Memories Outside of Awareness: Conditioning, Skill Learning & Priming

July 8, 2015
Karen LaRocque
Announcements

• **Midterm** is Wednesday, July 22nd in class

• Additional conditioning materials are posted on the course website
  

• If you find any interesting articles, videos, etc. that relate to the course material please email them to us and we’ll post them!
Homework

- Memory in Action: Depth of Processing Demo due 8 PM on Sunday, July 12th
  - http://web.stanford.edu/class/psych136s/memoryinaction/index.html#depth-of-processing-demo
  - You will be prompted to answer questions throughout the demonstration — please type your answers on a separate page
  - Demo will be posted by Friday morning

- Memory in Action: Brainstorm due 9 AM on Monday, July 13th
  - Keep a non-declarative memory journal for three days. Pay attention to behaviors that you might not usually notice, and ask yourself ‘Why did I behave this way?’. Try to identify:
    - An instance of classical conditioning and an instance of operant conditioning
    - An instance of perceptual priming and an instance of conceptual priming
    - A skill in the cognitive stage, a skill in the associative stage, and a skill in the autonomous stage

- Reading Response to Henkel et al. (2014) due 9 AM on Wednesday, July 15th
Last time

• What is conditioning? classical conditioning and operant conditioning

• Stages of conditioning: acquisition, extinction, & recovery / renewal

• Factors affecting conditioning: contiguity, contingency, timing, surprise, attention, biological plausibility, reinforcement schedules

• Clinical applications of conditioning: drug addiction and treatment
This time

- Neural bases of conditioning
- What is skill learning?
- Acquiring new skills
- What is priming?
- Mere exposure effect
- Advertising
This time

- Neural bases of conditioning
- What is skill learning?
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Conditioning

Transient memory
- Sensory
- Working (short-term)

Long-term memory
- Declarative
  - Episodic
  - Semantic
- Non-declarative
  - Conditioning
  - Skill learning
  - Priming
- Classical
- Operant
What is being learned?

Classical conditioning: **CS-CR** (bell - salivate) or **CS-US** (bell - food)

I’m drooling!

That bell is was followed by food in the past … thinking about food coming makes me drool!
What is being learned?

Classical conditioning: **CS-CR** *(bell - salivate)* or **CS-US** *(bell - food)*

- I'm drooling!
- That bell is was followed by food in the past … thinking about food coming makes me drool!

Operant conditioning: **R** *(press lever)* or **R-O** *(press lever - food)*

- I'm pressing this lever!
- Pressing this lever gave me food in the past … I will press it again to get more food!
In healthy individuals, there is evidence for both types of learning. We can dissociate these types of learning in patients with brain damage.
Neuraneatomy

• Cortical structures: sensory regions and control / attention networks

• Subcortical structures:
  • Medial temporal lobe cortex and hippocampus — critical for declarative memory
  • Amygdala — involved in emotion
  • Basal ganglia — involved in mapping stimuli to motor outputs, relies on dopamine
Fear conditioning (classical)

- View stream of colored squares
- Blue squares (CS) are accompanied by loud, startling horn (US)
- Two dependent variables
  - **Classical conditioning**: skin conductance response (SCR; measure of sweat) during blue squares *without* the horn (CR)
  - **Declarative memory**: how many colors were there? what colors were there? how many colors were paired with the horn? which color(s) were paired with the horn? [learning episode & CS-US contingencies]

Bechara et al., 1995
Healthy controls show conditioned response (increase in SCR to blue squares) and almost perfect declarative memory for the conditioning episode.
Fear conditioning (classical)

Healthy controls show conditioned response (increase in SCR to blue squares) and almost perfect declarative memory for the conditioning episode.

Patient SM has amygdala damage – fails to show conditioned response but has almost perfect declarative memory for the conditioning episode.

Bechara et al., 1995
Fear conditioning (classical)

Healthy controls show conditioned response (increase in SCR to blue squares) and almost perfect declarative memory for the conditioning episode.

Patient SM has amygdala damage — fails to show conditioned response but has almost perfect declarative memory for the conditioning episode.

Patient WC has medial temporal lobe damage — shows conditioned response but has no declarative memory for the conditioning episode.

