PSYC 5303: Theories of Learning

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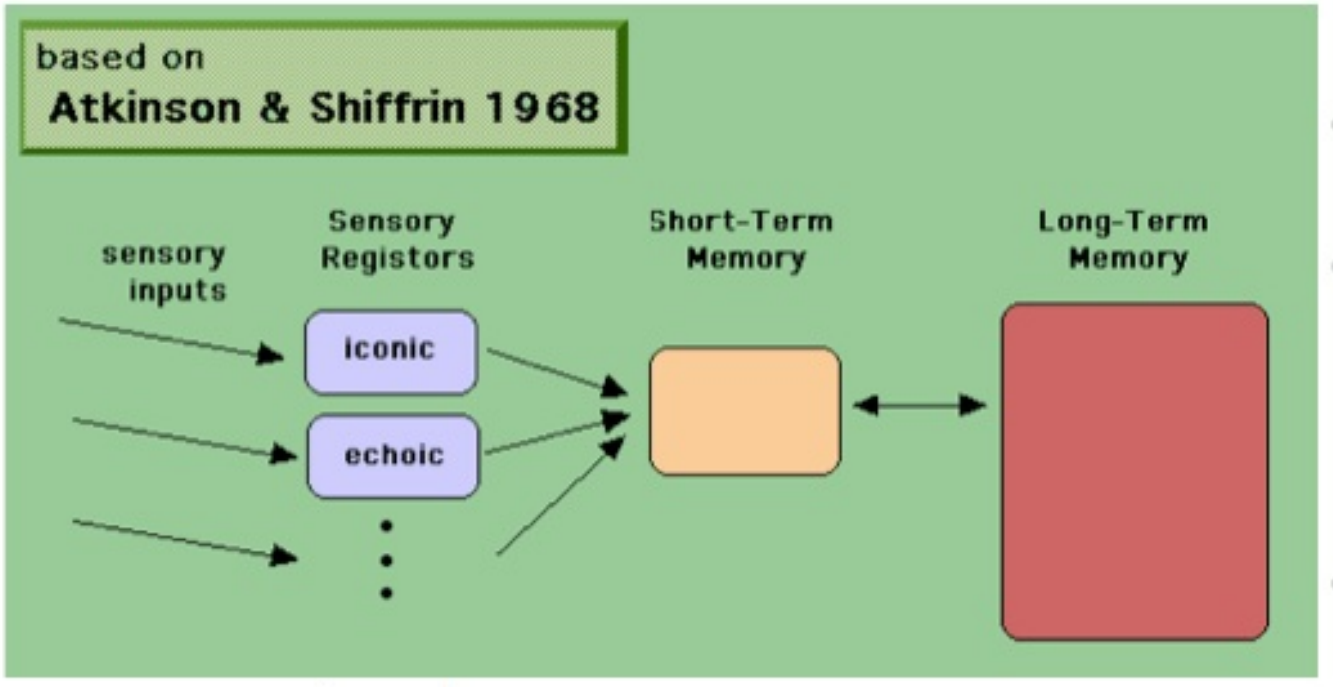
Week 6: Conceptual Models of Human Memory

Structural (modal) model of memory



Memory composed of distinct storage structures that hold information for a period of time

- Sensory memory
- Short-term memory (STM)
- Long-term memory (LTM)

Short-term memory

Functions

- Re-codes info from sensory memory for longer storage
- Some info goes into long-term memory – stored for an indefinite amount of time
- Rehearsal important part of STM
  - maintains a memory trace for a short period of time
  - helps transfer information from STM to LTM
- Main features that we will talk about
  - Capacity
  - Encoding
  - Duration
  - Retrieval

STM capacity

How much information can be held in STM?

- limited capacity
- *Span* = measure of STM capacity
- Visual or auditory information

STM capacity

- Miller (1956) proposed capacity $= 7 \pm 2$ "chunks" of info
- Chunk = unit of info recoded from the sensory input
- 1 chunk = 1 letter = 1 syllable = 1 word, etc...

STM capacity

Digit span task: how many sequential numbers can you remember?

