

The Memory System: Sensory Memory and Short-Term or Working Memory

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- 1960s Many models of memory proposed
- Atkinson & Shiffrin (1968)-Modal Model
 - Sensory Memory
 - Short-term Memory
 - Long-term Memory

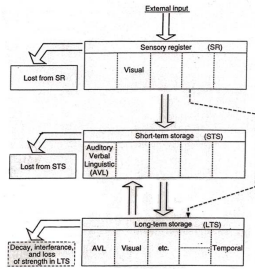
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William James

- Primary Memory
- Secondary Memory

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Atkinson & Shiffrin Model of Memory (1968)



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Properties of the Different Memory Stores

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Research on the A & S Model

- Serial Position Effect
- Recency Effect
- Behavioral Neuroscience Evidence

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Serial Position Effect Demo

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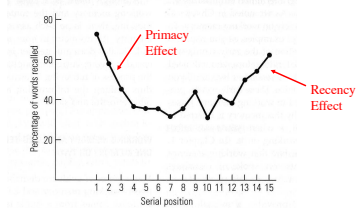
Serial Position Effect Results

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Serial Position Effect Graph

The U-Shaped Serial Position Curve



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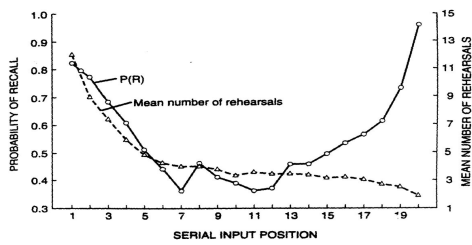
Questions

- How could we test the idea that the last few items are in STS?
- How can we test that the primacy effect represents LTS?

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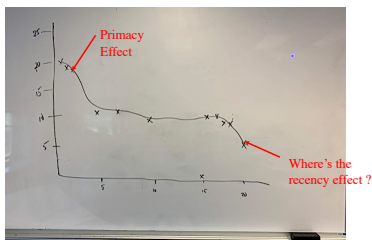
Rundus (1971)



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Serial Position Effect Graph - Psy 321 F2019



Why is our serial position curve different than the predicted shape?

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Behavioral Neuroscience Evidence for the STM-LTM Distinction

- H.M. - Epileptic
 - Temporal Lobes / Hippocampus
 - STM ---> LTM disrupted
- K.F.- Damage to Left Cerebral Cortex
 - LTM Normal
 - STM capacity severely limited

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Behavioral Neuroscience Evidence for the STM-LTM Distinction

The dog bit the man and the man died.

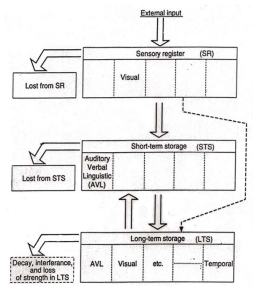
vs.

The man the dog bit died.

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Atkinson & Shiffrin Model of Memory (1968)



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The Sensory Store

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Lightning



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How long does the lightning last?

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Lightning Demonstration

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Sensory Memory

- Sensory memory or sensory register
- Visual, auditory, touch, taste, smell
- Relatively raw, unprocessed form

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Why Do We Need Sensory Memory?

- Stimuli change
- Maintain for selection and further processing
- Integrate fragments of a stimulus into a single unitary perception

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Classic Studies on **Iconic** Memory

- Sperling (1960)
- Averbach & Sperling (1961)

