Long-term Memory vs. Short-term Memory

Chapter 6

Learning Objective Topics

- Divisions of LTM
- Are LTM and STM two separate processes?
- How do we get information from STM into LTM?
  - Modal Model
  - Levels of Processing
Division of LTM

LONG-TERM MEMORY

EXPLICIT (conscious)
- Episodic (personal events)
- Semantic (facts, knowledge)

IMPLICIT (not conscious)
- Priming
- Procedural memory
- Conditioning

memory

Other types: source memory, false memory, meta-memory, memory for discourse, memory for pictures, everyday memory, recent vs. remote LTM …
Modal Model

Focus of Today’s Class…
Focus of Today’s Class…

Questions for Today

Are short term and long term memory are two distinct processes?

How do we get information from short term memory into long term memory?
Nature of Short-Term Memory vs. Long-Term

Try to remember these words as I read them aloud.

Nature of Short-Term Memory vs. Long-Term

Now write down all the words that you remember from the list.

We will tally responses for each word (excel sheet).
Two distinct memory stores?

- Why does this happen?
- What were you doing to remember them?
- How does this relate to short and long term memory?

Evidence for two distinct memory stores

Serial position effect in recall

Primacy effect = LTM

Recency effect = STM
Primacy Effect: Rehearsal

<table>
<thead>
<tr>
<th>ITEM PRESENTED</th>
<th>ITEMS REHEARSED (REHEARSAL SET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 REACTION</td>
<td>REACTION, REACTION, REACTION, REACTION</td>
</tr>
<tr>
<td>2 HOOF</td>
<td>HOOF, REACTION, HOOF, REACTION</td>
</tr>
<tr>
<td>3 BLESSING</td>
<td>BLESSING, HOOF, REACTION</td>
</tr>
<tr>
<td>4 RESEARCH</td>
<td>RESEARCH, REACTION, HOOF, RESEARCH</td>
</tr>
<tr>
<td>5 CANDY</td>
<td>CANDY, HOOF, RESEARCH, REACTION</td>
</tr>
<tr>
<td>6 HARDSHIP</td>
<td>HARDSHIP, HOOF, HARDSHIP, HOOF</td>
</tr>
<tr>
<td>7 KINDNESS</td>
<td>KINDNESS, CANDY, HARDSHIP, HOOF</td>
</tr>
<tr>
<td>8 NONSENSE</td>
<td>NONSENSE, KINDNESS, CANDY, HARDSHIP</td>
</tr>
</tbody>
</table>

What do you think would happen if you slowed down the presentation rate?
Evidence for two distinct memory stores

- Primacy effect boosted by slower presentation rate
- Recency effect unaffected by presentation rate

What do you think would happen if we added a 30 second delay after I read the list?
Evidence for two distinct memory stores

Primacy effect unaffected by delay

Recency effect disappears with delay (30-sec is outside duration of STM)

Are Short Term and Long Term Memory two separate processes?
Dissociation

- **Single Dissociation** - when something (Factor X) disrupts one thing (Task 1) but not another (Task 2)
  - Question it could answer: is this brain area involved in this process?

- **Double Dissociation** Two experimental manipulations effect two different things
  - You do one thing (Factor X) and it effects the first variable (Task 1) and not the second (Task 2)
  - You do another thing (Factor Y) and it effects second variable (Task 2) and not the first (Task 1)
  - Question it could answer: Are these two brain areas involved in separate processes?

Evidence for two distinct memory stores

**Delay:** impairs **recency**; no effect on **primacy**

**Rate of presentation (study duration):**
impairs **primacy**; no effect on **recency**

Is this a double dissociation? Why?
Neuroimaging evidence

Serial position curve

- List of 12 words
  - Fast presentation to eliminate primacy effect
- Recognition Test (old or new)
  - Beginning of list
  - End of list
  - New
- Control: shown the actual words “old” or “new”

Talmi, Grady, Goshen-Gottstein, & Moscovitch (2005).

Neuroimaging evidence for separate STM vs. LTM

Serial position curve

Early vs late probe = item presented at beginning of list vs end of list

<table>
<thead>
<tr>
<th>Early vs late probes</th>
<th>Hippocampus</th>
<th>Early vs late probes</th>
<th>Perirhinal cortex</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
<td>b</td>
<td></td>
</tr>
</tbody>
</table>

Early probes: activated hippocampal memory system (long term memory)
Late probes did not.