STM capacity

Digit span task: how many sequential numbers can you remember?

Span of 4:	6	1	9	4						
Span of 5:	3	7	8	5	2					
Span of 6:	9	6	5	2	8	3				
Span of 7:	4	2	6	9	8	5	1			
Span of 8:	8	1	6	3	7	2	4	9		
Span of 9:	6	2	5	7	3	4	9	8	1	
Span of 10:	9	3	8	2	4	7	1	5	3	6

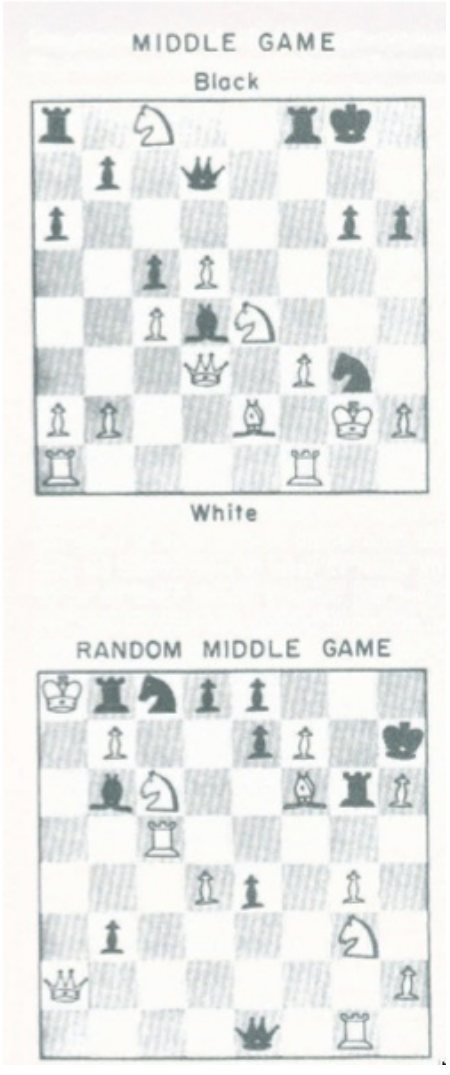
STM capacity

- *Span* differs slightly depending on definition of "chunk" (varies with complexity of the chunk)
  - Digit span = 7.7
  - Letter span = 6.35
  - Word span = 5.5
  - Trigrams (CVCs) = 3.2
- Span can also vary based on chunking abilities (integrated and elaborated with knowledge in LTM)

STM capacity – Chunking

Chase and Simon (1973)

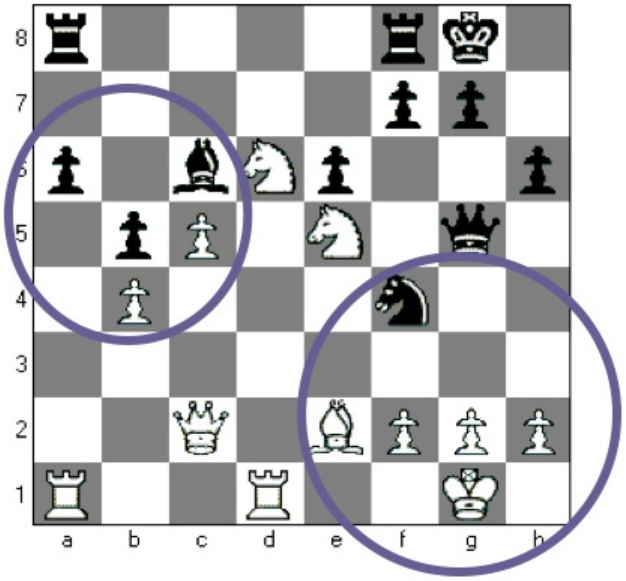
- Used chess players
  - Novices: $<$ 100 hours
  - Experts: $>$ 10,000 hours
- players viewed either an actual or a random "middle game" for 5 seconds