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A Tachistoscope



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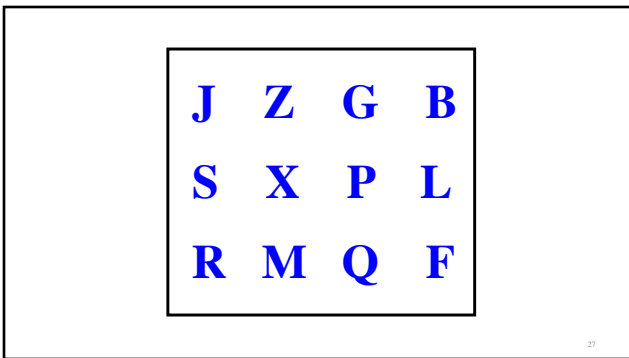
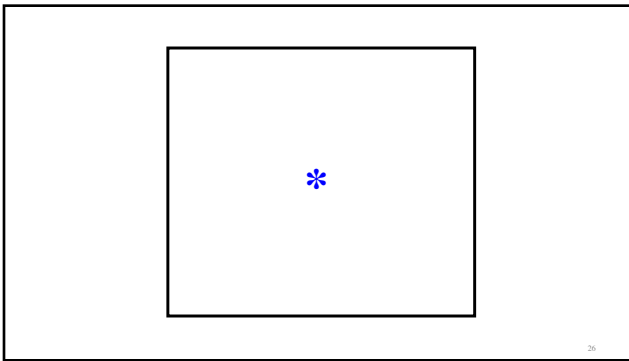
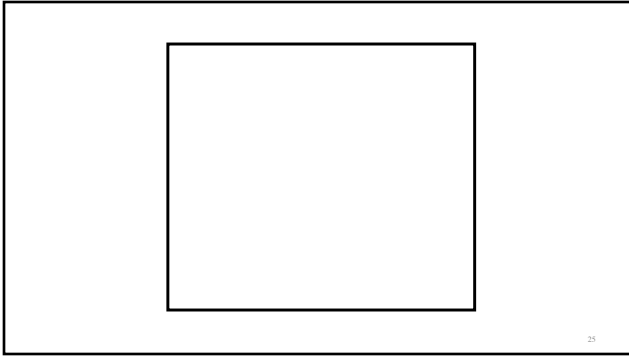
Whole Report Procedure

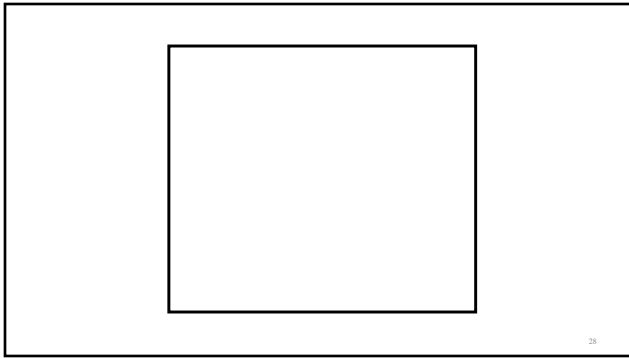
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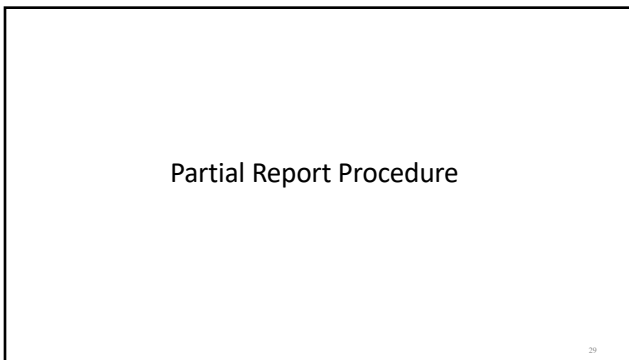
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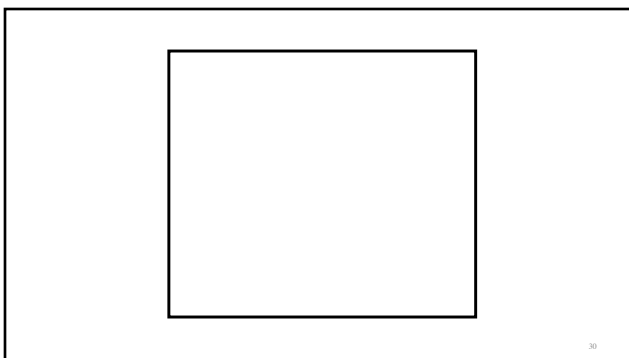




