Chapter 7:
Memory

Constructing and Reconstructing
Our Pasts

C. Brown Unit 8

Lecture Preview

- Discuss the reconstructive nature of memory and three memory systems
- Explore memory encoding, storage, and retrieval
- Examine the development of memory in humans, and its malleability
- Identify the neural basis of memory storage
- Discuss cases of forgetting and false memories

The Paradox of Memory

- Our memories are surprisingly good for some situations...

- and surprisingly poor for others

Three Memory Processes

- ___________ – forming a neural representation.
- ___________ – developing a “durable” representation.
- ___________ – Utilization of stored information.

- A failure of memory may be due to a breakdown at any of these three levels.

Stages of Memory

<table>
<thead>
<tr>
<th>Keyboard (Encoding)</th>
<th>Disk (Storage)</th>
<th>Monitor (Retrieval)</th>
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<tbody>
<tr>
<td>Sequential Process</td>
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Information-Processing Model of Memory

- A model of memory in which information must pass through discrete stages via the processes of attention, encoding, storage, and retrieval.
The Three Systems Model of Memory: Sensory, Short-Term, and Long-Term

- Each system differs in terms of span and duration.

Memory

- Sensory Memory
  - Iconic Memory
    - a momentary sensory memory of _______ stimuli
    - a photographic or picture image memory lasting no more than a few _______ of a second
  - Echoic Memory
    - momentary sensory memory of _______ stimuli

The Sensory Register

Testing for Iconic Memory

- Invented by George Sperling
- A letter array is shown briefly
- After array is gone, tone signals which row to report
- Subjects recalled more letters when signaled to recall only one row compared to trying to recall all the letters

The Sensory Register

Duration of Iconic Memory

- The duration for sensory memory is
  - A. Milliseconds
  - B. Minutes
  - C. Hours
  - D. Days
What Do We Encode?

- Encoding
  - encoding of meaning
  - including meaning of words
- Acoustic Encoding
  - encoding of sound
  - especially sound of words
- Visual Encoding
  - encoding of picture images

Memory

- Memory
  - focuses more on the processing of briefly stored information
- Short-Term Memory
  - activated memory that holds a few items briefly
  - look up a phone number, then quickly dial before the information is forgotten
- Long-Term Memory
  - the relatively permanent and limitless storehouse of the memory

Duration of Short-Term Memory

- Subjects memorized nonsense syllables, e.g., MJK, ZRW.
- To prevent rehearsal, they were given a distracter task during the waiting period.
- When a cue was given, subjects tried to recall the letters.
- Short-term memories vanish within twenty seconds.

Encoding

- Effortful Processing
  - requires attention and conscious effort
- Rehearsal
  - conscious repetition of information
    - to maintain it in consciousness
    - to encode it for storage

Memory

- Short-Term Memory
  - activated memory that holds a few items briefly
  - look up a phone number, then quickly dial before the information is forgotten
- Long-Term Memory
  - the relatively permanent and limitless storehouse of the memory

PRS

- The duration of storage of information in short-term memory is
  - A. Seconds
  - B. Minutes
  - C. Hours
  - D. Days
Short-Term Memory Capacity

**Memory-Span Test**
- Read the top row of digits, then look away and repeat them back in order. Continue until a mistake is made. The average capacity is seven items of information.

| 5 7 3 |
| 8 9 7 6 |
| 0 9 1 3 5 6 |
| 8 6 0 4 8 7 2 |
| 1 7 5 4 2 4 1 9 |
| 9 6 5 8 3 0 8 0 1 |
| 5 7 3 5 1 2 0 2 8 5 |
| 3 1 7 0 2 1 5 0 6 4 2 |
| 2 1 0 1 9 7 4 1 9 8 3 5 |

How can we aid our short-term memory?

