Chapter 6

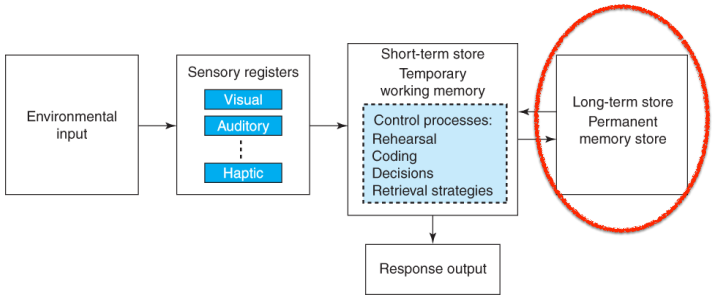
Learning and Remembering
Episodic Long Term Memory

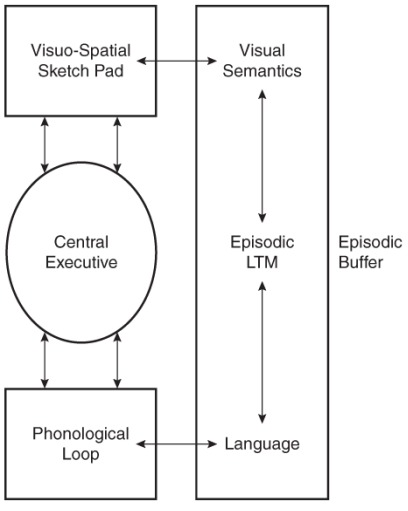
Chapter Outline

- Review / Background
  - WM, LTM models, Taxonomy
  - Mnemonics
  - Ebbinghaus
  - Metamemory
- Learning (Storing information in LTM)
  - rehearsal, depth, generation & enactment, organization, imagery, context
- Remembering (Retrieving information from LTM)
- Clinical Evidence
  - Amnesia and Implicit Memory

Review / Background

Atkinson Shiffrin "Standard Model"

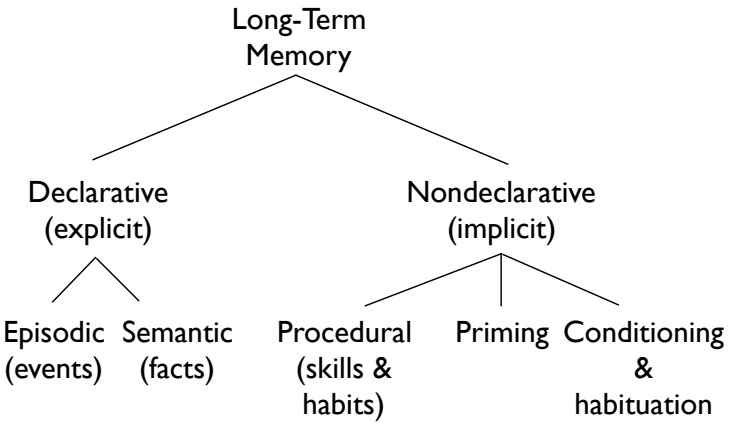




Working Memory Components

- Baddeley (2000)
- Episodic Buffer is new: stores & links information (e.g. sound of voice, image of face)

Squire (1993) Taxonomy of Long-Term Memory



Explicit vs Implicit LTM

- Explicit (Declarative):
  - Knowledge that can be retrieved and then reflected on consciously.
- Implicit (Nondeclarative):
  - Knowledge that can influence thought and behavior without any necessary involvement of conscious awareness.

Episodic vs Semantic LTM

- Episodic (Events):
  - Autobiographical memory-- stores personally experienced events -- "What flavor ice cream did you have this morning?"
- Semantic (Facts):
  - Stores general world knowledge : concepts and categories -- "What is ice cream?"

Mnemonic

- pronounced "nuh MON ic" (first M is silent)
- learning technique related to memory

3 Mnemonic Principles

1. Provide a structure for learning (**encoding**)
2. By means of visual images and rhymes, they form durable and distinctive memory traces (**distinctiveness / retention**)
3. Guide retrieval by providing effective cues for recalling the information (**retrieval**)

Mnemonic Devices

- The Method of Loci:
  - Dates back to Ancient Greece.
- The Peg-word Technique:
  - Miller, Galanter and Pribam (1960).