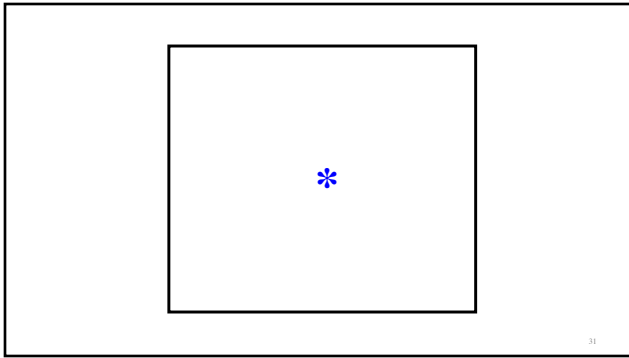
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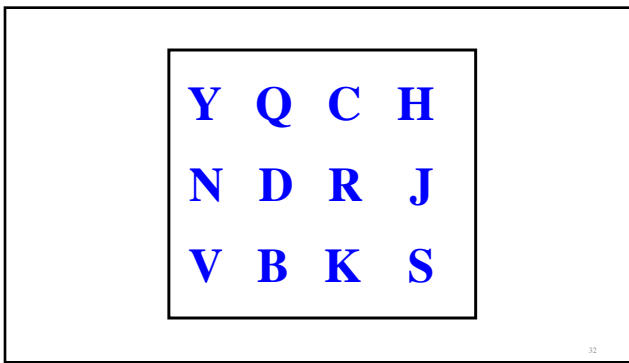
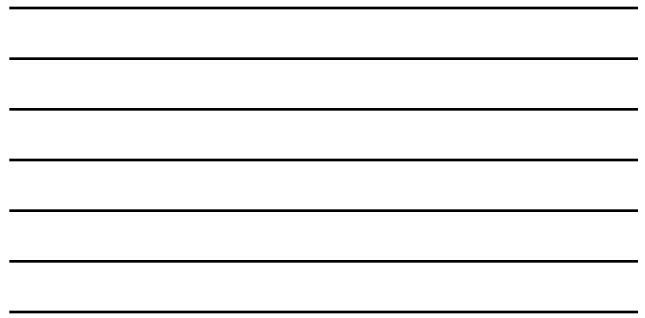
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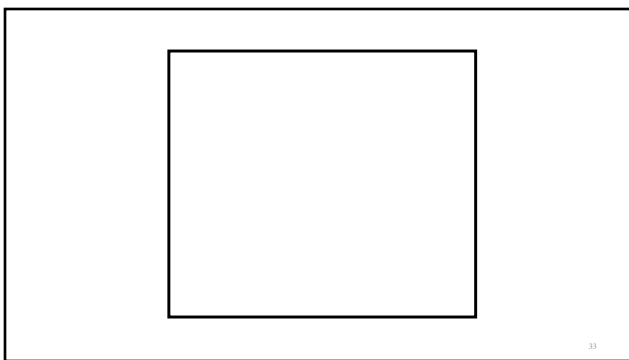
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 **V B K S**

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 **N D R J**

35

 **Y Q C H**

36

high
med
low

Y Q C H
N D R J
V B K S

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Schematic of Typical Sperling Exp

Fixation point appears for 500 msec
Letter array appears for 50 msec
Postfield duration of 0 to 5 seconds
Tone cue for report
Written or verbal report

Timer starts running here

A schematic diagram of a typical trial in Sperling's (1960) experiments. After a fixation point appears for 500 msec, the letter array is displayed. The visual field after the display is blank. The tone cue can occur at the same time as the postfield, or it can be delayed up to 5 seconds.