Talmi, Grady, Goshen-Gottstein, & Moscovitch (2005).
Neuroimaging evidence for separate STM vs. LTM

Serial position curve

- Both early and late probes activated areas associated with STM-WM, including frontal and parietal cortices.
- Primacy – Long term memory, but has to be put into STM to access
- Recency – just STM

Early vs late probe = item presented at beginning of list vs end of list

- Early vs late probes
  - Hippocampus
- Early vs New
  - Left medial temporal lobe

Talmi, Grady, Goshen-Gottstein, & Moscovitch (2005)
Modal Model of Memory (Atkinson & Shiffrin)

Richard Atkinson

Richard Shiffrin

- All information must pass through STM before being in LTM
- more rehearsal in STM = more likely to be stored in LTM
- When retrieve information from LTM, must hold that information in STM to use that information
**Modal Model of Memory (Atkinson & Shiffrin)**

- All information must pass through STM before being in LTM
- more rehearsed in STM = more likely to be stored in LTM
- When retrieve information from LTM, must hold that information in STM to use that information

**Amnesia**

- “The Last Hippie” by Oliver Sacks
- “A few more questions convinced me that Greg F had virtually no memory of events much past 1970, certainly no coherent chronological memory of them. He seemed to have been left, marooned, in the sixties – his memory, his development, his inner life had since then come to a stop.”
- The Music Never Stopped (movie)
Amnesia

- Anterograde amnesia
  - Memory loss after point of damage
  - E.g. H.M.; Korsakoff’s syndrome; encephalitis
  - [http://www.nytimes.com/2008/12/05/us/05hm.html?_r=1&](http://www.nytimes.com/2008/12/05/us/05hm.html?_r=1&)

Problems for the Modal Model

- Patient H.M.
  - Amnesic after removal of medial temporal lobes to treat epilepsy
  - Has relatively normal STM but dramatically impaired LTM
Clive Wearing

- Dense retrograde and anterograde amnesia patient
- Born in 1938, contracted viral encephalitis in 1985
- Previously a very successful musician
- Husband to 2\textsuperscript{nd} wife; has children from 1\textsuperscript{st} marriage

- BBC 2005 – “Man with the 7s memory”
  - 20 yrs post injury – 67 yrs old
- 1998 documentary
  - 13 yrs post injury – 60 years old
  - \url{http://www.youtube.com/watch?v=Lu9UY8Zgg-Q&feature=related}
  - \url{http://www.youtube.com/watch?v=xCyrzl2aVUo&feature=related}
  - \url{http://www.youtube.com/watch?v=9BrCBq2FY_U&feature=related}

Amnesia

- Retrograde amnesia
  - Can’t remember events \textit{prior} to point of injury
  - “Soap opera amnesia” – rare and most can recover
  - E.g. K.C. – Motorcycle – damage to left cerebral cortex
    - Can’t remember past, can form new memories
    - Reduced STM: digit span; Reduced recency

- Problem for multi-mode model of memory?
  - How does information get into LTM if no STM?
Baddeley & Warrington (1970)
Amnesic vs control

Anterograde Amnesia
– No LTM, no primacy effect

Patient K.F.
- Hit with motor bike, causing parieto-occipital damage
Patient K.F.

- You ask him to remember 7 numbers
  - He remembers 1
- You show him pictures of some famous people and he remembers them
- You quiz him on facts about himself and the world and he answers perfectly.

What would you conclude?

- Has a markedly reduced STM (only a 1-item recency effect) but has a normal LTM (normal primacy effect)

- Suggests that STM is not required for LTM!

- Is this a double dissociation, single dissociation, or neither?
Neuropsychological evidence of separate STM and LTM

- H.M. and Clive Wearing
  - Intact STM; impaired LTM
- K.F.
  - Intact LTM; impaired STM
- Double dissociation?

Evidence for separate STM/LTM Stores

- H.M. & Clive Wearing – Intact STM span, impaired LTM
- K.F. – Intact LTM, impaired STM span
- What is this?
- What does it tell us?
All information must pass through STM before being in LTM.