STM capacity – Chunking

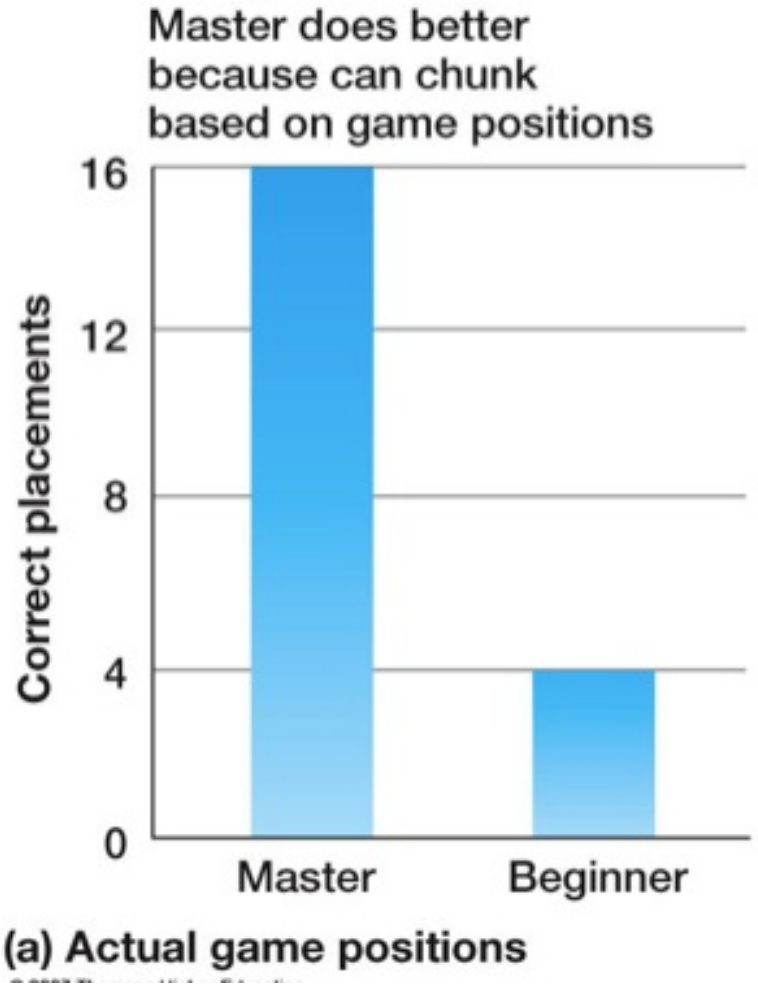
Chase and Simon (1973)

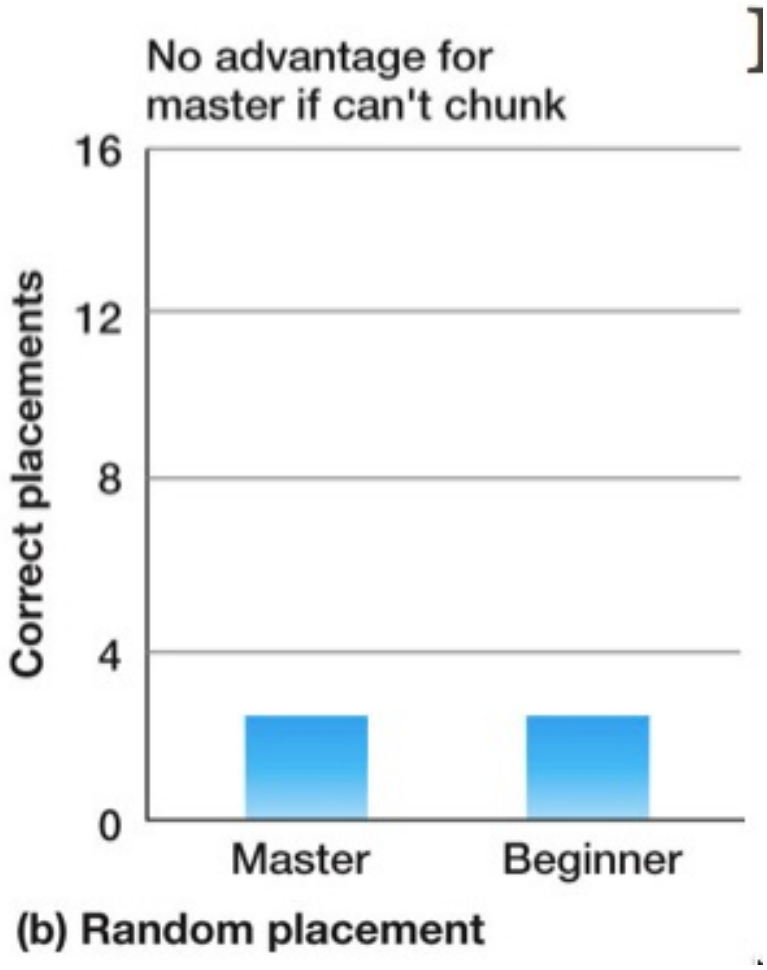
- Information stored in memory as chunks
- Chunks can be recognized instantly
- Masters have a large number of chunks