Bechara et al., 1995
Neural basis of classical conditioning

Acquisition of CS-CR is dissociated from awareness of CS-US

Medial temporal lobe

The blue square has been followed by a loud noise in the past.

Amygdala

I’m sweating!

Double dissociation between classical conditioning and declarative memory
Neural basis of classical conditioning

Acquisition of CS-CR is dissociated from awareness of CS-US

Double dissociation between classical conditioning and declarative memory

Other brain structures are critical for other types of classical conditioning — double dissociations within classical conditioning!
Habit learning (operant)

Materials: four cards — unknown to participants, each predicts ‘rain’ or ‘shine’ with a certain probability

Knowlton et al., 1996
Habit learning (operant)

Materials: four cards — unknown to participants, each predicts ‘rain’ or ‘shine’ with a certain probability

Task:
- See one, two, or three cards (S)
- Predict ‘rain’ or ‘shine’ (R)
- Immediate feedback of ‘correct’ or ‘incorrect’ (O) — true ‘rain’ or ‘shine’ determined by average probability of displayed card

Knowlton et al., 1996
Habit learning (operant)

Materials: four cards — unknown to participants, each predicts ‘rain’ or ‘shine’ with a certain probability

Task:

See one, two, or three cards (S)

Predict ‘rain’ or ‘shine’ (R)

Immediate feedback of ‘correct’ or ‘incorrect’ (O) — true ‘rain’ or ‘shine’ determined by average probability of displayed card

This combination predicts rain 34% of time

Knowlton et al., 1996
Habit learning (operant)

Materials: four cards — unknown to participants, each predicts ‘rain’ or ‘shine’ with a certain probability

Task:
See one, two, or three cards (S)
Predict ‘rain’ or ‘shine’ (R)
Immediate feedback of ‘correct’ or ‘incorrect’ (O) — true ‘rain’ or ‘shine’ determined by average probability of displayed card

Two dependent variables:

Operant conditioning: Number of correct responses (‘rain’ or ‘fine’) over time
Declarative memory: Questions about the task — e.g., how many cards were there? what shapes were on the cards? [learning episode]

Knowlton et al., 1996
Healthy controls show operant conditioning (increase reinforced choices in response to set of cards) and good declarative memory for the conditioning episode.

Knowlton et al., 1996
Habit learning (operant)

Healthy controls show operant conditioning (increase reinforced choices in response to set of cards) and good declarative memory for the conditioning episode.

Patients with basal ganglia / dopamine dysfunction (Parkinson’s disease) fail to show operant conditioning but have good declarative memory for the conditioning episode.
Habit learning (operant)

Healthy controls show operant conditioning (increase reinforced choices in response to set of cards) and good declarative memory for the conditioning episode.

Patients with basal ganglia / dopamine dysfunction (Parkinson’s disease) — fail to show operant conditioning but have good declarative memory for the conditioning episode.

Patients with medial temporal lobe damage — show operant conditioning but have almost no declarative memory for the conditioning episode.
Acquisition of S-R is dissociated from awareness of the learning trials.

**Neural basis of classical conditioning**

Double dissociation between operant conditioning and declarative memory.

Also can find double dissociations between classical conditioning and operant conditioning.
This time

- Neural bases of conditioning
- What is skill learning?
- Acquiring new skills
- What is priming?
- Mere exposure effect
- Advertising
What is skill learning?

Skill learning: improved performance with repeated practice on a motor, perceptual, or cognitive task
What is skill learning?

Skill learning: improved performance with repeated practice on a motor, perceptual, or cognitive task.
What is skill learning?

**Skill learning**: improved performance with repeated practice on a motor, perceptual, or cognitive task.

Differences from declarative memory:

- Can be acquired without conscious awareness
- Typically hard to verbalize
- Requires practice
Skill learning: a separate system

Patients with damage to the medial temporal lobe can acquire new skills even though they have no declarative memory of practicing them.