- **Rehearsal** - repeating info to extend the duration of STM
  - **Maintenance rehearsal** - repeating stimuli in the original form (e.g., repeating phone number long enough to dial it)
  - **________ rehearsal** - linking stimuli in a meaningful way

- **Levels-of-processing model** - the more deeply we transform info, the better we remember it

Memory Span

- The magic number __ plus or minus 2 (5-9).
  - Each item in immediate memory is a chunk, by increasing the size of a chunk, the memory span may be increased. Each chunk can be a letter, a word, a sentence, a paragraph (and so forth).

Encoding

- **Chunking** - organizing items into familiar, manageable units
  - like horizontal organization--1776149218121941
  - often occurs automatically
  - use of acronyms
    - HOMES--Huron, Ontario, Michigan, Erie, Superior
    - ARITHMETIC--AR at In Tom’s House Might Eat Tom’s Ice Cream

The Three Systems Model of Memory: Long-Term

3) **Long-term memory** - permanent store of information

**Differs from STM**
- LTM capacity is very ______
- LTM may endure for ______
  - permastore
  - Errors of LTM differ from those of STM
    - semantic vs. acoustic
**Bahrick: Language Retention**

Forgetting Is Not Random

- **Initial effect** - tendency to remember words at the beginning of a list better than those later in the list
  - Likely reflects rehearsal and LTM processes, hippocampal activity
- **Final effect** - tendency to remember words at the end of a list better than those earlier in the list
  - Likely reflects STM processes, dorsolateral prefrontal cortex activity
- **Von Restorff effect** - tendency to remember distinctive stimuli

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**The Serial Position Curve**

Cooperative Learning

- You are trying to memorize twelve new words for your Spanish class, you only have time to review 4 words before class starts, and you might have a pop quiz at the start of class. Should you review (a) the first four words, (b) the middle four words, or (c) the last 4 words?
  - Meet with your group and decide. You have 60 seconds.

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**Long-Term Memory Forgetting**

- **Interference**
  - The tendency for previously learned material to disrupt the recall of new information
- **Interference**
  - The tendency for new information to disrupt the memory of previously learned material

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**Long-Term Memory Forgetting Interference and Forgetting**

- **Proactive interference** - B disrupts A
  - Experimental: Study A, Study B, Test B
  - Control: Study A, Study B, Test B
- **Retroactive interference** - A disrupts B
  - Experimental: Study A, Study B, Test A
  - Control: Study A, Study A, Test A
Primacy Effect

- Good memory for the _______ items learned in a series. Proactive interference may be one factor that produces the primacy effect. Initial learning interferes with recall of more recently learned items.

Recency Effect

- Good memory for the most _______ items learned in a series. Retroactive interference may be one factor that produces the recency effect. Recent learning interferes with recall of previously learned items.

Long Term Memory

- The greater the time and effort devoted to rehearsal - the better the memory

Encoding

- Ebbinghaus used nonsense syllables
  - TUV ZOF GEK WAV
  - the more times practiced on Day 1, the fewer repetitions to relearn on Day 2

- Spacing Effect
  - distributed practice yields better long-term retention than massed practice

Measuring Memory: 3 Rs

- __________ - generating previously remembered information
- __________ - selecting previously remembered information from an array of options
- __________ - “savings”; how much more quickly we reacquire something learned before
Repetition Effects

- _______ repetitions are better for recall than are massed repetitions.
- The _______ the interval between repetition sessions, the more durable the memory.
- Study hint: cramming is a relatively ineffective study technique. Space out your rehearsal episodes.

Long-Term Memory Forgetting Curve

- How much Spanish vocabulary is remembered over time?
- Most forgetting occurs within the first three years.
- After that, memory remains stable.

Helpful Study Hints Derived from Memory Research

<table>
<thead>
<tr>
<th>Distributed vs. Massed Study</th>
<th>Spread out study time, avoid cramming</th>
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<tbody>
<tr>
<td>Elaborative Rehearsal</td>
<td>Connect new knowledge with existing</td>
</tr>
<tr>
<td>Levels of Processing</td>
<td>Process ideas deeply and meaningfully, in your own words (not your instructor's)</td>
</tr>
<tr>
<td>Mnemonic Devices</td>
<td>Recall cues to help connect your existing knowledge base to new material</td>
</tr>
</tbody>
</table>

Study Hint

- Complete course sequences in close succession
  - Chem 1 - Chem 2
  - Spanish 1 - Spanish 2
Spaced repetitions produced more durable memories than do massed repetitions.