STM capacity – Chunking

Chase and Simon (1973) – results





STM capacity

Cowan (2000) – 6 modern views against the "7 ± 2" capacity limit:

- Time is the limiting capacity, not # items
- No STM, all memory follows general rules (e.g., interference)
- No capacity limits, but constraints on scheduling conflicts in performance
- Multiple capacity limits depending on material
- Separate capacity limits for storage and processing
- Capacity limits are task specific

What is the nature of the information that is encoded in STM?

STM: Encoding

Coding: the way information is represented

- Types of codes:
  - Auditory: acoustic, linguistic
  - Semantic: meaning-based
  - Visual: image-based
- Most studies indicate that most info is stored AUDITORILY

STM: Encoding

Conrad (1964)

- Presented letter pairs briefly, asked to write down the letters
- Included letters that looked alike (V and X) or sounded alike (V and C)
- Error analysis indicated tendency to confuse letters with similar sounds – evidence for auditory STM encoding

STM: Encoding

Baddeley (1966)

- In all lists, words either sounded alike (cat, hat, sat), had similar meanings (tiny, small, little), or were unrelated
- Results: more errors when subjects studied words that sounded alike compared to words that have similar meanings

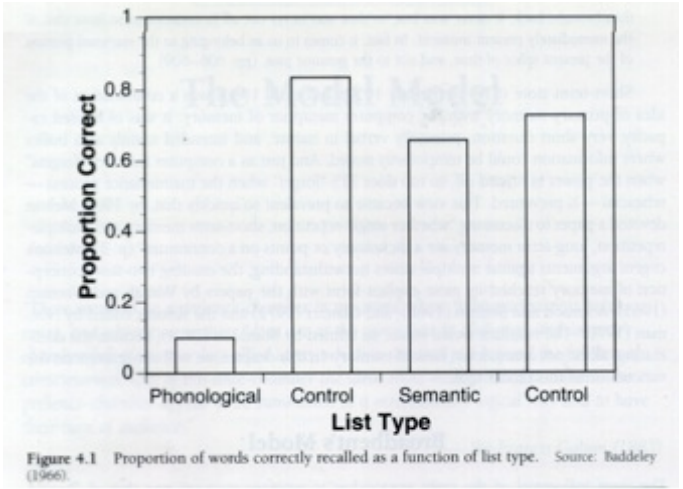


Figure 4.1 Proportion of words correctly recalled as a function of list type. Source: Baddeley (1966).

Conclusion: similar sounding words interfered with each other in STM because memory code was based on acoustic information