Patients with damage to other brain areas have trouble acquiring new skills even though they have declarative memory of practicing them.
This time

- Neural bases of conditioning
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Stages of skill learning

- Fitt’s three-stage model (1964)
- Cognitive stage
  - Initial period, typically verbal, rely on rules, requires effort
  - *Clumsy and slow, rehearse rules to change lanes: “turn signal, check blind spot, now turn wheel”*
- Associative stage
  - Less reliance on verbal rules, more stereotyped behavior
  - Many actions (e.g., change lanes) stereotyped but need conscious control to determine appropriate sequence of actions
- Autonomous stage
  - Skill is automatic and requires little attention
  - *Can listen to the radio and chat with friends, maybe don’t remember your drive home*
Effective practice: what and when

• Spacing
  • Massed: concentrated practice
  • Spaced: practice spread out over multiple sessions

• Variability
  • Constant: practice focused on single skill
  • Variable: practice that alternates between a set of skills
Power law of learning

Rapid gains in learning at first, then slows down
Power law of learning

Rapid gains in learning at first, then slows down

Resetting the power law with deliberate practice

Feedback
Focused attention
Regularly changing context and conditions
Risk of failure
Experts are made not born

10,000 hours of deliberate practice
Experts are made not born

10,000 hours of deliberate practice

Do you ever wonder why it was you and not someone else who became a great cellist? What sets you apart?

“Let me just say that I have no idea. I’m an accident. I don’t think there’s a rhyme or reason and I have spent a lot of time thinking about it.” — Yo-Yo Ma
Experts are made not born

10,000 hours of deliberate practice

Do you ever wonder why it was you and not someone else who became a great cellist? What sets you apart?

“Let me just say that I have no idea. I’m an accident. I don’t think there’s a rhyme or reason and I have spent a lot of time thinking about it.” — Yo-Yo Ma

Yo-Yo Ma estimates that he practices cello for 10,000 hours every five years
Experts are made not born

10,000 hours of deliberate practice

https://www.youtube.com/watch?v=4Uugz5Y7u6M
Experts are made not born

10,000 hours of deliberate practice

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“Maybe it’s my fault that you didn’t see that failure gave me strength, that my pain was my motivation. Maybe I led you to believe that basketball was a god-given gift, and not something that I worked for … every single day of my life.”
“Success is not an accident. Success is actually a choice. And Stephen Curry is one of the best shooters on the planet today because he has made the choice to create great habits. And my question to you is, are the habits that you have today on par with the dreams that you have for tomorrow?”

– Alan Stein, on Stephen Curry

https://www.youtube.com/watch?v=RbsmMnAKeOI
This time

- Neural bases of conditioning
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What is priming?

Priming: a change in performance with a stimulus due to the prior presentation of that stimulus or a related stimulus

Perceptual priming: physical properties are made more available

Conceptual priming: conceptual properties are made more available
Priming tasks in the lab

• “Encoding stage”
  • Expose participants to certain stimuli
  • Often use a ‘cover task’

• “Retrieval stage”
  • Participants must identify or generate stimuli
    • Tend to identify previously viewed stimuli more accurately and more quickly
    • Tend to generate previously viewed stimuli more frequently
  • Whether the retrieval stage relies on perceptual or conceptual properties determines whether the task is perceptual or conceptual priming
Priming tasks in the lab

Rate each item as pleasant or unpleasant!

race  frat  
clock  closet  
estamp  stand  
pear  banana  
airplane  train  
petal  stem  
stool  table
Priming tasks in the lab

Rate each item as pleasant or unpleasant!

What word did you see?
- RACE flashed very quickly — “race”
- FRAT flashed very quickly — “?”

<table>
<thead>
<tr>
<th>Item</th>
<th>Rate as pleasant or unpleasant</th>
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<tbody>
<tr>
<td>race</td>
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</tr>
<tr>
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<tr>
<td>stand</td>
<td></td>
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<tr>
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</tr>
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Priming tasks in the lab

Rate each item as pleasant or unpleasant!

- race
- clock
- stamp
- pear
- airplane
- petal
- stool

What word did you see?
- RACE flashed very quickly — “race”
- FRAT flashed very quickly — “?”

What is this?
- “camel”
- “?”

Generate the first four that come to mind:
- Fruits?
- “apple, orange, pear”

- Vehicles?
- “car, bus, airplane”

Generate the first word that comes to mind:
- Flower - “petal”
- Chair - “stool”

Rate each item as pleasant or unpleasant!

- race
- frat
- clock
- closet
- stamp
- stand
- pear
- banana
- airplane
- train
- petal
- stem
- stool
- table
Primming tasks in the lab

Rate each item as pleasant or unpleasant!