The Method of Loci

- Loci = plural of Locus (place)
- Two parts
  - Loci : set of locations (personally relevant to you). Fixed, unchanging.
  - List of items to be remembered (not relevant to you, varied, temporary).
- Method
  - associate each list item with each locus
  - visual imagery

The Method of Loci: Example

Locus	Item	Associations
Driveway	Grapefruit	Grapefruit instead of rocks along driveway
Garage Door	Tomatoes	Tomatoes splattered on garage door
Front Door of House	Lettuce	Lettuce leaves hanging over door instead of awning
Coat Closet	Oatmeal	Oatmeal oozing out of closet door

Peg-Word Technique

Numbered Pegs	Item	Associations
One is a Bun	Cup	Hamburger bun with smashed cup
Two is a Shoe	Flag	Running shoes with flag
Three is a Tree	Horse	Horse stranded in tree
Four is a Door	Dollar	Dollar bill tacked to door

Mnemonic Success Stories

- Daniel Tammet memorized Pi to 22514 decimal places
- Lu Chao: world record holder, 67890 digits
  - Used "method of loci"
  - Each two digit number gets an image:
    - 00 chair
    - 01 horse
    - …
    - 99 king

Other Mnemonics

- Names
  - Roy G Biv (colors of rainbow in order)
  - Red Orange Yellow Green Blue Indigo Violet
- Song or Music
  - The alphabet song "A B C D…"

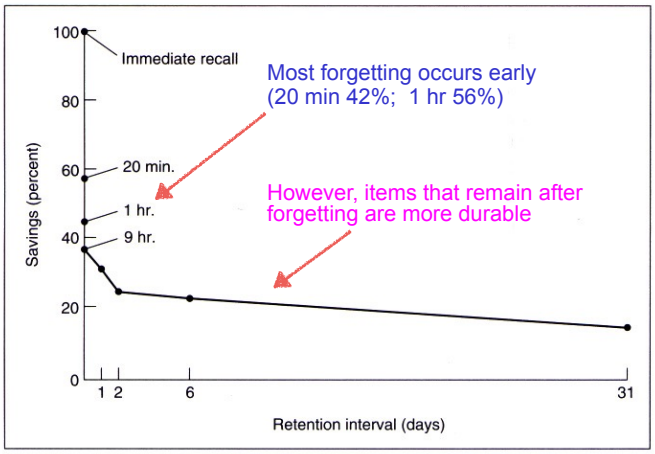
Ebbinghaus (1885)

- First scientific research on memory
  - He was his only subject
  - Learned over 1,200 lists!
- Studied **nonsense syllables**
  - Why? Remove meaning, in order to isolate pure memory
  - CVC (Consonant, Vowel, Consonant)
    - VAR, BEW, NIN, LOD, FAP, CAS…

Ebbinghaus Methods

- **Relearning Task**
  - A list is learned, set aside for some time, and then relearned to the same level of accuracy
  - 20 min, 1 hr, 9 hr, 1 day, 2 days…
- **Savings Score**
  - The reduction in the number of trials necessary for relearning (compared to the number of trials for original learning)
  - (t1 - t2) / t1

Forgetting Curve



Ebbinghaus Findings

- Most forgetting occurs early
- Possible to re-remember forgotten items "reminiscence"
- Possible to remember more over time (hypermnesia)
- Over-learning:
  - leads to stronger memories (e.g. 64 repetitions > 32)
  - can lead to perfect memory (100% savings score)

Metamemory

- Knowledge about one's own memory
- In Learning Task
  - Self-monitoring: "have I learned this?"
- Strategy or self-control
  - "region of proximal learning" - study material which is just learnable - saving the really hard info for later.

Learning (Storage in LTM)

- Factors
  - frequency…
  - distinctiveness…
- Methods
  - rehearsal…
  - organization…
  - imagery…

Learning Factors: Frequency

- Frequency
  - Ebbinghaus: more repetitions better
  - Metamemory: sense of familiarity related to frequency
    - Hasher & Zacks (1984) propose that event frequency is fundamental part of Episodic LTM

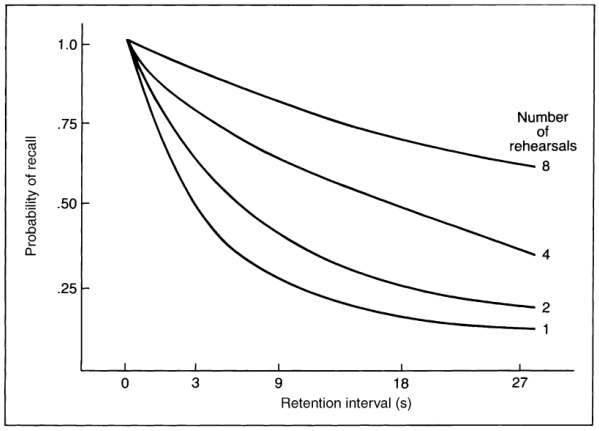
Learning Factors: Distinctiveness

- Distinctiveness
  - Unusual, unexpected, infrequent events
  - Isolation Effect
    - aka the von Restorff effect - better memory for information that is distinct from information around it

