Memory - Retention and Retrieval

weekly_readings #week-5

Contents

> Taken from John Anderson - Cognitive Psychology and Its Implications (2015, Freeman_Worth) - libgen.li.pdf
> Ch-7

Are memories really Forgetten?

The **temporal region** (particularly the ***hippocampal region***) play role in **retention** of memory

> *Experiments:*
>
> **Penfield (1959)**
>
> - electrial stimulation to recall forgotten mem.
> - discounted
>
> **Nelson (1971)**
>
> - paired assosiates (changed, unchanged)
>
> **J. D. Johnson, McDuff, Rugg, and Norman (2009)**
>
> - brain imagin study

Penfield 1959

- Stimulated portions of patients brain and asked participants what they felt
- This way he understood fxns of various parts of brain
- **Observations:** Stimulations to temporal lobes led participants to recall memories (which they were unable during normal recall)
- **Conclusion:** This means, much of what seems forgotten is still stored in memory
- **Ctritics:** participants reports may not be accurate (since no way to verify it).

Nelson 1971

Task:

- Learn a list of 20 paired associates (num-noun). Studies and tested until recall with no error
- After 2 weeks again tested (75% recall 25% forgot)
- Given new trials with 2 types of pairs: **num-noun_same** or **num-noun_changed**
- Again tested on the new list

Observations:

- Of the formely missed items: 78% of unchanged (same) items recalled while only 43% of changed items recalled.

Conclusion:

- This large advantage in for unchanged items => some mem. of so called forgotten items were retained in the memory

J. D. Johnson, McDuff, Rugg, and Norman (2009)

Task:

- Participants saw a list of words and for each word they were asked to either
  1. imagine how an artist would draw the object denoted by the word, or
  2. imagine functional uses for the object
- Participants were shown the words again and the classifier was applied to the brain activation patterns.

Observations:

- Classifier was able to recognise (with better than chance accuracy) from the patterns, what task the word had been assigned to.
- It was successful both for recalled and forgotten words

Conclusion:

- Even though we may have no conscious memory of seeing something, aspects of how we experienced it will be retained in our brains

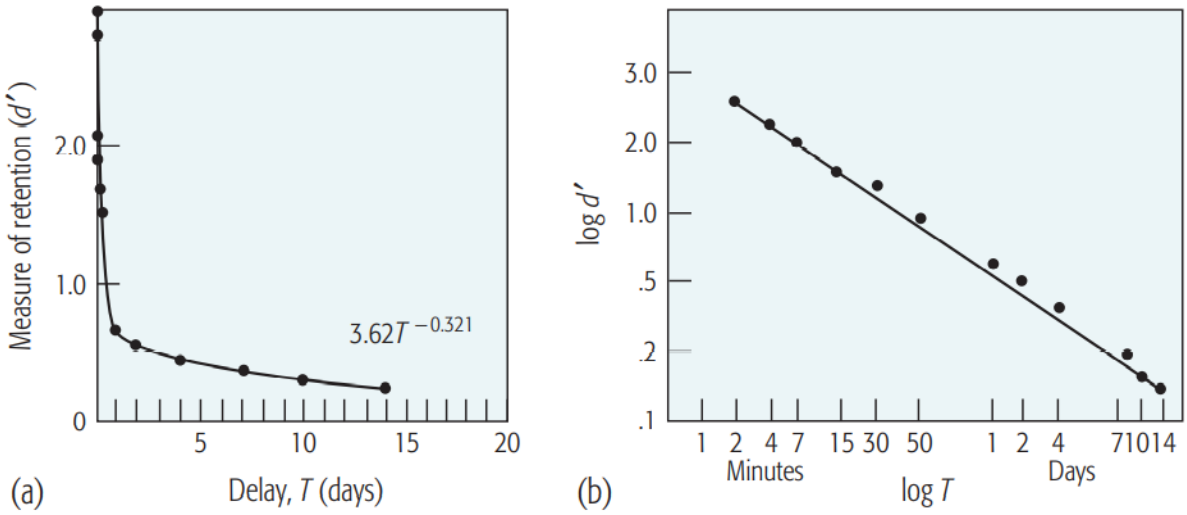
The Retention Function

> The strength of a memory trace decays as a power function of the retention interval
>
> **Decay Theory of forgetting**:
>
> - memory traces simply decay in strength with time.
> - one of the common explanations of forgetting.
>
> **Interference Theory:**
>
> - in next `section`

Recognition Experiment (Wickelgren, 1975)

- Participants presented with a seq of words to study
- Examined the probability of their recognition (d') after delays (T) from 1 min - 14 days.

