Improving Learning and Memory

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Herman Ebbinghaus

- First to study learning and memory using scientific method
- Process of association formation
- Non-sense syllables
- Invented the 1st method of measuring memory - Savings Method

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The Learning Task

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Nonsense Syllables

DAX
GIK
TEB
KOV
SUV
HET

Click to Repeat

4

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Nonsense Syllables

DAX
GIK
TEB
KOV
SUV
HET

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Ebbinghaus's Measure of Memory

1. List learned to 2 perfect recitations (# trials)
2. Set aside (varied delay)
3. Relearn (# trials)
4. Measurement of Savings

$$\frac{\text{\# Trials to Learn} - \text{\# Trials to Relearn}}{\text{\# Trials to Learn}}$$

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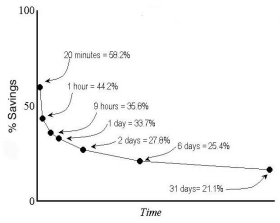
Forgetting Curve



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Ebbinghaus's Findings

- Newly-learned information forgotten quickly
- Some information remembered -> perma-store.
- Why?

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Improving Learning & Memory

- Practice: How we practice/study Important
- Memory – Encoding, Storage, & Retrieval
- Mnemonics – Techniques for Remembering Difficult to Remember Material
- Memory as a skill
- The Brain

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Practice

- Total Time Hypothesis
- Distributed vs. Massed Practice
- Interleaved vs Blocked Practice
- Desirable Difficulty
- Expanded Retrieval Practice
- Deliberate Practice (Ericsson)

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3 Important Memory Processes

- Encoding
- Storage
- Retrieval

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The Encoding Process

- Shallow vs Deep Processing
- Elaboration – Using Prior Knowledge
- The Self-Reference Effect
- Divided Attention – (e.g. Multitasking)

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The Retrieval Process

- Retrieval Cues
- Retrieval Context
- Encoding Specificity Principle (ESP)
- Testing Effects

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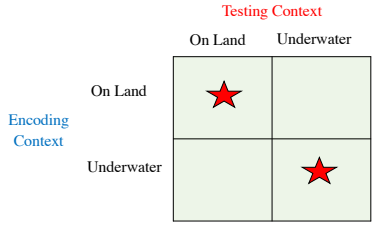
Godden & Baddeley (1975)



Half of the participants (deep—sea divers) learned the test material while underwater; half learned while on land. Then, within each group, half were tested while underwater; half were tested on land. Where do we expect a retrieval advantage?

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Learning Names using Faces as Retrieval Cues

What's his name?

Tim!

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The MOST important memory improvement strategy – Retrieval Testing

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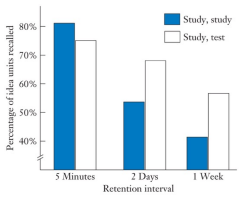
Testing Effect Study



The Effect of Learning Condition (Repeated Study vs. Testing) and Retention Interval on Recall (Roediger & Karpicke, 2006)

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Mnemonics - Techniques for Remembering Difficult to Remember Material

- Visual Imagery Mnemonics
  - Interactive Visual Imagery
  - Keyword Method
  - Method of Loci
- Organizational Mnemonics
  - Hierarchical Technique
  - 1st Letter Mnemonic
  - Narrative Technique
  - Calendar Mnemonic

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Interactive Visual Imagery

Imagine writing on a ball with a pen.

Puncturing a ball with a pen.

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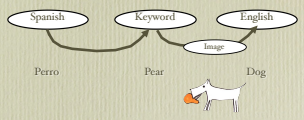
Keyword Method



The keyword method is a mediational technique that involves first relating a Spanish word (*perro*) to a similar-sounding English word called the keyword (*pear*) and then relating the keyword to the English definition (*dog*) by generating an interactive visual image involving the two referents.