True/False

Russian-English bilinguals were prompted in English and in Russian to recall stories.
They recalled more Russian-experienced events when interviewed in Russian and more English-experienced events when interviewed in English.

Bilingual foreign students should form a study group and quiz each other using
A. their ‘native language’.
B. English.

A diagram shows the relationship between encoding and recall under different conditions.
Questions and Answers

- Q: Where did you go?
  - A: To the movie. (Episodic)
- Q: Did you like it?
  - A: Yes, it was great! (Episodic)
- Q: What was it called?
  - A: I don’t remember. (Semantic)
- Q: Who was in it?
  - A: I don’t remember…but you should see it! (Semantic)

Long Term Memory Storage
The Hippocampal Region

- Hippocampus: Part of the limbic system that plays a key role in encoding and transferring new information into long-term memory.
- Anterograde amnesia
  - Inability to store new information
- Retrograde amnesia
  - Inability to retrieve memories from the past

Storage:
Long-Term Memory

- MRI scan of hippocampus (in red)

The Amygdala and Emotional Memory

- The amygdala is responsible for the storage of emotional components of memory, especially fear memories

Emotion and Memory

- The more you care about the content of semantic memory, the more durable the memory.
- Sometimes the “feelings” about an event are more durable than are the episodic memories.
- Repression - can potent negative emotions produce motivated forgetting?

Long-Term Memory Retrieval

- __________ Memory
  - The types of memory elicited through the conscious retrieval of recollections in response to direct questions.
  - Conscious retention, direct tests, disrupted by amnesia, encoded in the hippocampus
- __________ Memory
  - A nonconscious recollection of a prior experience that is revealed indirectly, by its effects on performance.
  - Nonconscious retention, indirect tests, intact with amnesia, encoded elsewhere
Forms of Long-Term Memory

2. Implicit memory - not deliberately remembered ("automatic"), doesn't require conscious effort, many different forms
   a. memory - motor skills and habits, "know how" memory

Implicit Memory

Procedural Memory

- Stored long-term knowledge of learned habits and skills.
- Examples are how to drive, ride a bike, tie one's shoes, etc.

Storage: Long-Term Memory

- the loss of memory
- Explicit Memory
  - memory of facts and experiences that one can consciously know and declare
  - also called declarative memory
  - hippocampus--neural center in limbic system that helps process explicit memories for storage
- Implicit Memory
  - retention independent of conscious recollection
  - also called procedural memory

Amnesia

- Semantic memory impairment
- Reduced impact on procedural memory

  - "I still know how to perform brain surgery and fly an airplane, I just can't remember my name!"

Forgetting

- Retroactive Interference

<table>
<thead>
<tr>
<th>Percentage of syllables recalled</th>
<th>After sleep</th>
<th>Without interfering events, recall is better</th>
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<tbody>
<tr>
<td>90%</td>
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<tr>
<td>80%</td>
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<td>70%</td>
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<td>0%</td>
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Hours elapsed after learning syllables

Study Hint

- Study before bedtime. Fewer interfering events to disrupt consolidation of memory processes.
**Similarity Effects**
- The more similar the material to be learned, the greater the
- Long-term memory is interfered most strongly by semantic similarity (happy-carefree).
- Short-term memory is interfered most strongly by acoustic similarity (John-Don).
- Study hint: study biology between psychology and sociology.

**Autobiographical Memory Memorable Transitions**
- **Autobiographical Memory**
  - The recollections people have of their own personal experiences and observations.
  - People’s memories are most for times of transition.
  - In college, these are memories from the beginning of the first year and end of the last year.