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Number of Letters Recalled as a Function of Technique & Delay

NUMBER OF LETTERS RECALLED, AS A FUNCTION OF TECHNIQUE AND DELAY
(TYPICAL RESULTS)

Delay (seconds)	Partial-report technique (estimated recall)	Whole-report technique
0.0	10	4
0.15	8	4
0.3	6	4
0.5	5	4
1.0	4.5	4

Delay between disappearance of stimuli and presentation of tone (in seconds)

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Examples of Iconic Memory in Our Everyday Experience

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Examples of Sensory Memory

EXAMPLES OF SENSORY MEMORY

Visual Sensory Memory. Hold your hand in front of your eyes and quickly wave it back and forth. If your hand motion is quick enough, you will be able to "see" your hand in one position for a fraction of a second after it has moved on to a different position.

Auditory Sensory Memory. With your hands, beat a quick rhythm on the desk. Can you still hear the echo after the beating is finished?

Tactile (Touch) Sensory Memory. Quickly rub the palms of your hands along a horizontal edge of your desk, moving your hands so that the heels touch first and the fingertips touch last. Can you still feel the sharp edge, even after your hand is off the desk?

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Demo: Unitary Perception from Fragments

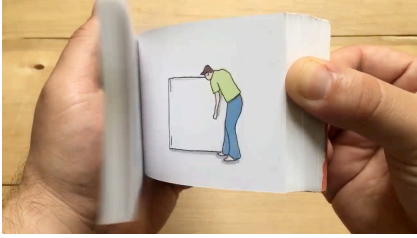
HOW SENSORY MEMORY CREATES A UNITARY PERCEPTION FROM FRAGMENTS. BASED ON COWAN, 1998.

Take an index card and cut a narrow slit (about 1/8" wide) in the middle of the card, orienting the slit lengthwise and making it as long as possible. Then hold the slit in front of the cover of this textbook, at a distance that allows you to see both the top and the bottom edges of the book. Now, begin with the slit toward the left edge of the textbook and move it toward the right. In reality, you are seeing a sequence of fragmentary views of the photo. However, sensory memory allows you to incorporate these fragments into one single perception of the photo.

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Videos & Movies



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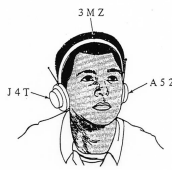
Auditory Sensory Memory

- Neisser (1967) - Echoic memory and the echo
- Darwin, Turvey, & Crowder (1972)
- Differences from iconic memory
- Crowder (1982)

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An Echoic Memory Study

A PERSON PARTICIPATING IN AN ECHOIC MEMORY STUDY



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Properties of the Different Memory Stores

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Short-Term Memory

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Short-Term Memory

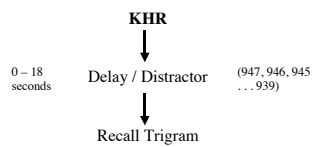
- Duration
- Nature of Forgetting
- Nature of Code
- Capacity

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Short Term Memory

- Brown/Peterson & Peterson (1959)
- Trigram task



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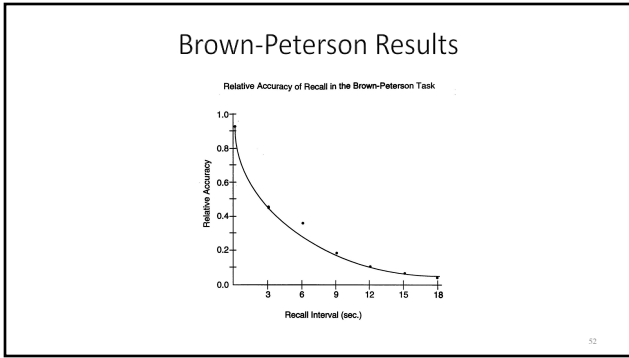
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Trigrams