- d' = c.T^(-b)
- log(d') = A - b.log(T)
- where, A = log(c)



- The memory loss is "negatively accelerated" - the rate of change gets smaller and smaller as the delay increases

> ***Wixted and Ebbesen (1991***) concluded that "retention functions are generally power function"
> The relationship is called **Power Law of Forgetting**

Bahrick 1984

extensive investigation on "negative accelaration"

Collected data on Participants retention of English-Spanish vocabulary items delay (immeditely to 50 years since learning)

Data shows:

1. Slow decay of knowledge - with substantial "practise effect" (more num of courses => more recall)
2. nearly flat between 3-25 years - as expected by a power fxn
3. further drop-off between 25-49 years - probably due to physiological deterioration in old age

Raymond and Redman 2006

explanations for the retention functions - maybe found in underlying neural process

Long-term potentiation (LTP) - an increase in neural responsiveness due to prior electrical stimulation

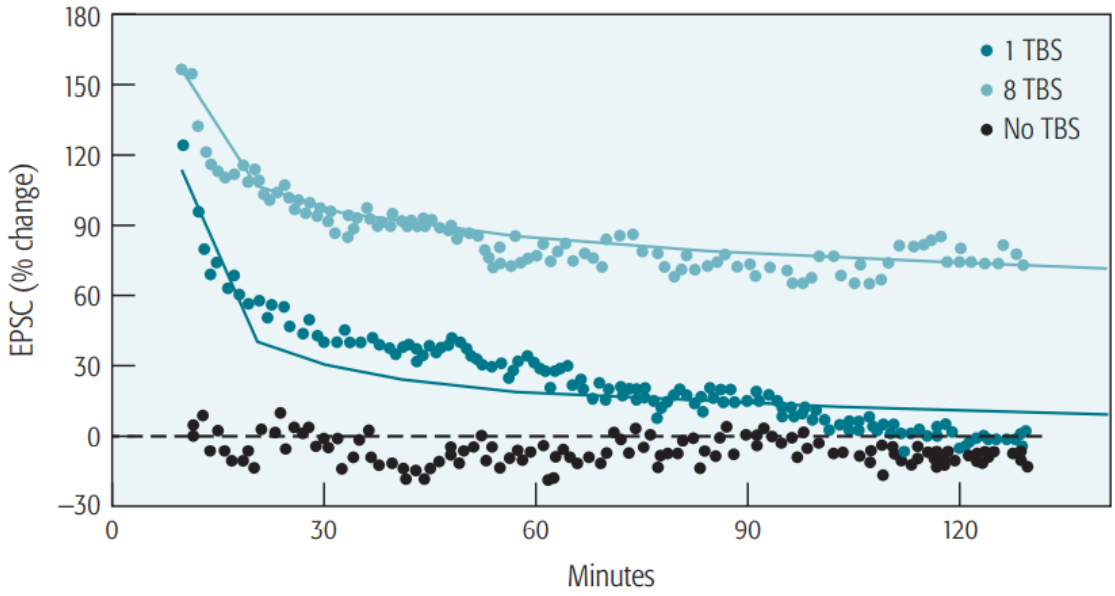
Conducted an experiment on rats:

Task:

- Plotted there are three conditions:
    1. a control condition - no stimulation,
    2. single stimulation to induce LTP, and
    3. 8 such stimulations

Observations:

- Observe the decrease in LTP in the rat hippocampus with delay
- level of LTP is greater in the condition with eight stimulations than in the condition with one (a learning effect), both conditions show a drop-off with delay



How Interference Affects Memory

> Retention strongly impacted by (not only delay, but also) interfering material

Experiments on interference

Task:

- Participants divided into 2 groups - Experimental group and Control Group - and made to learn paired associates
- After learning both the lists, both the groups are tested after considerable delay (24 hrs - 1 week)

Experimental Group	Control Group
Learn A–B	Learn A–B
cat-43	cat-43
house-61	house-61
apple-29	apple-29
etc.	etc.
Learn A–D	Learn C–D
cat-82	bone-82
house-37	cup-37
apple-45	chair-45
etc.	etc.

Observations:

- Experimental group performs worse than Control group

Conclusion:

- Evidence that learning the A–D list interferes with retention of the A–B list and causes it to be forgotten more rapidly

```
It is harder to maintain multiple associations for the same item

=> (1) diff to learn new assos to these items
   (2) diff to retain old assos once the new assos are learned

=> It seems, learning new info about a concept is poor for memory

But, Fortunately
----> Some important additional factors ("redundancy") counteract
"interference"
```

Fan Effect

more facts (Fi) associated with a concept (C), slower is the retrieval of any one of the facts

Study by JR Anderson 1974

Partipants asked to memorize 26 sentences of the form "<person> is in a <location>" Example:

