1) **Learned Motor Skills** ("procedural memory")

2) **Priming Effects**
   A) Word priming: word or non-word?
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   B) “Subliminal Advertising”: ALL OVER THE PLACE!

3) **Conditioned Responses** (next slide)
Conditioned Responses

A) Operant Conditioning
B) Classical Conditioning
Conditioned Responses

A) Operant Conditioning:
   1) Reward (or “Reinforcement”)-> increase the likelihood of behavior X
      i) positive: “if you do X, I’ll give you candy”
      ii) negative: “if you do X, I’ll stop hitting you”

   2) Punishment -> decrease the likelihood of behavior Y
      i) positive: “if you do Y, I’ll hit you”
      ii) negative: “if you do Y, I’ll stop giving you candy”

“Carrot and Stick”
Conditioned Responses (One type of Implicit Memory)

A) Operant Conditioning: “If you do this, I'll do that”

B) Classical Conditioning: uses “natural”, automatic response
“*When I do this, you'll do that*”

Developed by Ivan Pavlov, Nobel Prize 1904
Classical Conditioning

**Before**
- Unconditioned Stimulus (UCS)
- Unconditioned Response (UCR)
- Neutral Stimulus
- No Conditioned Response

**During**
- Neutral Stimulus
- Unconditioned Stimulus (UCS)
- Unconditioned Response (UCR)

**After**
- Conditioned Stimulus (CS)
- Conditioned Response (CR)
Donald Hebb (1950s): Learning/Training is an *increase in connectivity between neurons as a result of simultaneous activity in those neurons ("Hebbian" Mechanisms)* (more next lecture)

So, let’s use Hebbian Mechanisms to explain Pavlov’s Dog!

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**Diagram:**
- **Training:**
  - UCS (meat)
  - CS (bell)
  - CR (saliv.)
  - Olfactory cortex
  - Auditory cortex
  - Brain stem
  - Cranial Nerve IX

 **Classical Conditioning:**

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**Back to Humans**
Role of the Hippocampus in Memory
Involved in Implicit or Explicit? We’ll come back to…

Human Hippocampal Damage -> Memory Loss (“Amnesia”)

First, let’s define different types of Amnesia

- Retrograde Amnesia: loss of events prior to injury
- Anterograde Amnesia: inability to create new memories after the injury

Symptoms after Hippocampus Damage (H.M. and others):

- Severe Anterograde amnesia,
  but only slight Retrograde amnesia (1-3 years before)
- Anterograde Amnesia for LTM, not STM
- Anterograde Amnesia for explicit LTM,
  but not implicit LTM
  (e.g., mirror drawing)

Ok, so ……Role of the Hippocampus

- Not where memories are stored (since only mild retrograde amnesia)
- Consolidates STM -> LTM
- Consolidates Explicit, but not Implicit, LTM

Hmmm…. But why is there ANY retrograde amnesia after hippocampal damage?

But for SPATIAL memory in RATS (and maybe humans?), it IS where memories are formed and stored.
First, what is Spatial Memory? Explicit? Implicit?

**Hippocampal Lesions in Rats:**
- a permanent loss of the learned water maze (Hippocampus necessary for retention, i.e., it is where the spatial memory is “stored”)
- loss in the ability to learn new water maze (Hippocampus necessary to form new spatial memories)

*Other Evidence that Rat Hippocampus Involved in Spatial Learning*

“Place Cells” in Hippocampus (O’Keefe & Dostrovsky, 1971) have *spatial receptive fields* (based on sensory cues in room)