STM: Encoding

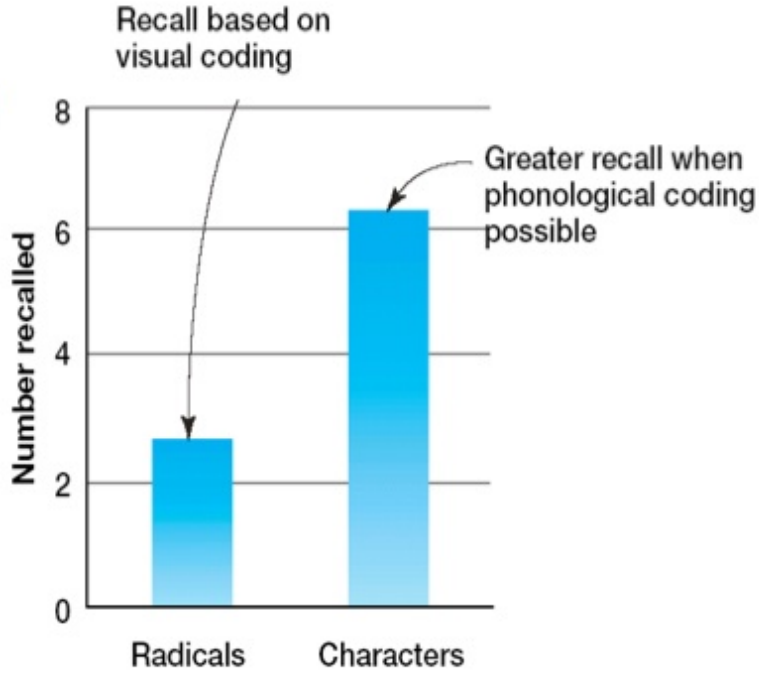
Zhang & Simon (1985)

- Chinese radicals (no sound) and characters (has sound) to Chinese native speakers.
- **Results** –recalled 2.7 radicals (visual code) versus 6.4 characters (auditory code).

Radical (no sound)

Character (has sound)

(a)

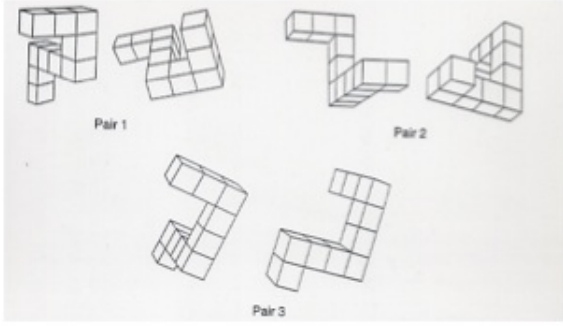


(b)

But...evidence for visual coding?

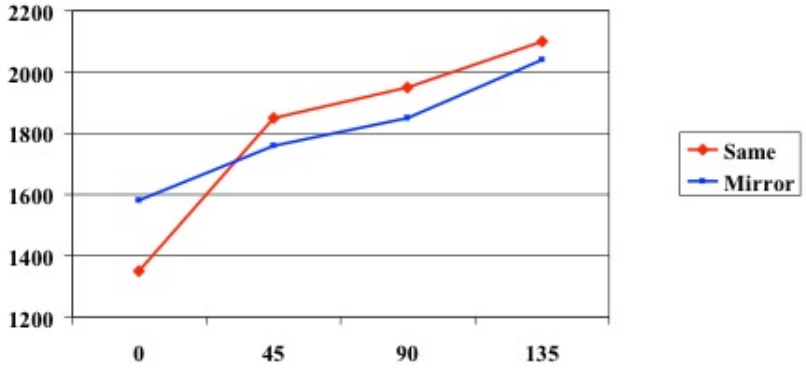
Shepard & Metzler (1971)

- Subjects shown 2 objects and asked if they were the same or different in different orientations



- **Results**: Subjects took longer to answer when the object had been rotated further 60^0, 90^0, 120^0

- **Interpretation:** people held the 1st figure in STM and mentally rotated the 2nd to make a comparison