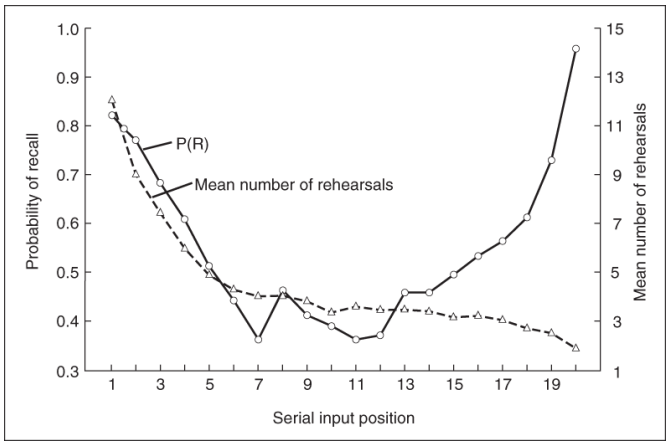
Learning Methods: Rehearsal

- Rehearsal happens in STM (WM)
  - maintains information in WM
  - helps transfer to LTM
- Hellyer (1962)
  - recall accuracy ~ # repetitions of learning
- Rundus (1971)
  - primacy effect is dependent on rehearsal

Hellyer (1962)



Rundus (1971)



Massed vs. Distributed Practice?

- Massed Practice:
  - Study in single long session
- Distributed Practice:
  - Study across multiple small sessions
- Which is better for memory?

Kinds of Rehearsal

- **Maintenance Rehearsal**
  - low level (focused on surface features)
  - poor transfer to LTM
  - example:
    - holding phone # in STM until you dial it
- **Elaborative Rehearsal**
  - higher level, focuses on meaning
  - better transfer to LTM
  - example:
    - thinking about how a new phone # is similar to your phone number and street number

Depth of Processing

- Craik & Lockhart (1972)
  aka "levels of processing"
- LTM quality depends on quality, not quantity
- Shallow processing:
  - poor retention
- Deep processing:
  - better retention
- LTM comes from **thinking** not just **rehearsing**

Craik & Watkins (1973)

- Does maintenance rehearsal lead to LTM storage?
- Methods
  - Long list of words
  - S's to remember only most recent "G" word
  - variable # of words between each G word

Craik & Watkins (1973)

- Results:
  - All G words remembered equally well
  - e.g. # of repetitions didn't matter

Challenges to Depth of Processing

- Circular Logic
  - "Deep processing is that which gives good memory"
- How to define "depth"?

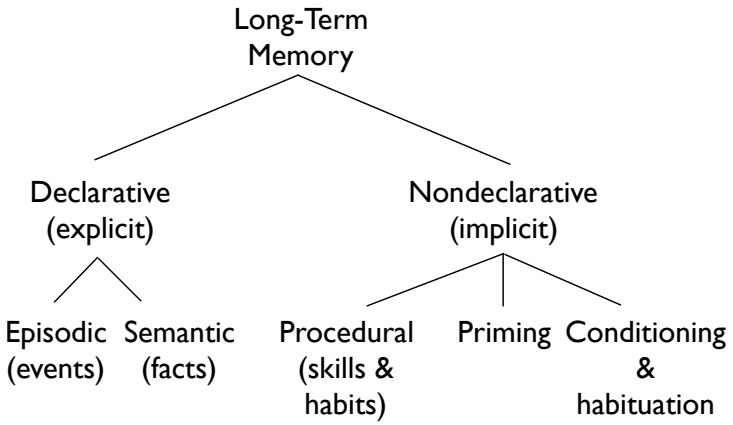
Challenges to Depth of Processing: Task effects

- Recognition memory is better with higher # of rehearsals; Recall memory does not.
- Glenberg et al. (1977)
  - Brown-Peterson task: Encode a number then recite words as a distractor task
  - Surprise test – remember the words (not the numbers)
  - Recall tasks- consistent with DOP
    - Poor recall no matter how many repetitions
  - Recognition tasks -
    - Performance was better with more repetition