- K X J
- P L G
- S Y T
- H Z R

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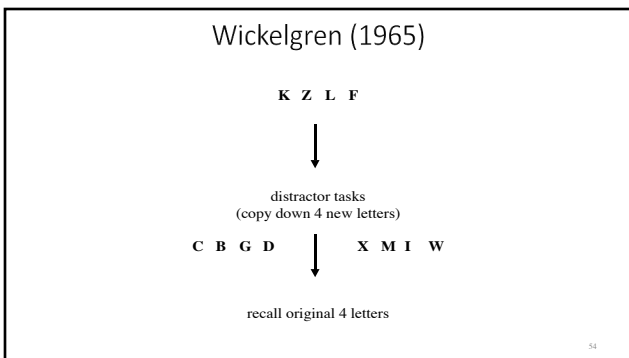
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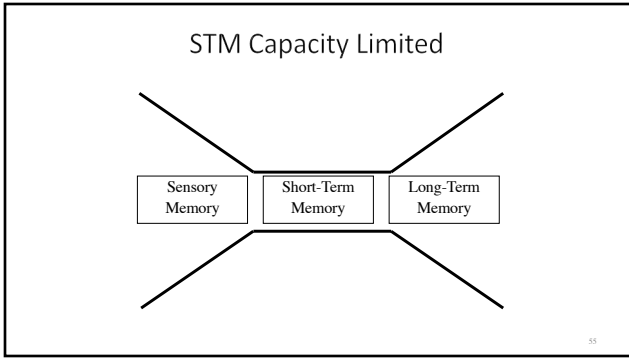
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- ### STM--Nature of the code
- Conrad (1964)
 - Visual display of letters
 - Phonological confusions: ('D' for 'E' but not 'F' for 'E')
 - Wickelgren (1965)

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Capacity of STM

- Limited Capacity (7 ± 2)
- Digit Span Task

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Listen to the following digit sequence and try to recall it when I say "Go"...



The digits I read: 1, 4, 9, 2, 1, 7, 7, 6, 2, 0, 1, 9

Did you notice? 1 4 9 2 1 7 7 6 2 0 1 9

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By the way...

Try to recall all 12 digits now:

1, 4, 9, 2, 1, 7, 7, 6, 2, 0, 1, 9

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Capacity of STM (cont.)

- Recoding: (1 4 9 2 ----> '1492' Columbus)
- Chunking
- Chase & Ericsson (1982)

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SF DIGIT SPAN Experiment

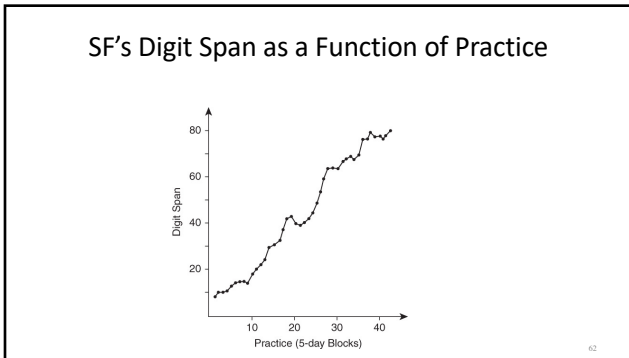
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SF Digit Span Experiment – 3 Sessions

<p>Session 1 (Initial): (8 digits): Digits: 1 0 5 3 1 8 7 4 SF's Recall: 105 31874 SF's Report: Blocked 1st set & rehearsal</p>	<p>Session 3 (Much Later): (22 digits): Digits: 4 1 3 1 7 7 8 4 0 6 0 3 4 9 4 8 7 0 9 4 6 2 SF's Recall: 413.1 77.84 0603 494 870 946.2 SF's Report: 4:13.1 mile time 06:03 mile time 9:46.2 2-mile time ... Click to move on to next slide...</p>
<p>Session 2 (Later): (11 digits): Digits: 9 0 7 5 6 6 2 9 8 6 7 SF's Recall: 907 566 29867 SF's Report: 9:07 a 2-mile time</p>	