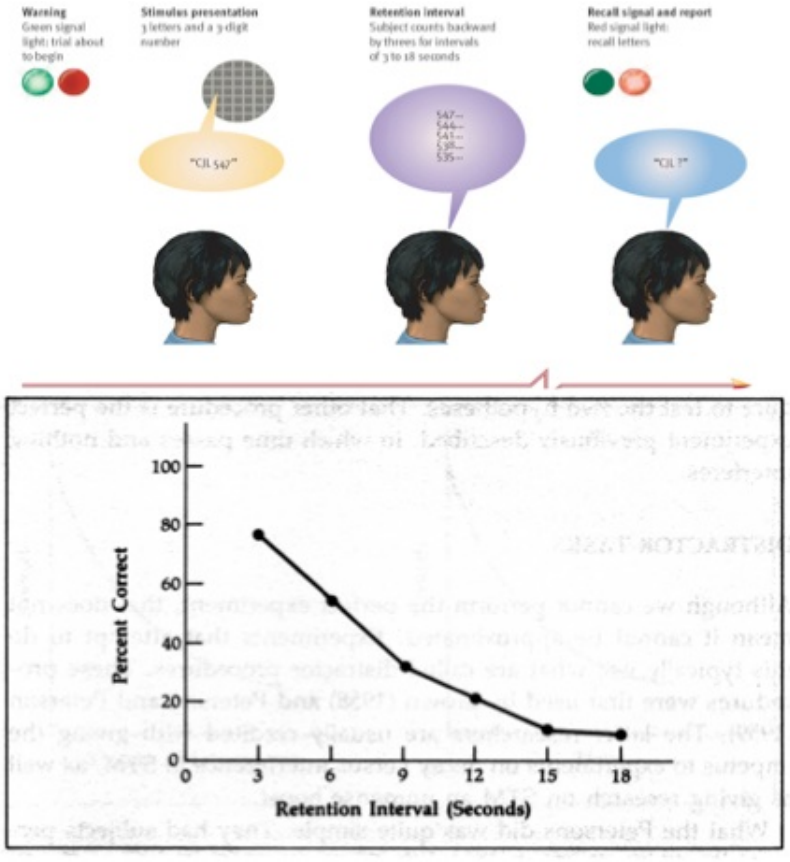


Duration: How long does information last in STM?

STM: Duration

Peterson & Peterson (1959) / Brown (1958)

- Experimenter says: CHJ 506
- Begin counting backward by 3's
- After set time, recall three letters:
  - "506, 503, 500 ... CHJ"



- After 3 seconds of counting, participants performed at 80%
- After 18 seconds of counting, participants performed at 10%

STM: Duration

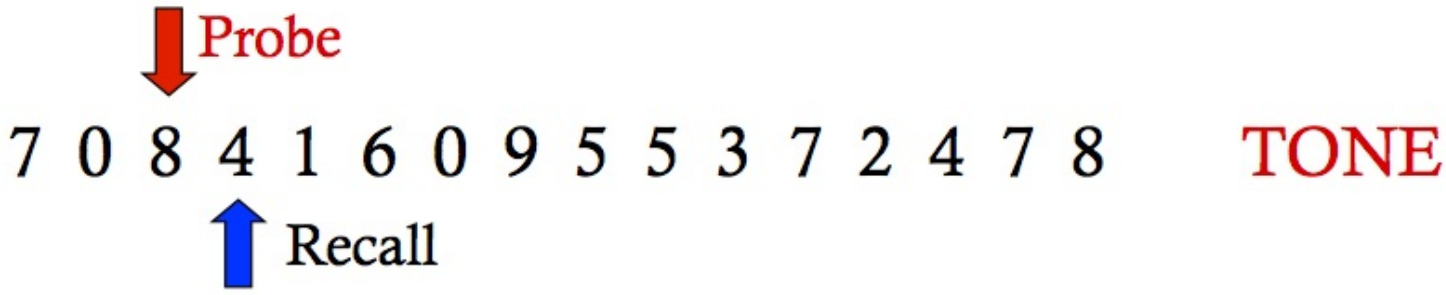
So what is happening here?

- STM decay due to time only?
- proactive interference?
  - Waugh & Norman (1965)
  - Wickens et al. (1963)

STM: Duration

Waugh & Norman (1965)

- subjects presented with lists of 16 digits
- tone signaled subject to recall digit that followed the earlier presentation of last digit