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stamp
pear
airplane
petal
stool

What word did you see?
RACE flashed very quickly — “race”
FRAT flashed very quickly — “?”

What is this? “camel” “?”

Complete these word stems:
CLO-ck
STA-mp

frat
clock
closet

stand
bananas

train

petal
stem

stool

Generate the first word that comes to mind:
Flower -
“petal”
Chair -
“stool”

Generate the first four that come to mind:
Fruits?
“apple, orange, pear”
Vehicles?
“car, bus, airplane”

Rate each item as pleasant or unpleasant!

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airplane
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petal
frat
stool
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Primming tasks in the lab

Rate each item as pleasant or unpleasant!

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- clock
- stamp
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What word did you see?
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Complete these word stems:
- CLO-ck
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Generate the first four that come to mind:
- Fruits? “apple, orange, pear”
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Priming tasks in the lab

Rate each item as pleasant or unpleasant!

- race
- clock
- stamp
- pear
- airplane
- petal
- stool
- frat
- closet
- stand
- banana
- train
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Priming in the real-world

Recognize a blurry street sign in the fog if you’ve seen it before

Find the item you are interested in faster on a menu if you’ve seen the menu before

Deja vu

“I just said that!”

Cryptomnesia — unconscious plagiarism
Priming: a change in performance with a stimulus due to the prior presentation of that stimulus or a related stimulus

Unlike declarative memory, does not require conscious awareness

Unlike skill learning, tied to a specific stimulus (or a set of related stimuli)
Priming: a separate system

Priming effects are present even when declarative memory for a stimulus is minimized — either due to experimental procedures or through brain damage.
Priming: a separate system

Three groups of patients

- MTL damage
- Visual cortex damage (VIS)
- MTL + anterior temporal lobe (ATL) damage

Three tasks

- Declarative memory: What word did you see that started with “BAN-“
- Perceptual priming: What’s the first word you think of that starts with “BAN-“
- Conceptual priming: What’s the first fruit that comes to mind?

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<th>Conceptual priming</th>
</tr>
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<tr>
<td>MTL</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>VIS</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>MTL + ATL</td>
<td>no</td>
<td>yes</td>
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1. Double dissociation between perceptual priming and declarative memory
2. Single dissociation between conceptual priming and declarative memory
3. Double dissociation between perceptual priming and conceptual priming
Primimg of related stimuli

Participants *subliminally* primed with black or white faces

Later performed object identification task

Subliminal exposure to black faces *selectively* improved the detection of crime-relevant objects

**Primimg as a tool to uncover associations that people may not be aware of or may not be willing to share**

Eberhardt et al., 2004
Does priming affect our behavior?

One hypothesis: previously encountered concepts aren’t only easier to identify and generate — they are so fluent that they also shape our behavior.
This time

- Neural bases of conditioning
- What is skill learning?
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- Mere exposure effect
- Advertising
Priming affects our preferences

Kunst-Wilson & Zajonc, 1980: Affective discrimination of stimuli that cannot be recognized

• What have previous studies discovered about how past exposure influences are preferences? Why is this study different?

• What is the general procedure? Independent and dependent variables?

• How did previous exposure affect recognition and preference?

• How do the authors interpret their results?

• Applications to the real world?

Alternate interpretation: increased fluency in processing (without recognition) is responsible for increase in preference
This time

• Neural bases of conditioning
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Advertising

Mere exposure effect

hulu
Advertising

Increased probability of generation

I’m thirsty. I think I’ll drink … Coke.

These apples are … fresh.

Flowers!

nature

smell

fresh

tree

spring
This week

• **Types of non-declarative memory**

  • **Conditioning**: learning about associations between stimuli or between responses and outcomes
    ★ Addiction

  • **Skill learning**: improved performance with repeated practice on a motor, perceptual, or cognitive task
    ★ Optimized practice and expertise

  • **Priming**: a change in performance with a stimulus due to the prior presentation of that stimulus or a related stimulus
    ★ Advertising

• **Neural bases of non-declarative memory**

  • Non-declarative memory does not rely on the medial temporal lobe!

  • Non-declarative memory relies on brain structures that are specific to the type of conditioning, priming, or skill learning in question
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Exit ticket

Questions?