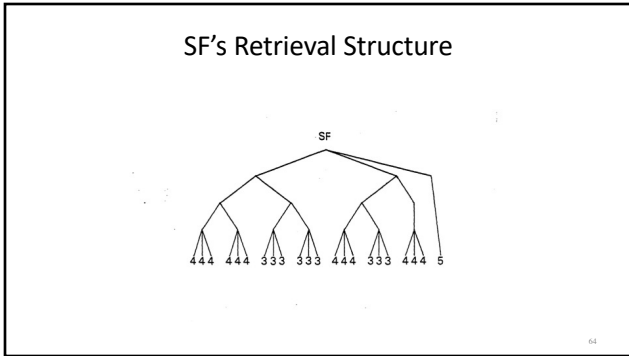
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Do the SF results challenge the 7 plus or minus 2 idea about STM?

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Revisions to the STM Idea

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Brown & Peterson - Revisited

- Decay vs. Interference
- Time and Interference Confounded in the Counting Backwards Task
- How to dis-entangle?
- Waugh & Norman (1965) - Digit Probe task
- Varied Time and Interference Independently

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Digit Probe Experiment: Waugh & Norman (1965)

1. Participants hear a series of 16 digits...

5 3 5 1 9 6 4 3 7 3 2 8 6 7 3 4

3. As soon as they hear the probe digit, they must recall the last instance of the probe digit and the digit that followed it.

2. The last digit they hear is the probe.

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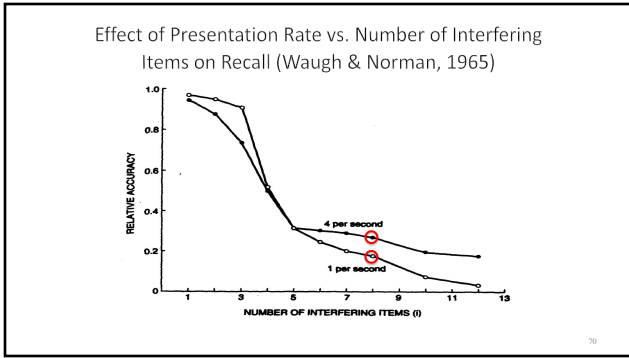
Trial Type 1: Vary the Time While Holding the Number of Intervening Digits Constant

1 digit/sec 5 3 5 1 9 6 4 3 7 3 2 8 6 7 3 4

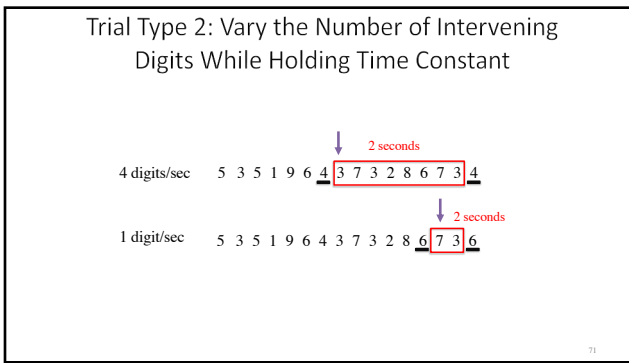
4 digits/sec 5 3 5 1 9 6 4 3 7 3 2 8 6 7 3 4

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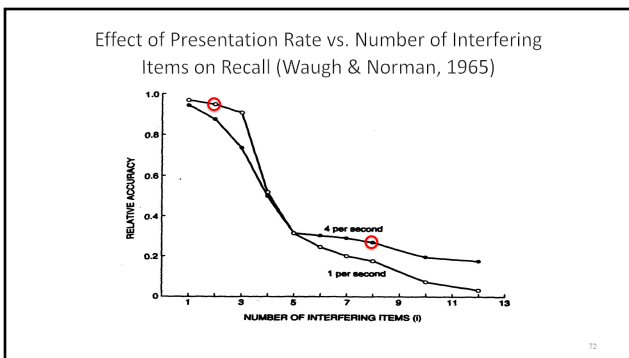
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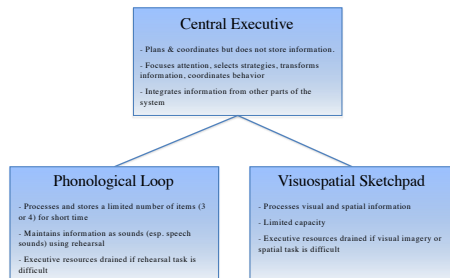
Working Memory