STM: Duration

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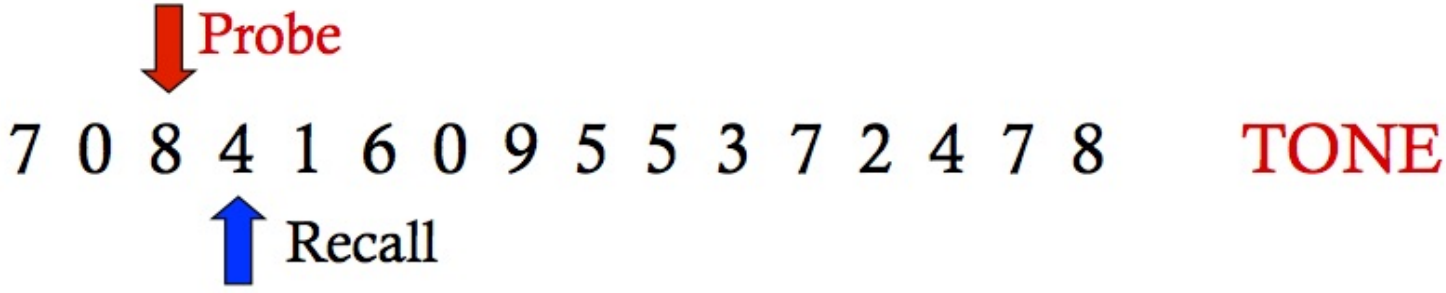

- between probe and signal, two things happen: (1) time passes, and (2) more digits presented
- which is more important in causing forgetting?
  - forgetting = decay $\rightarrow$ time
  - forgetting = interference $\rightarrow$ more digits

STM: Duration

Waugh & Norman (1965)

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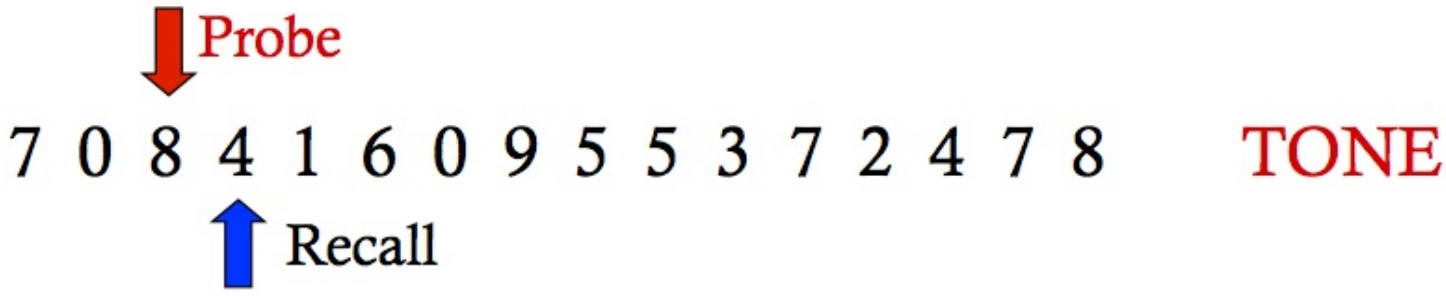
- tone signaled subject to recall digit that followed the earlier presentation of last digit