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Method of Loci Used to Remember a List of Unrelated Items

- Select a route that consists of a series of locations – these are your "loci."
- Associate the word for each item with one of the locations as you mentally 'walk' your path.
- Form an interactive visual image involving the item and the location.
- To remember your list of items, retrace your path or route and simply retrieve your items by looking at each location as you retrace your path.

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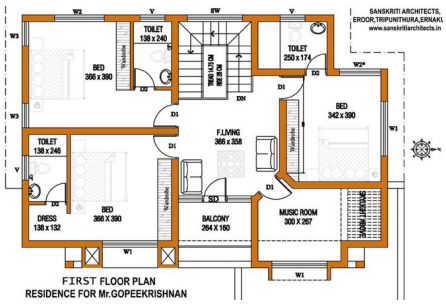

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Organizational Mnemonics

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The Hierarchical Technique

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Duck
Manx
Pinto
Arabian
Warbler
Dachshund
Collie
Sparrow
Swan
Wren
Goose
Persian
Shepherd
Finch
Mustang

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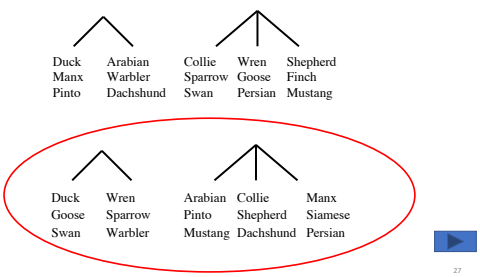
Bower (1969)



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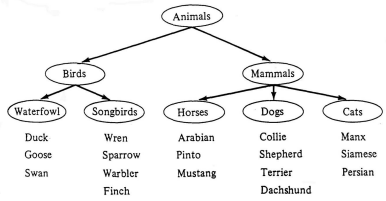
AN EXAMPLE OF A HIERARCHY



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First-Letter Mnemonic

- Examples:
- ROY G BIV
  - Red, Orange, Yellow, Green, Blue, Indigo, Violet
- HOMES
  - Huron, Ontario, Michigan, Erie, Superior

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Narrative Technique

- Make up a story that links the to-be-remembered words together
- Bower & Clark (1969)
  - Six times as many words recalled by narrative group
- Narrative must be sensible and hang together as a story

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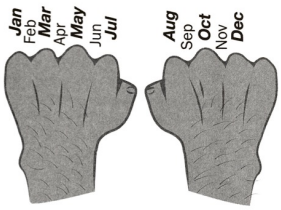
Calendar Mnemonic



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Memory as a Skill

- Memory as a skill rather than a fixed process
- Improving memory requires practice
- Important components of memory skill
  - Learning to relate unfamiliar material to prior knowledge
  - Creating retrieval structures or cues that will make it easy to retrieve the to-be-remembered material.
- Importance of how you practice:
  - Distributed vs Massed practice
  - Retrieval Testing
  - Objectively Evaluate performance

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Skilled Memory Examples

- Increasing STM Digit Span – Beyond 7 Plus or Minus 2
- Memorizing the number Pi to 80,000 places
- The Hardest Memory Test in the World – Driving a Cab in London

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Digit Span

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Capacity of STM

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

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Digit Sequences

3 7 1	(03)
4 9 8 2	(04)
7 8 4 6 3	(05)
5 8 1 4 9 6	(06)
2 4 5 3 8 7 1	(07)
6 9 1 4 3 8 2 5	(08)
4 7 5 3 9 8 1 7 4	(09)
3 1 9 6 8 2 3 5 4 6	(10)
5 4 7 5 6 3 9 8 1 4 3	(11)
2 9 6 4 2 5 8 4 3 9 1 5	(12)
6 9 8 2 5 3 4 7 4 9 5 4 3	(13)

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SF DIGIT SPAN Experiment

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SF Digit Span Experiment – 3 Sessions

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

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

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…

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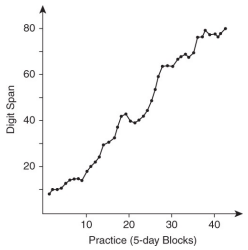
SF's Digit Span as a Function of Practice