- Revision of STM
- 3-part system
- Baddeley
- Dual task paradigm

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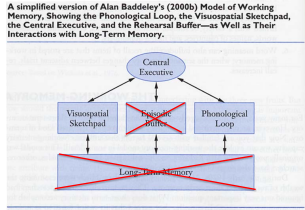
Baddeley Working Memory Model



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Working Memory Model with Episodic Buffer & Long-Term Memory



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Reasoning Task with Letter Recall

AB

- 'A' precedes 'B' ? T or F
- 'B' is preceded by 'A' T or F
- 'B' does not precede 'A' . T or F

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Reasoning Speed and Letter Recall

Experiment 1:

0, 1, 2 items preloaded
 ↓
 reasoning task
 ↓
 letter recall

Experiment 2:

0 or 6 items
 ↓
 reasoning task
 ↓
 letter recall

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Reasoning Times & Letter Recall Results

Table 4-3 REASONING TIMES AND LETTER RECALL UNDER VARIOUS MEMORY LOAD CONDITIONS

Experiment 1			
	Memory load (number of letters held in memory)		
	0	1	2
Reasoning times	3.20 sec	3.31 sec	3.31 sec
Letter recall	Essentially perfect		

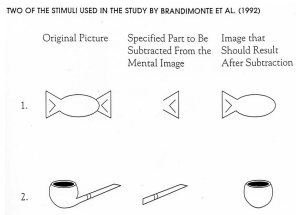
Experiment 2			
	Memory load		
	0	6	
Reasoning times	3.27 sec	3.46 sec	} "Equal stress"
Letter recall	5.5	3.7	
Reasoning times	2.73	4.73	} "Memory stress"
Letter recall	5.8	5.0	

Note: In both experiments, a memory load of 0 was a control condition. In these conditions, subjects performed the reasoning task, and only then were they given the set of letters for the memory span task. Thus letter recall of 5.8 in the 0 Memory load condition means that 5.8 letters were recalled immediately after their presentation, where presentation followed the reasoning task.

Adapted from Baddley & Hitch, 1974

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Brandimonte Et al. (1992)



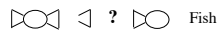
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Brandimonte (1992)

Condition 1

1. Study 6 pictures

2. Create mental image, subtract a specific part, and name it.



Result?

3. Number of correct items: 2.7

Condition 2

1. Study 6 pictures while saying "la, la, la..."

2. Create mental image, subtract a specific part and name it.

3. Number of correct items: 3.8

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Pronunciation Time & Memory Span

- Read the following words. When you have finished look away and try to remember them:
 - England, Burma, Greece, Spain, Iceland, Malta, Laos
- Again read the words, look away and try to remember them:
 - Czechoslovakia, Switzerland, Nicaragua, Afghanistan, Venezuela, Philippines, Madagascar

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Pronunciation Time & Memory Span

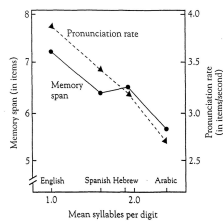
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Memory Span and Pronunciation Rate

MEMORY SPAN AND PRONUNCIATION RATE FOR NUMBERS IN FOUR DIFFERENT LANGUAGES. NAVEN-BENJAMIN & AYRES (1966).



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Capacity of STM

- Difficult to Estimate
- Different meanings (storage capacity vs. processing capacity)
- Digit Span Task
- Miller – “The Magical Number Seven, Plus or Minus Two . . .”
- 7 ± 2

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