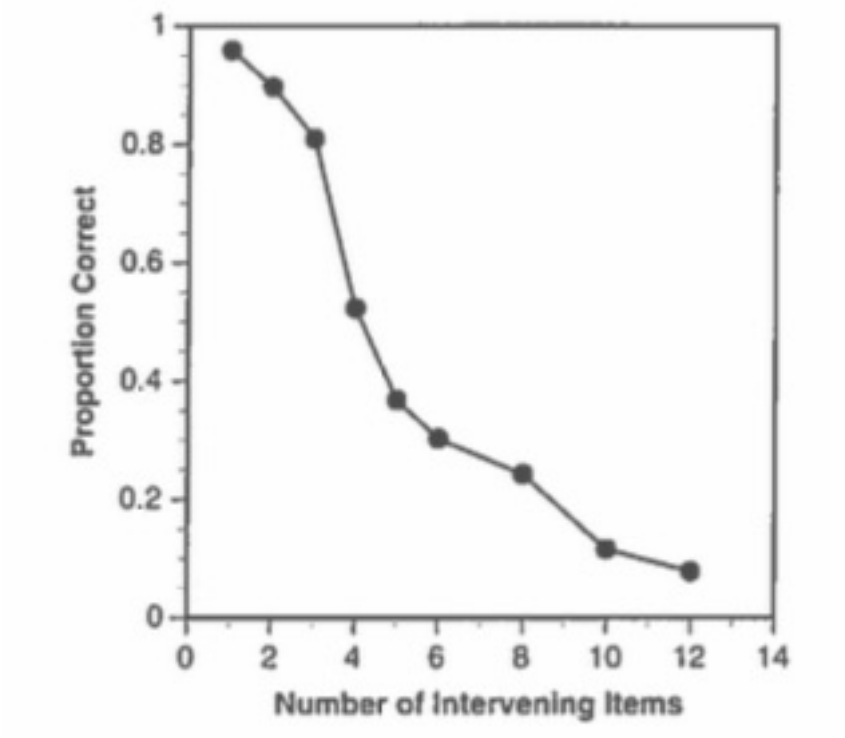


- problem: time and digits are correlated (they are confounds)
- solution: two presentation rates: slow (1 digit per second) and fast (4 digits per second)

STM: Duration

Waugh & Norman (1965) – results

- no difference in recall with fast vs. slow presentation with probes at beginning of list
- recall decreased as probe moved toward beginning of list



STM: Duration

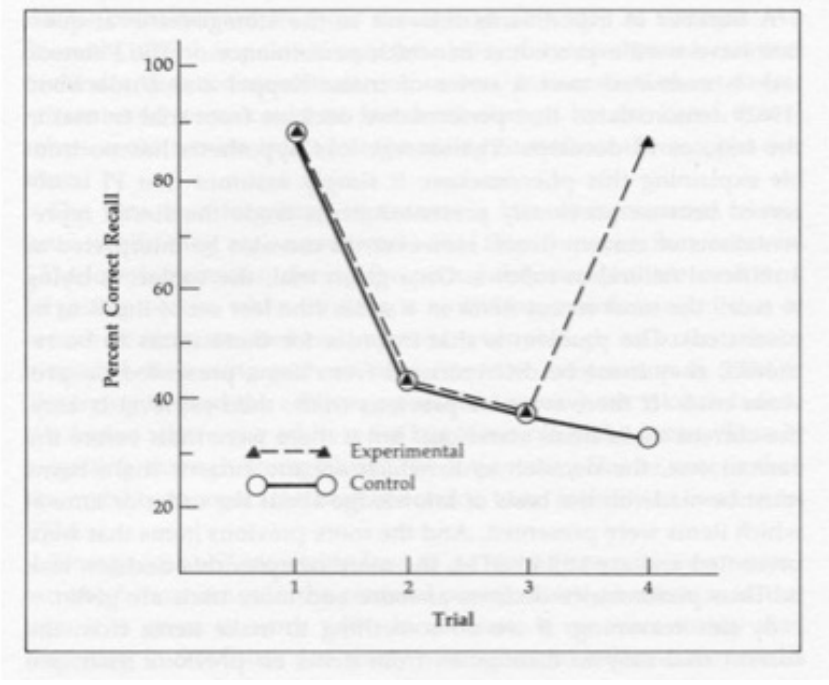
Wickens, Born, & Allen (1963) – Release from proactive interference

- Changing the nature of the items to be remembered reverses the decline in performance due to proactive interference
  - Two groups of subjects given 3 trials following Brown-Peterson task (letters). Memory performance declined with each trial
    - Control group given 4th trial with letters
    - Experimental group switched to remembering digits

STM: Duration

Wickens, Born, & Allen (1963) – Release from proactive interference

- Changing the nature of the items to be remembered reverses the decline in performance due to proactive interference



STM: Retrieval

How do we get information out of STM?

- Retrieval from STM appears to operate by searching STM contents one at a time (serial search)
  - Sternberg (1966): we'll see a presentation on this tonight!

STM Summary

- Encoding: info mostly stored in auditory form
- Capacity: can hold 7 ± 2 chunks (though Cowan's model specifies a smaller limit of 3-4 units)
- Duration:
  - STM is a short store of about 15-20 seconds without rehearsal
  - Interference, not decay
- Retrieval: serial search procedure (items searched one at a time)