Memory Part II
Memory Stages and Processes
Overview

• Memory processes
  – encoding, storage, and retrieval

• Capacity & duration of memory stages
  – sensory memory
  – short-term memory
  – long-term memory

• Working memory
Memory Processes

• **Acquisition** or “encoding”
  – turning sensory stimuli into a form that can be stored in memory

• **Storage**
  – retention of information in a memory trace

• **Retrieval**
  – bringing stored information into awareness where it can be reviewed/manipulated
Properties of Memory Stages

• **Capacity**: how much information can be maintained

• **Duration**: how long information stays there
Stage theory of memory
Stage theory of memory
Sensory Memory

• Impressions of sensory information that persist after the original stimulus has ended
Experiments by Sperling on Sensory Memory

• Presented array consisting of three rows of four letters

• Participants were cued to report part of or whole display

![Array of letters]

Demo: [http://bcs.worthpublishers.com/psychsim5/Iconic%20Memory/PsychSim_Shell.html](http://bcs.worthpublishers.com/psychsim5/Iconic%20Memory/PsychSim_Shell.html)
Another demo: [http://psiexp.ss.uci.edu/research/teaching9B/IconicMemory.pps](http://psiexp.ss.uci.edu/research/teaching9B/IconicMemory.pps)
Full report condition

• Instruction: report any letter from the array

Results: participants report 4 out of 12 letters

But… they saw more letters than that
Partial Report Condition

- Instruction: report only cued letters from the array

M N X L
R T J S
K Y G B

array flashed for 50msec
auditory tone or visual cue indicates which set of letters to report (in this example: top row)

Example response

Results: participants can report 3.3 of the 4 cued letters (on average)
Implication for the Memory Capacity

• Participants did not know which letters would be cued

• By extrapolation, reporting 3.3 of 4 cued letters corresponds to reporting 10 letters out of 12 letters from whole display

• Participants retain most or all of the items displayed very briefly in a visual sensory register → high capacity
Rapid Decay

- Vary length of time between turning off the display and onset of the cue (tone/visual cue)

- Result: memory of display decays rapidly and is gone within one second if not attended
Remember this array of letters:

| ECUASELPPAENIPV | GSEMGMTVGGCPPSM  |
| TEBGARORDRCXAS  | OHHLNPCAAAFJNU   |
| VCUGUAPIWZNMOAW  | DAOKDERLSSBLKNE  |
| GEJOFDBOEAEVDAL  | SPSRIYXEMRRIBI   |
| LUCGCOFRPRVRC    | PIRASPBERRYLWYG  |
| TJCPTETQESYCQRO  | KUMQUATSHUWDAH    |
| OILFRWTOCIRPASG  | QCOLOSEGEJELLYY  |
| FENKTAJVLSONBKS  |
Stage theory of memory
Short-term memory

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

• George Miller (1956): capacity of short-term memory is seven plus or minus two items
Measuring Digit Span

• Remember the following digit sequences
Rehearsal of Words

• Verbal information is coded *phonetically*

• We use our “inner voice” when using silent rehearsal

• Memory span is influenced by pronunciation time
Working Memory Capacity influenced by word length

• Experiment:

<table>
<thead>
<tr>
<th>LIST 1:</th>
<th>LIST 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burma</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Greece</td>
<td>Nicaragua</td>
</tr>
<tr>
<td>Tibet</td>
<td>Afghanistan</td>
</tr>
<tr>
<td>Iceland</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Malta</td>
<td>Philippines</td>
</tr>
<tr>
<td>Laos</td>
<td>Madagascar</td>
</tr>
</tbody>
</table>

• Word length effect – mean number of words recalled in order (list 1 → 4.2 words; list 2 → 2.8 words)
Working memory and Language Differences

- Recall for numbers are different across languages

- E.g. memory for English number sequences is better than Spanish or Arabic sequences
Growth in digit-span for one subject (S.F.) with practice
Chunking

- Capacity of short-term memory is not fixed by number of digits, but by chunks

- A chunk is a meaningful way to group information
Remember this sequence:
Dividing the sequence into chunks
Video: Chunking Digit Sequences (~2 min)

full video clip available at: http://www.youtube.com/watch?v=6vsYCSmBcM0
(relevant section starts at 3:50)
Chase & Simon (1973)
Number of pieces successfully recalled by chess players after the first study of a chess board.

(Chase & Simon, 1973)
Number of pieces correctly placed

- Actual game positions
- Random positions

(Chase & Simon, 1973)
Conclusion from Chase & Simon (1973)

- Chess masters only expert with real chess positions. They do not have better memory in general.

- Expertise allows **chunking** of salient information to promote memory of good moves.
Role of Rehearsal

Items need to be rehearsed in short-term memory to entering long-term memory.
a memory test...
Serial Position Effects

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

• Distractor task (e.g. counting) after last item removes recency effect
Explaining Serial Position Effects

• Explanation from stage theory of memory

  – primacy effect: early items can be rehearsed more often: more likely to be transferred to long-term memory

  – recency effect: last items of list are still in short-term memory (with no distractor task)
Working Memory and Prefrontal Cortex
• Correct response requires keeping location of food in mind.

• Monkeys and humans w/lesions of PFC fail these tasks.
Delayed Saccade Task  
(Goldman-Rakic)
Implication

- Evidence of brain-related activity during remembering
Overview

• Memory processes
  – encoding, storage, and retrieval

• Capacity & duration of memory stages
  – sensory memory
  – short-term memory
  – long-term memory

• Working memory