- more rehearsal in STM = more likely to be stored in LTM
- When retrieve information from LTM, must hold that information in STM to use that information.
Modal Model of Memory (Atkinson & Shiffrin)

- All information must pass through STM before being in LTM
- more rehearsal in STM = more likely to be stored in LTM
- When retrieve information from LTM, must hold that information in STM to use that information

Rehearsal and Free Recall

<table>
<thead>
<tr>
<th>ITEM PRESENTED</th>
<th>ITEMS REHEARSED (REHEARSAL SET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 REACTION</td>
<td>REACTION, REACTION, REACTION,</td>
</tr>
<tr>
<td>2 HOOF</td>
<td>HOOF, REACTION, HOOF, REACTION,</td>
</tr>
<tr>
<td>3 BLESSING</td>
<td>BLESSING, HOOF, REACTION</td>
</tr>
<tr>
<td>4 RESEARCH</td>
<td>RESEARCH, REACTION, HOOF, RESEARCH</td>
</tr>
<tr>
<td>5 CANDY</td>
<td>CANDY, HOOF, RESEARCH, HOOF,</td>
</tr>
<tr>
<td>6 HARDSHIP</td>
<td>HARDSHIP, HOOF, HARDSHIP</td>
</tr>
<tr>
<td>7 KINDNESS</td>
<td>KINDNESS, CANDY, HARDSHIP</td>
</tr>
<tr>
<td>9 NONSENSE</td>
<td>NONSENSE, KINDNESS, CANDY,</td>
</tr>
<tr>
<td></td>
<td>HARDSHIP, HOOF, HOOF, HOOF</td>
</tr>
<tr>
<td>10 CELLAR</td>
<td>CELLAR, ALCOHOL, MISERY, CELLAR</td>
</tr>
</tbody>
</table>

• Primacy effect may exist because those items have been rehearsed more than items that occur later in the list

(Rundus, 1971)
Altrinate Hypothesis: Levels-of-Processing

Maybe it’s not the **TIME** spent in STM that dictates whether something is transferred to LTM

Maybe it’s the **TYPE OF PROCESSING** that’s done with the stimuli

---

**Problems for the Modal Model**

*Rehearsal in STM and transfer to LTM*

- Duration of maintenance/rote rehearsal doesn’t always predict LTM performance
  - Rundus (1971) effects likely due to meaningful elaboration

<table>
<thead>
<tr>
<th>ITEM PRESENTED</th>
<th>ITEMS REHEARSED (REHEARSAL SET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 REACTION</td>
<td>REACTION, REACTION, REACTION</td>
</tr>
<tr>
<td>2 HOOF</td>
<td>HOOF, REACTION, HOOF, REACTION</td>
</tr>
<tr>
<td>3 BLESSING</td>
<td>BLESSING, HOOF, REACTION</td>
</tr>
<tr>
<td>4 RESEARCH</td>
<td>RESEARCH, HOOF, RESEARCH</td>
</tr>
<tr>
<td>5 CANDY</td>
<td>CANDY, HOOF, RESEARCH</td>
</tr>
<tr>
<td>6 HARDSHIP</td>
<td>HARDSHIP, HOOF, CANDY</td>
</tr>
<tr>
<td>7 KINDNESS</td>
<td>KINDNESS, CANDY, HARDSHIP</td>
</tr>
<tr>
<td>8 NONSENSE</td>
<td>NONSENSE, KINDNESS</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10 CELLAR</td>
<td>CELLAR, ALCOHOL, MESERY, CELLAR</td>
</tr>
</tbody>
</table>
Levels-of-Processing  
(Craik & Lockhart, 1972; Craik & Tulving, 1978)

During reading, we process

- **perceptual** features of the presented words
- **phonological** features as we convert visual word forms to speech-based codes
- **semantic** features as we access and evaluate the meaning of the words

Is each type of processing equally effective at transferring information into LTM?
Is each type of processing equally effective at transferring information into LTM? **NO!**

\[ LTM = \text{incidental byproduct of processing of an event} \]

- LTM ≠ rehearsal time in STM
- “deeper” processing = more effective and durable encoding
Modal Model of Memory (Atkinson & Shiffrin)

- All information must pass through STM before being in LTM
- More rehearsal in STM = more likely to be stored in LTM
- When retrieve information from LTM, must hold that information in STM to use that information

What remains?
- STM and LTM as distinct processes
- General diagram with added arrow