Memory

- There are different memory systems:
  - Sensory memory, short-term/working memory, long-term memory
- Different systems have different characteristics
  - Durations, capacities, contents
- Unifying model: Stage theory
  - Or “modal model”

Stage theory

- Also called iconic memory
  - Auditory sensory memory is called echoic memory
- Holds 1 item per spatial location
  - Presenting another item at that location masks (overwrites) the previous one

Visual sensory memory

- Stores unidentified “blobs”
  - Attending to a blob and encoding it into short-term memory takes time
- Contents can be overwritten
- Contents also decay over time
  - Neurons return to baseline
  - An item in iconic memory lasts about 1 sec
    - An item in echoic memory lasts 2-3 sec

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Decay

Subitizing

- We can encode the number of items in iconic memory, up to about 4 or 5, without counting
- For more items, we have to count
  - Or estimate, if items decay before we can count them all

Visual sensory memory

- Probably stored in occipital lobe

Working memory (WM)

- Roughly equivalent to conscious awareness
- Has verbal and visual components
  - Often called “buffers”
  - Verbal working memory is better studied

Verbal working memory

- Duration is a few seconds
  - Items decay, but can be maintained in an active state using rehearsal
  - Without rehearsal, an item lasts no longer than about 30 seconds
- Capacity is limited
  - Two different estimates:
    - $7 \pm 2$ chunks
    - As many items as you can rehearse in 2 seconds
Free recall procedure

- You’ll see 15 words, one at a time
  - Half a second apart
- Afterwards, write them down, in any order

Typical accuracy results

Primacy and recency effects

- Primacy: Early items get more rehearsal
  - Maintenance rehearsal: say the item repeatedly
  - Elaborative rehearsal: link the item to existing knowledge
- Recency: Late items are active because you just encoded them
  - Left alone, they decay

Verbal chunking

Visual chunking
Implications of chunking

• The more you know about a task, the easier it is to remember details about it
  — Experts effectively have large working memories in their domains of expertise
  — In other domains, their working memory is no different anyone else’s

The “working” in working memory

• You’ll see two numbers
• Multiply them in your head
• While thinking out loud

\[ 760 \times 93 \]

Altmann’s verbal protocol:

so 760 times 93, uh
3 times 760
so 3 times 6 is 0, 3 times 6 is 18, uh
it was 760, so 3 times 7 is 21
plus carry 1 is 22, uh
so 3 times 760 is 22, 2 2 8 0, ok
that’s the first line, the second line is
I was multiplying by 93, I think, times 760
so 9 times 0 is 0, 9 times 6 is 54
[?] the 4, carry the 5, uh
9 times 7 is, um ... 63
plus 4 is 67, so 6 7 4 0
plus ... 2 2 8 0
0 plus 0 is 0, 8, uh
now I’ve lost the second number