**Infantile Amnesia**
- We are unable to recall personal experiences that took place before about 3 to 5 years of age
- **Why? Theories:**
  - Hippocampus is not yet developed, so we can’t retain new explicit memories
  - Infants have little or no sense of self

**Memory Development**
- From the crib to elementary school, children’s memories improve dramatically due to
  - Memory span increasing with age (rehearsal, physical maturation)
  - Increasing conceptual knowledge of the world
  - Development of memory skills

**Retrieving Memories**
- Memories are _____________
- Many types of forgetting result from retrieval errors: the memory is present but not accessible
  - Retrieval cues help

**Put down your pen (or laptop) and READ these lists:**
- Sour Nice Candy
- Honey Sugar Soda
- Bitter Chocolate Good
- Heart Taste Cake
- Tooth Tart Pie
Now, write down the list that you saw

Did you include the word __________? 

- If so, you've experienced a memory illusion - a false but convincing memory
- Memory is reconstructive - we extract the gist to make things easier to remember (but this may contribute to memory errors)

Memory Construction

- Eyewitnesses reconstruct memories when questioned

Eyewitness Testimony

- Weak correlation between witness confidence in their testimony and its accuracy
  - Less accurate when
    - Observing others of different race
    - Witness has talked to other witnesses
    - The observed situation is stressful (e.g., threatening, weapon involved)
  - Improved accuracy with sequential (vs. simultaneous) lineup

Suggestibility and Child Testimony

- Young children are especially vulnerable to suggestions to recall events that did not occur
  - May cling to __________ memory, even when assured it did not occur
  - Repeated questioning may elicit misinformation
  - Especially affected by schemas

Storing Memories

- Schemas - organized knowledge structure, or mental model, that provides a frame of reference for interpreting new situations
  - Help simplify, but may lead to memory distortions
  - Because children have __________ schemas, the use of an inappropriate frame of reference may lead to construction of false memories.
**Memory**

- Observed in about 10% of children.
- Images last 40 seconds or longer, and can be scanned by normal eye movements.
- Positive color with the clarity of an external object.
- Objects occupy a particular place, and can be examined like in a picture.

**Tip-of-the-Tongue Phenomenon**

- The experience of knowing that we know something but are unable to access it.
- Memory was stored, but not retrieved properly.

**Retrieval**

- Forgetting can result from failure to retrieve information from long-term memory.

**Forgetting - Interference**

- Motivated Forgetting
  - People unknowingly revise memories.
  - Defense mechanism that banishes from consciousness anxiety-arousing thoughts, feelings, and memories.

**The Biology of Memory**

- 1920s - Karl Lashley's unsuccessful search for a single ________ (physical trace of memory in the brain).
  - Rats in maze: more brain tissue removed = worse memory.
  - Location of damage didn't seem to matter.
- 1949 - Donald Hebb - engram is located in assemblies of neurons.
  - Neurons that “fire together, wire together.”

**LTP: How Neurons Change to Form Memories?**

- Long-term potentiation (LTP) - strengthening of connections among neurons due to simultaneous stimulation (firing together, wiring together).
  - Neurons in the hippocampus, amygdala, and cortex show a long-term enhanced response (“potentiation”) following certain stimulation (e.g., after a learning episode, such as Pavlovian fear conditioning).
  - Neural basis of memory?
    - LTP occurs at glutamate synapses.
    - Glutamate binds to NMDA and AMPA receptors.
**ECS and Memory**

- Electroconvulsive shock disrupts memory, but its effect is time dependent.
  - Disruption
  - Severe: 5 seconds
  - Moderate: 60 minutes
  - Mild: 8 hours

**Consolidation of Memory**

- New memories are easily disturbed, while old memories persist. Hence, the neural basis of memory must be transformed from a temporary unstable form to a stable long-lasting form.
  - Short-term: activate some synapses and inhibit others.
  - Long-term: grow new dendritic spines (change in the number of receptor sites on the post-synaptic membrane).

