An Introduction to Learning

Lecture 8

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Agenda for Today

- Introduction to Cognitive or ‘Conscious’ Memory
  - History
  - Lessons from H.M.: there are different forms of memory!
  - Distinguishing cognitive memory?
  - Forgetting
  - Encoding
  - Context and Retrieval
1 History
Traditions diverge...

Pavlov

Learning

Ebbinghaus

Memory

Experimental Methods!
Traditions diverge...

Pavlov

Learning

Ebbinghaus

Memory

Experimental Methods!
Ebbinghaus’s Forgetting Curve

- Ebbinghaus (1885) studied memory for nonsense syllables

- Forgetting increases as time progresses...
Lessons from H.M.
What could he do?

Recall

Pattern-Analysis Skill

Knowing ‘how’ vs Knowing ‘what’

Priming
What could he do?

Visual Recall
Cognitive memory (place learning) vs. procedural memory (response learning)
Memory Systems

Long-term memory

Declarative memory
- Episodic memory
- Semantic memory

Nondeclarative memory
- Procedural memory: skills, habits
- Priming
- Simple classical conditioning
- Habituation, sensitization
- Reflex pathways

Brain regions:
- Medial temporal lobe, diencephalon
- Basal ganglia
- Neocortex
- Amygdala, cerebellum

Nature Reviews Neuroscience

Henke, 2010
Memory Systems (updated)

- **Rapid encoding of flexible associations**
  - Hippocampus
  - Neocortex
  - Episodic memory

- **Slow encoding of rigid associations**
  - Basal ganglia
  - Cerebellum
  - Neocortex
  - Procedural memory
    - Classical conditioning
    - Semantic memory

- **Rapid encoding of single or unitized items**
  - Parahippocampal gyrus
  - Neocortex
  - Familiarity
  - Priming

Henke, 2010
3 Distinguishing ‘cognitive memory’
• Conscious access to representations (semantic and/or episodic)

• Flexibility/inferential
1. A -> E ?
2. B <-> D ?

Flexibility
(A) Constant start position training

(B) Novel probe tests

(C) Swim paths on probe tests
   Normal rats
   Rats with hippocampal damage

(D) Mean latency (seconds)
   - Normal
   - Hippocampal damage

Trail
Flexibility

Retrieval or Encoding?
Conscious access to representations

Flexibility/inferential
4 Forgetting
Forgetting

What are the reasons why we fail to remember things?

Trace decay?

Today we will focus on interference: Learning about one thing can mess up your memory for other things.

We will show that some kinds of forgetting that appear to be attributable to trace decay may, in fact, be caused by interference.
Interference

Two mechanisms for interference:

New memories might overwrite or damage old memories

Even if new & old memories co-exist peacefully, you might still end up getting competition at retrieval
Interference and competition

- **Competition Assumption** (Anderson, Bjork, & Bjork, 1994):
  - A cue activates all of its associates to some degree
  - The activated associates compete for access to awareness
    - **Competitors** are any associates other than the target memory

- Interference:
  - Increases with the number of competitors a target has
  - **cue-overload principle**:
    - The tendency for recall to decrease with the number of to-be-remembered items paired with the same cue

Adapted from Anderson and Neely (1996).
Proactive Interference

- Studied in the lab using the AB-AC interference paradigm
- Forgetting increases as a function of the number of previously studied lists
- Especially if the learning experiences are similar (e.g. share a cue)
Conclusion: forgetting is caused by interference, not trace decay
How to avoid interference?

Shereshevskii: A case study in distinctive encoding

- Subject of “The Mind of a Mnemonist” by A. Luria

- Newspaper reporter with apparently unlimited capacity for memorization

- Experienced synesthesia: e.g., words evoke visual impressions, and sometimes sensations of taste and touch

- Synesthesia led to hyper-distinctive encoding

- Reduces interference

- Incredible memory for details but problems categorizing & generalizing
Mnemonic techniques = techniques for improving recall

Almost all mnemonic systems work by fostering distinctive encoding

Peg-word mnemonic:

- one is a bun
- two is a shoe
- three is a tree
- four is a door
- five is a hive
- six is sticks
- seven is heaven
- eight is a gate
- nine is wine
- ten is a hen
Mnemonics

Peg-Word Mnemonic

one is a bun
two is a shoe
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Peg-Word Mnemonic

one is a bun
two is a shoe
three is a tree
four is a door
five is a hive
six is sticks
seven is heaven
eight is a gate
nine is wine
ten is a hen
donkey
cup
elephant
stocking
fire engine
ring
caterpillar
sausagepan
rabbit
top hat
Mnemonics

Peg-Word Mnemonic

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Effective mnemonics require two things:

- Subjects need to form distinctive memory traces -- distinctiveness prevents the memory traces from getting confused with (or overwriting) one another

- Subjects need a way of **finding** these distinctive traces

- Peg-word gives us a way

  One is a bun
  Two is a shoe...
Availability and Accessibility

- Availability: Is the memory retrievable in principle?

