Memory
The Modal Model
Working Memory

Basic Distinctions

• STM
  – short term memory
  • limited capacity
  • limited duration
  • holding available recent and relevant information in a temporary store

• LTM
  – long term memory
  • unlimited storage
  • relatively permanent
  • store for episodic and semantic memory

Modal Model of Memory
(Atkinson & Shiffrin, 1968)

Short-term memory is a limited capacity store for information -- place to rehearse new information from sensory buffers

Items need to be rehearsed in short-term memory before entering long-term memory

Probability of encoding in LTM directly related to time in STM

Serial Position Effects

• In free recall, more items are recalled from start of list (primacy effect) and end of the list (recency effect)

• First items recalled tend to be from end of study list

Serial Position Effects

• Modal model explanation for primacy:
  early items can be rehearsed more often → more likely to be transferred to long-term memory

• Modal model explanation for recency:
  Last items of list are still in short-term memory → they can be read out easily from short-term memory
Other predictions (1)

• There should be more rehearsal for early items
• Have subjects rehearse overtly

Problems with Modal model (2)

Long-term “recency” effects can occur even after weeks – STS contents should be lost by then
Size of recency effect depends on the relative duration of retention interval (RI) to interitem presentation interval (IPI)

Other predictions (2)

• Recency effect should disappear with delay.
• During delay, contents of STS should be lost

Problems with Modal model (3)

• STS “knows” the identity of items coming from the sensory register
• How does it know?
• The sensory register has to make contact with LTS ➔ model loses appealing simplicity

Problems with Modal model (1)

• The recency effect re-appears with distractor activity after every list item, including the last item

Coding in Short Term Memory:
Remember the following sequences

1. BZTK
2. DJRNQP
3. MTXHVLFCSR
4. FROGBATPIGDUCK
Short-term memory

• Miller’s (1956) magical number 7
  – Number of digits that can be repeated after one presentation
  – Normal digit span = 7 ± 2 (phone number)
  – Miller proposed we can hold about seven (give or take two) **chunks** of information. (chunk = a piece of meaningful information)
  – Encoding strategies help to chunk larger pieces of information

Coding in STM

• **Acoustic codes:**
  – when verbal rehearsal is possible, confusions in STM can be based on acoustic similarities. E.g., “T” might be confused with “V”

• **Visual codes**

• **Semantic codes**
  – Evidence for these codes: release from proactive interference

Proactive interference

• STM is influenced by content from long-term memory (e.g., semantic memory)
• Experiment:
  – Hear three items and recall
    • Robin, sparrow, starling
    • Count backward from a number and recall
  – Repeat for three more items from same category
    • bluebird, crow, seagull
  – Repeat for three more items from same category
    • cardinal parakeet, pigeon
  – Repeat for three items from:
    • experimental group: new category Rose, tulip, daisy
    • control group: same category

Views on Short-Term memory

• Miller’s memory span (5 +- 2 discrete slots)
• Baddeley’s theory of working memory
  – Set of slave systems rehearsing and “working” on information
• Short-term memory = activated long-term memory
• Working memory capacity
  – Measures focus of attention with distracting tasks

Baddeley’s theory of Working Memory

- Visual Store
- Episodic Buffer
- Phonological Loop
- Working Memory

Release from Proactive Interference

<table>
<thead>
<tr>
<th>Category</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rose</td>
<td>Tulip, Daisy</td>
</tr>
<tr>
<td>Owl</td>
<td>Hawk, Heron</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Robin, Sparrow, Starling</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bluebird, Crow, Seagull</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cardinal, Parakeet, Pigeon</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rose, Tulip, Daisy</td>
<td></td>
</tr>
</tbody>
</table>
Phonological Similarity

- Note: most working memory tasks involve serial recall
- Short-term memory worse for phonologically similar items → interference in phonological loop (Baddeley, 1966)

Articulatory Suppression

- Articulatory control process:
  - converts visually presented words into a speech code
- Articulatory suppression:
  - saying "the" all the time → disrupts phonological loop
- Prediction:
  - With articulatory suppression, visually presented items should not suffer from phonological interference

Word-length effect

- List 1: "Burma, Greece, Tibet, Iceland, Malta, Laos"
- List 2: "Switzerland, Nicaragua, Afghanistan, Venezuela, Philippines, Madagascar"
- Typical results:
  - list 1 → 4.2 words
  - list 2 → 2.8 words
- Phonological loop limited by syllables/phonemes, not words

Results

<table>
<thead>
<tr>
<th></th>
<th>List 1</th>
<th>List 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological Similarity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissim</td>
<td>0.73</td>
<td>0.68</td>
</tr>
<tr>
<td>Simil</td>
<td>0.73</td>
<td>0.68</td>
</tr>
<tr>
<td>Articulatory Suppression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>0.52</td>
<td>0.32</td>
</tr>
<tr>
<td>Auditory</td>
<td>0.52</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Working memory and Language Differences

- Different languages have different syllables per digit
- Therefore, recall should be different for English (numbers can be spoken rapidly) from Spanish and Arabic (numbers take longer to pronounce)
Problems with Baddeley’s theory

• Pronunciation time does not always predict recall very well

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Stimuli</th>
<th>Mean Pronunciation Time</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>apple, potato, order, handkerchief, sugar, person, apple, huddle, decer, phable</td>
<td>530 ms</td>
<td>70.2%</td>
</tr>
<tr>
<td>Long</td>
<td>Friday, session, fantastic, tomato, tomato, tomato, tomato, tomato, tomato, tomato</td>
<td>650 ms</td>
<td>65.5%</td>
</tr>
<tr>
<td>Short</td>
<td>butter, hotter, whole, spider, pencil, person, sword, candle</td>
<td>620 ms</td>
<td>60.3%</td>
</tr>
<tr>
<td>Long</td>
<td>panther, centaur, motion, sword, sword, sword, sword, sword</td>
<td>700 ms</td>
<td>61.8%</td>
</tr>
</tbody>
</table>

Problems with Baddeley’s theory

• Even with long delays, memory span does not decrease much
• Underspecified processes and representation
  – Serial recall requires memory for the order of items → how is order information stored?
  – How does central executive work?
  – How does interference in phonological loop work?