**How to Lose Your Mind!**

- Encephalitis - inflammation of the brain.
- __________ - head injury (failure to convert short-term memories into long-term).
- Inhibit protein __________ (scopalamine, childbirth and twilight-sleep).
- Korsakoff's syndrome - associated with chronic __________, vitamin B deficiency, disrupts the orderly recall of episodic memories (confabulation).

**Memory Construction**

- We filter information and fill in missing pieces.
- Korsakoff's patients invent possible memories to fill in the gaps.
- Misinformation Effect
  - incorporating misleading information into one's memory of an event
- Source Amnesia
  - attributing to the wrong source an event that we experienced, heard about, read about, or imagined (misattribution)

**Localization of Memory?**

- Damage to the hippocampus impairs the ability to convert short-term memory to long-term.
- Damage to the thalamus impairs correct recall of episodic memories.
- __________ of the brain - suggests that memories are stored in multiple sites in the neocortex (Alzheimer's disease severity correlates more closely with the density of the amyloid beta protein tangles rather than with its location).

**Biology of Memory Deterioration**

- Senility is not inevitable
- Individuals vary in the amount of everyday forgetfulness they display as they age
  - But there are small, consistent reductions in brain volume with normal aging
Biology of Memory Deterioration

- __________ disease
- 13% of those over 65 years, 42% over 85
- Dementia - overall cognitive decline, including severe memory and language loss
- Brain pathology
  - Plaques and tangles
  - Cell death: early = hippocampus, later = cortex and others
- Loss of acetylcholine cells in the basal forebrain - give medications to replace acetylcholine, aid memory
- Being physically active reduces the risk of cognitive impairment and Alzheimer’s disease - correlation or causation?

Brain Changes with Alzheimer’s Disease

Forecasting Alzheimer’s Disease

- Best studies have been conducted with nuns.
- Scored handwritten autobiographies.
  - __________ density - the number of ideas expressed in a passage. (Passages that relied on dates and names with few emotional associations were correlated with greater dementia).
- Developing a high cognitive __________ early in life seems to protect individuals against the development of dementia.

PRS

- More recently learned material is stored in the brain in a more durable form than are older memories.
  - True/False

Short cuts for memory?

- Learn Spanish while you sleep!
- Drugs that speed learning (glucose), and optimal doses of strychnine sulfate (kids don’t try this at home).
- Injection of memory in flatworms.
- No substitutes for __________ rehearsal!

Improve Your Memory

- Study repeatedly to boost recall
- Spend more time rehearsing or actively thinking about the material
- Make material personally __________
- Use mnemonic devices
  - associate with peg words--something already stored
  - make up story
  - chunk--acronyms
**Improve Your Memory**
- Activate retrieval cues—mentally recreate ________________
- Recall events while they are fresh—________ you encounter misinformation
- Minimize ________________
- Test your own knowledge
  - rehearse
  - determine what you do not yet know

**How to Improve Memory**
- **Mnemonics**
  - Memory aids designed to facilitate the recall of new information.
- Increase Practice Time
- Increase the interval ________ study sessions
- Increase the _________ of Processing
- Hierarchical Organization
  - **Study hint**: re-write and structure your notes, don’t just underline the material
- Minimize Interference
- Utilize Context Effects

**Cooperative Group Challenge**
- Only 6 of the following answers are used.
  1. encoding
  2. mnemonic
  3. serial position curve
  4. episodic
  5. semantic
  6. relearning
  7. chunking
  8. retrieval

**Q1**
- 1. _____ is the reactivation or reconstruction of experiences from our memory stores.

**Q2**
- 2. _____ is the process of organizing information in a format that our memories can use.

**Q3**
- 3. _____ is reacquiring knowledge that we’d previously learned but largely forgotten over time.
4. A learning aid, strategy or device that enhances recall is a _____.

5. To extend the span of short-term memory, we organize information into meaningful groupings using a process called _____.

6. _____ memory is a type of memory that could be activated as an eye-witness in a court of law.