Review

- **WM, LTM models, Taxonomy**
- **Mnemonics**
- **Ebbinghaus**
- **Metamemory**
- **Learning (Storing information in LTM)**
  - **rehearsal, depth**
- Improving Episodic Memory

Squire (1993) Taxonomy of Long-Term Memory



Improving Episodic Memory

- Episodic LTM is better when it is related to you, created by you, acted out by you, organized visually, or relevant to your survival

- Principles…
  - 1. Self-reference
  - 2. Generation
  - 3. Enactment
  - 4. Imagery/ Organization
  - 5. Survival

Self-reference effect

- better LTM for information related to you personally
- Example: Method of Loci

Generation Effect

- better LTM for information you create
- Example: word stem completion vs. simple repetition

Enactment effect

- better LTM if you act out the information (e.g. “knock on the table”)
- actors: rehearse dialog and action together

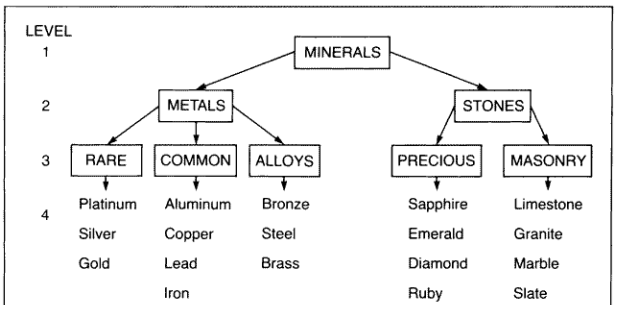
Imagery / Organization Effect

- better LTM if the information is visualized and organized.

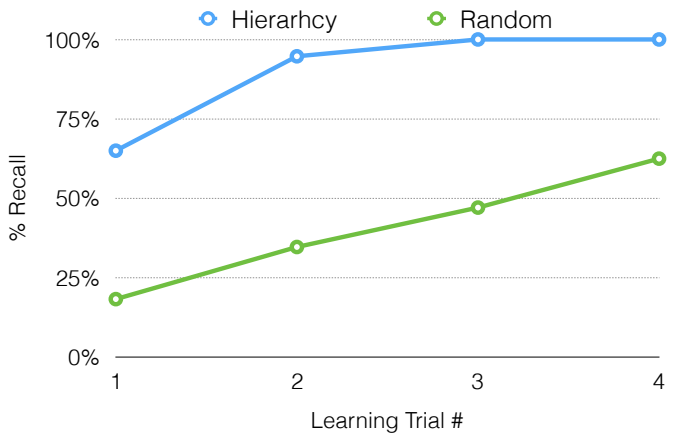
- Early research:
  - Bousfield (1953) **semantic clustering** during recall
  - related to Chunking?

Hierarchy (Bower, 1969)

- Learn 112 words
  - Control: words in random locations on chart
  - Exp: visual hierarchy w/categories



Bower (1969) Results



Subjective Organization

- Organization developed by the subject for structuring and remembering a list of items without experimenter-supplied categories.

Survival Effect

- better LTM for info relevant to survival
- aka “Adaptive memory”

Summary

- Episodic LTM is better when it is related to you, created by you, acted out by you, organized visually, or relevant to your survival
- Principles:
  - 1. Self-reference
  - 2. Generation
  - 3. Enactment
  - 4. Imagery/ Organization
  - 5. Survival

Visual Imagery

- The mental picturing of a stimulus that affects later recall or recognition.
- Schnorr and Atkinson (1969):
  - Subjects studied paired associates (dog-book) either by forming a visual image or by rote repetition.
  - Imagery condition did much better at remembering the second word (book) when cued with the first word (dog).