- Accessibility: Assuming that the memory is retrievable in principle, can it be retrieved?

For the peg-word mnemonic:

- Distinctive encoding ensures that the memory is available

- Structured retrieval probes ensure that the memory can be accessed
Method of Loci

Come up with a familiar route, comprised of multiple places (loci)

For example: The route from this classroom to my office

Start in the classroom
Walk to the elevator
down the hall
Into my lab
Into my office

Stash mental images of to-be-remembered stimuli at different places on the route

Example: Remember grocery list of strawberries, milk, bread, chicken, grapes
Memory champions can memorize random digit sequences that are hundreds of digits long. How?

One sample strategy:

Take the digit sequence & break it into 6 digit chunks

For each 6 digit chunk:

- The first 2 digits correspond to a **person**
- The second 2 digits correspond to an **action**
- The third 2 digits correspond to an **object**

E.g., 235637
- Person #23 (e.g. Todd)
- Action #56 (e.g. jumping)
- Object #37 (e.g. turtle)
Methods of memory masters

- Next step: Method of loci

- Stash the images in different loci along the route (e.g. put image of Todd jumping on a turtle in the office..)

- To recall the digit sequence, restart the route
- Look in each location
- Read out the image that’s stored there
5 Encoding

- Attention
- Levels of Processing
- Organization
- Spacing
- Prior Knowledge
5 Encoding

- Attention
- Levels of Processing
- Organization
- Spacing
- Prior Knowledge
Levels of Processing

- **Levels-of-Processing Hypothesis** (Craik & Lockhart, 1972):
  - Information can be processed on a variety of levels, from the most basic (visual form), to phonology, to the deepest level (contextual meaning)

  The depth of processing helps determine the durability in LTM

<table>
<thead>
<tr>
<th>Level of Processing</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHALLOW</td>
<td></td>
</tr>
<tr>
<td>1) Visual Form</td>
<td>“DOG” comprises the letters D, O, and G</td>
</tr>
<tr>
<td>2) Phonology</td>
<td>Rhymes with FOG</td>
</tr>
<tr>
<td>3) Semantics (Meaning)</td>
<td>A four-legged pet that often chases cats and chews on bones</td>
</tr>
</tbody>
</table>

DEEP
Levels of Processing
Craik and Tulving (1975)

- **Task:**
  - Participants viewed words and were asked to make three different types of judgments:
    - Visual processing (e.g. “Is LOG in upper case?”)
    - Phonological (e.g. “Does DOG rhyme with LOG?”)
    - Semantic (e.g. “Does DOG fit in the sentence: ‘The ___ chased the cat’?”)
  - Finally, participants were asked to recognize the words they had seen before in a surprise test

- **Results:**
  - Words that were more deeply processed were more easily recognized
    - Particularly for questions with a “YES” response
Levels of Processing

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Role of Retrieval Cues

The crucial role of retrieval cues

- Depth of processing / elaborative encoding is only part of the story

- A major determinant of memory success is how well the retrieval cues at test match the processing that subjects did at study...

- The better the match, the better subjects’ recall will be
Transfer-Appropriate Processing

- The Transfer-Appropriate Processing Principle:
  - Recall is better if the processing requirements of the test match the processing conditions at encoding

- Morris, Bransford, and Franks (1977) tested the principle:
  - Task:
    - Participants made either a phonological or semantic judgment about each item on a word list
    - The learning was incidental: participants didn’t know they would have to later recall the words
  - The final test was either:
    - A standard recognition test for the learned words
    - A rhyming recognition test for learned words
Transfer-Appropriate Processing
Morris, Bransford, and Franks (1977)

- **Results:**
  - Standard recognition test: Deeper processing led to better performance
  - Rhyming recognition test: Shallower rhyme-based encoding task led to better performance because it matched the testing situation

- **Conclusion:**
  - It only makes sense to talk about a learning method’s efficacy in the context of the type of final test
Summary

- Cognitive memory is our everyday memory for facts and events - unlike other forms of memory, it is declarative, accessible to consciousness and can be expressed flexibly.

- Cognitive memory exists across species and depends on the same brain systems.

- Encoding can be bolstered by imagery which improves distinctiveness, prior knowledge which increases associative binding but also contextual match.

- Retention of memories diminishes according to the Power Law. But there is compelling evidence that interference, not decay, is the primary element which determines whether a memory will be remembered or forgotten.

- Retrieval is facilitated by the appropriate retrieval cues - and the more of them. Context reinstatement facilitates retrieval.

- Hippocampus! (communication with cortex)
Key Principals for the Semester

- Learning and memory are closely related and intertwined states of information processing

- Major insights about learning and memory have come from studies of the brain

- The concept of multiple memory systems unifies the study of learning and memory

- The underlying bases of learning and memory are the same in humans and animals

- Our theoretical approaches to studying learning are always closely tied to technological advances that are unfolding in general society (e.g., today - machine learning)
The End