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Listen to the following digit sequence and 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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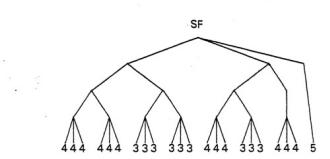
SF's Retrieval Structure



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Memorizing Pi

- The number π is a mathematical constant, the ratio of a circle's circumference to its diameter.
- 3.141
- 3.141592
- 3.14159265358979323846
- Pi World Ranking List

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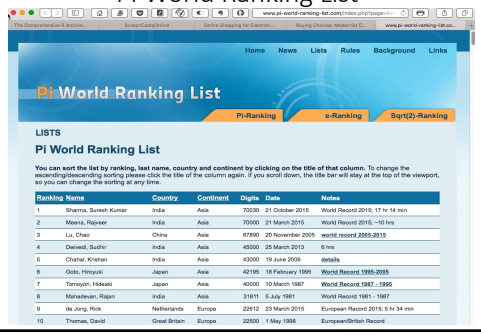
Pi World Ranking List



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The Hardest Memory Test in the World

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Studying to Become a London Cabbie

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Learning & Memory, & the Brain

- Learning changes neural representations of learning/memory.
- Strengthening existing synaptic connections vs adding new dendritic connections
- Sleep consolidates new learning and memories
- Neuroplasticity
- Exercise influences the growth of new neurons (in the Hippocampus)

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How can You Improve Your learning & memory?

- Encode new info using your prior knowledge.
- Instead of re-reading or re-studying, Test yourself (Retrieval over Encoding)
- Distribute your learning & practice
- Apply the Desirable Difficulty Principle (e.g. expanded intervals)
- Use Mnemonic Techniques in specific difficult learning situations
- Get lots of Sleep and Exercise
- Evaluate your learning and memory objectively (metacognition)

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Illusions of Knowing (from ***Make It Stick***)

- We are poor judges of when we are learning well and when we are not. When the going is harder and slower and it doesn't feel productive, we are drawn to strategies that we feel are more effective (e.g. cramming, repetition, and copying), unaware that gains from these strategies are often temporary.
- Students work hard to capture the precise wording of what they're trying to learn, operating under the illusion that mastery equals the exact words rather than the *ideas*. But repeating what you've read is NOT the same as restating (in your own words) what you've read.
- Learners labor under the assumptions that their own methods of learning and remembering work better than using research-proven strategies – but they seldom rigorously test these assumptions.
- The popular notion that you learn better when you receive instruction in a form consistent with your **preferred learning style** (e.g. as an auditory or visual learner) is not supported by the empirical research. We do have multiple forms of intelligence but you learn better when you "go wide" (see *Make It Stick*), drawing upon all of your aptitudes and resources, than when you limit instruction to one mode or style.

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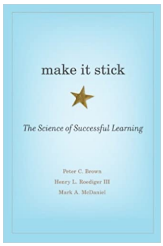
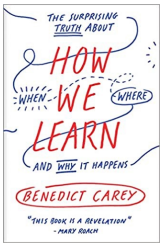
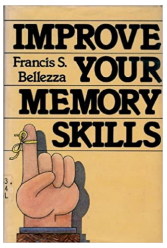
Books about Improving Learning and Memory







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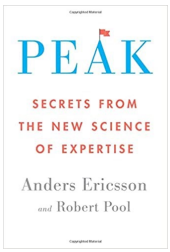

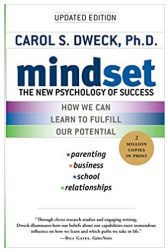

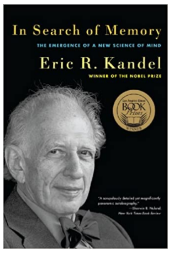

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Thank You

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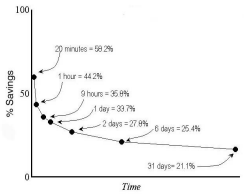
Can you explain Ebbinghaus' Findings?



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