Paivio’s Dual Coding Hypothesis

- Words that denote concrete objects can be encoded twice in memory
  - As the semantic meaning
  - As the image of the object

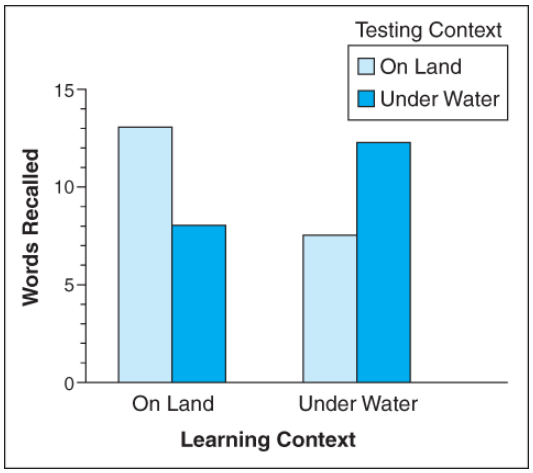
- Words that denote abstract objects (such as “idea”) can’t easily* be encoded twice.
- * you can create an image, e.g. lightbulb

Context & Encoding Specificity

- Tulving & Thompson (1973)
- Information is *encoded* in the *context it was in when it was encoded*

- The **context** can serve as a **retrieval cue** when it is time to recall information

Study in the environment in which you will remember?



Context

- Examples
  - eyewitness return to crime scene
- Neuroscience
  - brain has separate "what" vs. "where" systems
- State-dependent learning
  - information learned while intoxicated remembered better while intoxicated*
    - * note: many intoxicants have very negative effects on memory

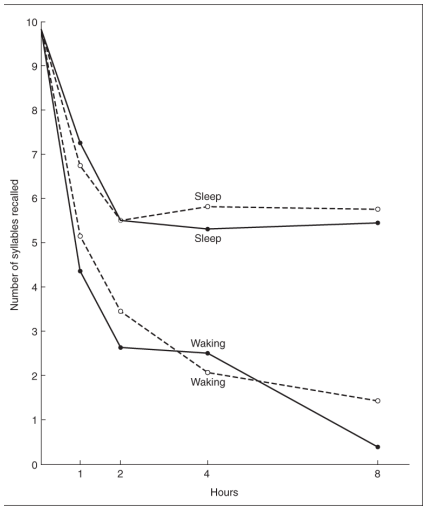
Remembering (Retrieval from LTM)

- Interference…
- Retrieval Failure…
- Retrieval Cues…

Decay from LTM

- Thorndike's "Law of Disuse"
  - Theory: passage of time -> forgetting
  - Data: not consistent
- Better theory:
  - Interference

- Difficult to test:
  - how to arrange passage of time w/o any interference?



Interference in LTM

- Jenkins & Dallenbach (1924)

- Subjects remained awake or asleep after learning

Consolidation

- Permanent storage in LTM is not instaneous
- Requires active process of **consolidation**
- Interference works by impacting consolidation?

Retrieval-Induced Forgetting

- Brain may also have active processes to suppress information
- Retrieving information "A" can block retrieval of information "B"

Retrieval Failure

- Newer theory: most information that is "forgotten" is still in memory.
- When a memory is lost <u>in the system</u> versus lost <u>from the system.</u>
- Example:
  - Tip of the Tongue States.
  - When a person is temporarily unable to remember some shred of information (e.g., a name) that they know is stored in LTM.

TOT: Tip of the Tongue state

- state when you know you know the information (metacognition)
- but can not recall the information itself (retrieval failure)

Availability vs. Accessibility

- Availability:
  - The memory trace exists / was encoded into long term memory.
- Accessibility:
  - Degree to which the memory trace can be retrieved now

Retrieval Failure

- Occurs when the information is **available**, but not **accessible**.

Review

- Learning
  - Improving Episodic Memory
    - self-reference, generation, enactment, imagery & organization, survival
  - Imagery / dual-coding hypothesis
  - Context / encoding specificity
- Remembering
  - Decay vs. Interference, Consolidation
  - Retrieval Failure: TOT, availability vs. accessibility

Tulving & Pearlstone (1966)

- Two groups studied same list of 48 items (4 words / 12 categories). Both groups got category name
- At recall, one group given categories, one group not.
- Category -> better recall (62% vs 40%)
- Suggests memories were *available*, but not *accessible*

Thomson & Tulving (1970)

- Learn a list of words. Some words had a cue, either High or Low associates.
- hot-COLD (high associate)
- wind-COLD (low associate)
- Recall tested under 3 conditions: low, high, or no cues at all.
- Low associates during study blocked effect of high associate at recall. (I.e. wind-COLD studied, receive hot as cue word for recall was of no value)
- Results support encoding specificity.

Retrieval Cues can Hurt

- Part-set Cuing effect:
  - task: remember list
  - given cue (part of list)
  - recall is worse than w/o cue
- Example:
  - Name 7 Dwarfs
  - Hint:
    - Bashful, Happy, Sleepy
- Theory:
  - Cue disrupts recall strategy
  - Triggers active inhibitory mechanism
    - (e.g. need to not remember the Cued items)

Testing is Learning

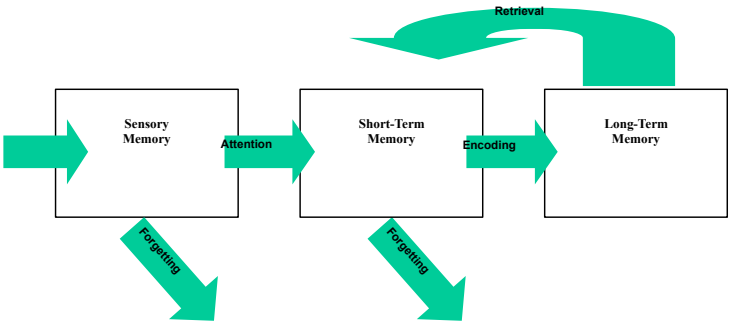
- Being tested on information invokes similar processes to *learning* information
- Retrieval cues -> recall -> elaboration

Amnesia and Implicit Memory

Amnesia and Implicit Memory

- Dissociation of Episodic vs. Semantic Memory…
- Anterograde Amnesia…
- Implicit vs. Explicit Memory…

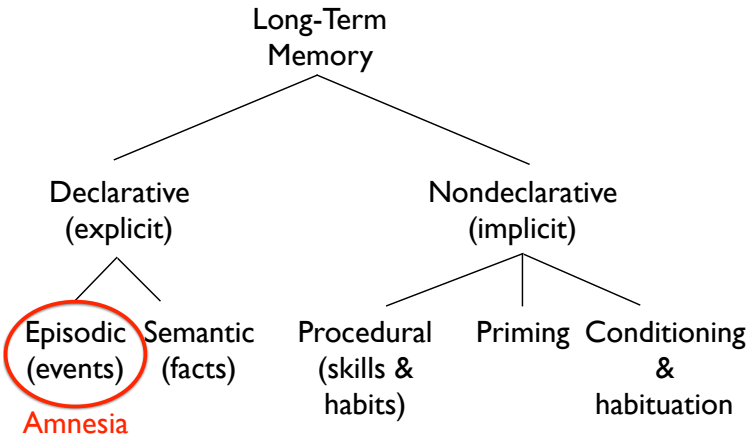
Overview of Memory



Amnesia

- Loss of memories or memory functions due to brain damage, dysfunction or disease
- Affects conscious (**explicit episodic)** memory only
  - WM intact
  - Semantic memory intact
  - Implicit memory intact: Skill learning, Word-stem completion, Repetition priming

Squire (1993) Taxonomy of Long-Term Memory



Kinds of Amnesia

- Psychogenic…
- Anterograde…
- Retrograde…

Psychogenic Amnesia

- Uncommon
- Sudden onset following physical or psychological stress
- Most commonly, personal information is forgotten
  - Sometimes the patient is unable to recall anything about his or her past
- During memory loss cognitive skills are intact
- Recovery is usually complete within 48 hours

Amnesia (organic)

- **Retrograde**: Loss of memory for events **before** the injury
  - Most common with neural degenerative disorders (e.g., Alzheimer's)
  - Mechanism: Failure of Learning, or Retrieval?
  - Often temporal gradient
- **Anterograde**: Loss of memory for events **after** the injury
  - Caused by damage or dysfunction to the hippocampus and temporal lobes
  - Mechanism: Failure of Learning or Retrieval?

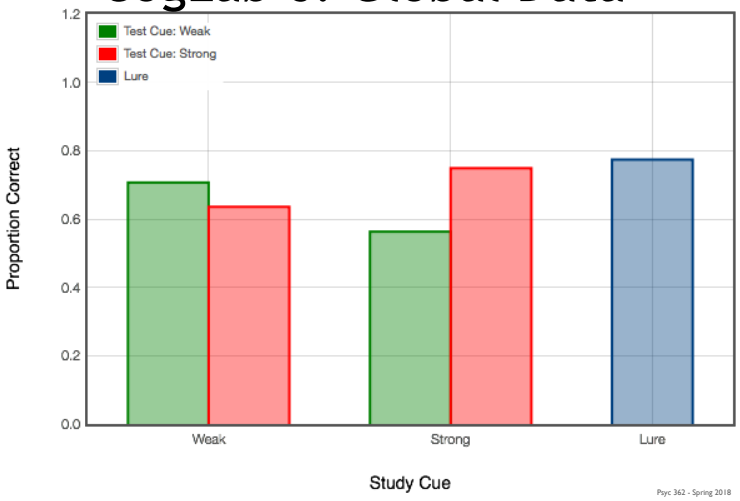
Clinical Evidence: Double Dissociation

- Double Dissociation
  - Double Dissociation: Finding reciprocal patterns of disruption-- In one patient, A is disrupted by brain damage but B is not.
  - In a second patient, B is disrupted but A is not.
- Episodic and Semantic systems show **double dissociation**
- **Anterograde** and **Retrograde** systems also show double dissociation
  - although patients w/amnesia often suffer both **anterograde** and **retrograde** symptoms

CogLab 6: Encoding Specificity

- Methods:
  - Phase 1: List learning of paired words (cue TARGET)
  - Phase 2: Judgement: was TARGET word shown?
- Independent Variable
  - strength of cue word (weak, strong)
- Theory
  - Encoding Specificity - recall depends on interaction between processing (mental activity) at time of encoding and processing at time of recall.
  - Weak cue can actually be better than strong cue
- Example
  Learn Bank-Dollar
  Recall Bank-River

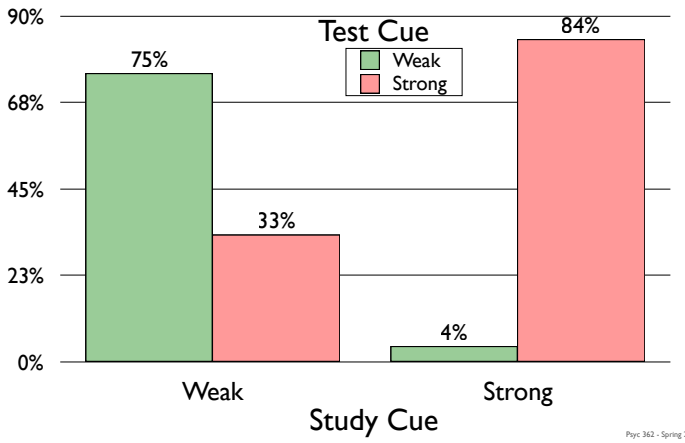
CogLab 6: Global Data



Thomson & Tulving (1970)

- Competing theory
  - Associative Continuity Hypothesis
    - ACH claims strong cues can aid recall in any situation.
      - e.g. “hot-COLD”
- Encoding Specificity Hypothesis claims only cues at time of study are effective

Thomson & Tulving Results



CogLab 6: Encoding Specificity

- Debriefing
  - Methods
    - differences?
  - Predictions
  - Robust? Limitations?

Clinical Evidence

Biological Evidence

- Early Theories
  - Lashley (1950) : believed LTM distributed throughout Neocortex
- Clinical and Surgical Cases
  - KC and HM…
- Modern Imaging…

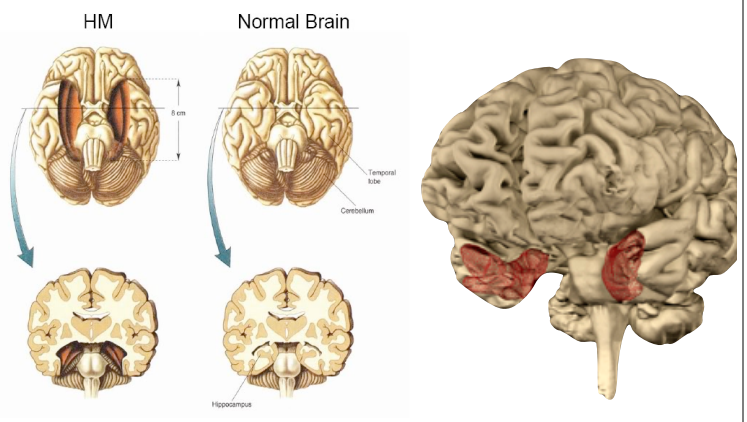
Clinical cases

- Patient HM
  - Anterograde Amnesia (unable to learn new info) but normal recall of pre-morbid information
- Patient KC (Kent Cochrane)
  - Full amnesia (episodic anterograde + retrograde)
  - Normal Semantic memory

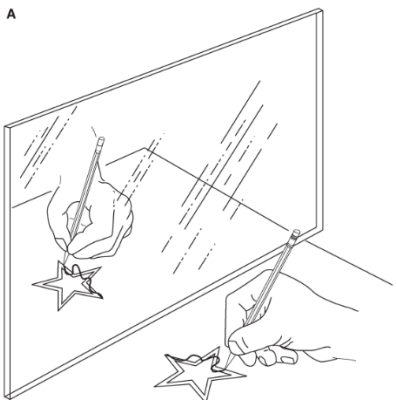
HM (Henry Moliason)

- Hippocampus removed on both sides (small, but important areas)
- Attention, STM and Retrieval of LTM for events before the surgery were intact
- IQ 118
- Complete Anterograde amnesia -- unable to learn form new episodic memories
- Implicit memory intact
- Mirror-drawing performance improved, but zero memory of having practiced

HM's Brain Damage

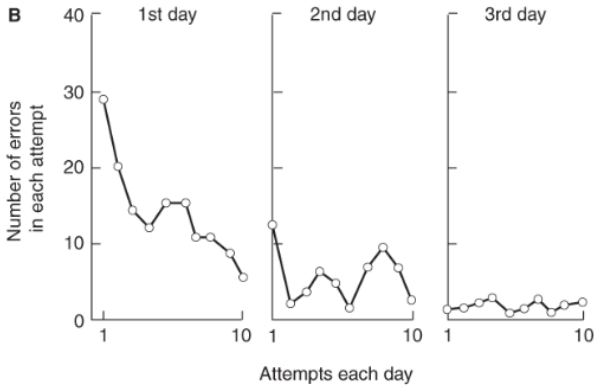


HM's implicit memory



- Motor learning task (mirrow-drawing)
- Measure # of errors
- Track improvement with practice

HM's implicit memory



Hippocampus

- Hippocampus is critical for transfer of explicit memories from STM to LTM
  - Gateway to LTM
  - Not a site of storage
- Amnesia is not due to injury of brain regions which process or store info

Priming

- Repetition Priming
  - When a previous encounter with information facilitates later performance on the same information, even if there is no conscious awareness
- Implicit memory

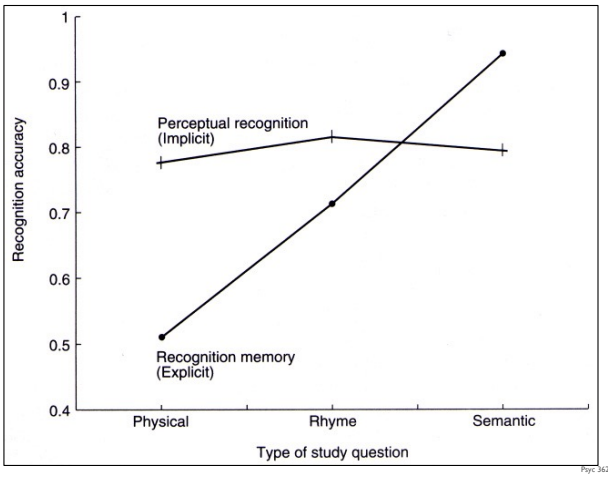
KC (Kent Cochrane)

- Widespread brain injury, especially frontal regions, in a motorcycle accident in 1981.
- Complete loss of episodic memory "he cannot remember…a single thing he has ever done or experienced in the past…from either before or after his accident"
- Can not "time travel" - (can not imagine future or past events or plans) - loss of "autonoetic consciousness"
- Episodic: Amnesia -- Anterograde? Retrograde?
  - but shows Priming
- Semantic: normal.
- Confabulation? -- brother's funeral was "very sad"
- b. 1951, d. March 2014

Jacoby & Dallas (1981)

- Subjects saw a list of words and answered questions about each word (manipulate LOP)
  - **Physical**: "Does it contain a L"
  - **Sound**: "Does it rhyme with purse"
  - **Semantic**: "Is it an animal"
- Test:
  - **Explicit:** Was this word on the list? Y/N
  - **Implicit:** lexical identification (word flashed on screen for 35msec)

Jacoby & Dallas (1981)



Jacoby & Dallas (1981)

- Conclusion:
  - Measures of **explicit** memory are sensitive to how the information is processed / studied.
  - Measures of **implicit** memory usually show facilitation regardless of how the information was processed / studied.

Patient "NA"

- In 1960 brain injury due to fencing foil at age 22
- Left hemisphere damage only initially (but additional damage possibly due to later brain surgery).
- Damage mainly to thalamus, bilaterally (Hippocampi are intact)
- Amnesia, primarily Anterograde for Verbal information