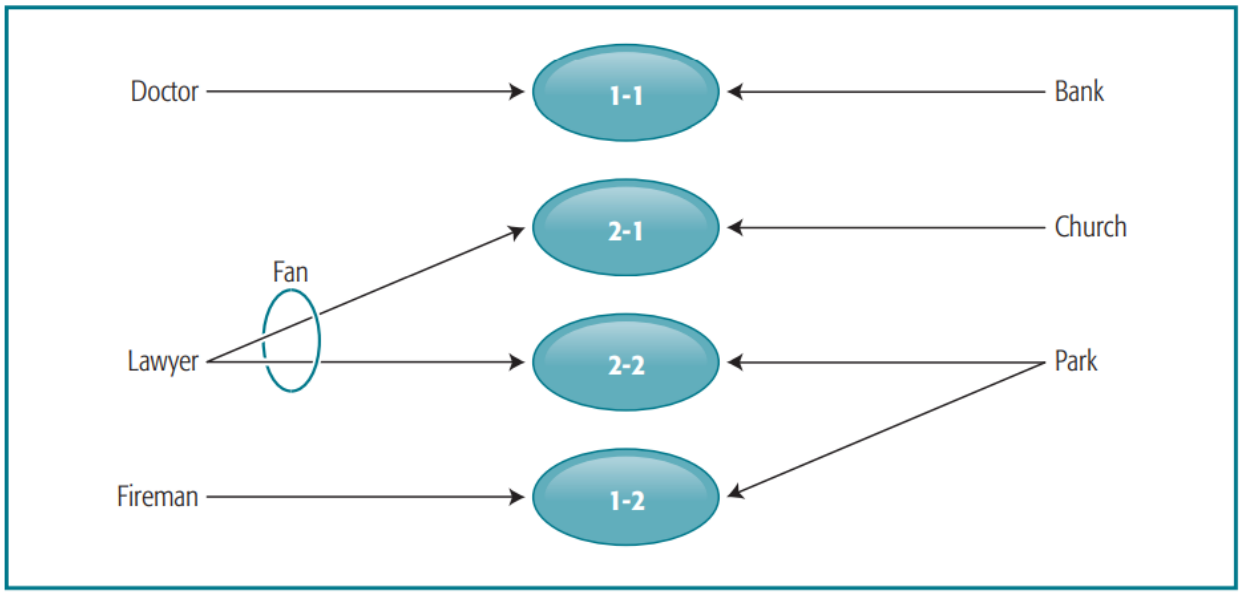
1. The doctor is in the bank. (1-1)
2. The fireman is in the park. (1-2)
3. The lawyer is in the church. (2-1)
4. The lawyer is in the park. (2-2)

They were then tested on test sentences (consisting of original sentences and re-pairing people-location from study set) and asked to recognize if the sentences were from study set or not.

Observations: Recognition (measured in terms of recognition time) was:

- best for (1);
- good for (2) and (3);
- poor for (4)

Explanations:

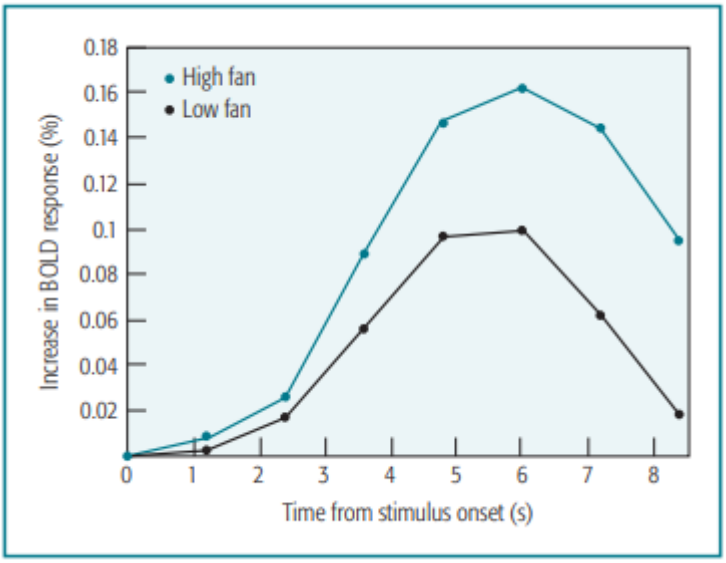
- 

- The ovals represented **mem struct** of the sentences.
- **Source concepts** are the set of persons P = {Doctor, Lawyer, Fireman} and set of locations L = {Bank, Church, Park}

- Each source concept has a **limited total activation** that can spread to the associated sentences
- Therefore, more spreading from a concept => lesser is the activation received by the associated sentences
- And, recognition time for a sentence is *inversely proportional* to activation level of its memory structure

Study, Sohn, Goode, Stenger, Carter, and Anderson (2003)

fMRI brain-imaging study - response in the prefrontal-cortex during such tasks
Observations: High-Fan sentence show greater hemodynamic response, since more work is done by the prefrontal structures for retireval.



Interfering Effect of Pre-existing Memories

Do such interference effects (fan-effect) occur with material learned outside of the laboratory

Lewis and Anderson 1976

Task:

- Learn fantasy facts about public figures (eg- Nepolian was from india)
- Subjects studied 0-4 such fantasy facts
- Then the were tested on 3 types of sentences:
    1. studied in the exp (**Exp True**)
    2. true fact about the public figure (**Act True**)
    3. false in both exp and truely (**False**)

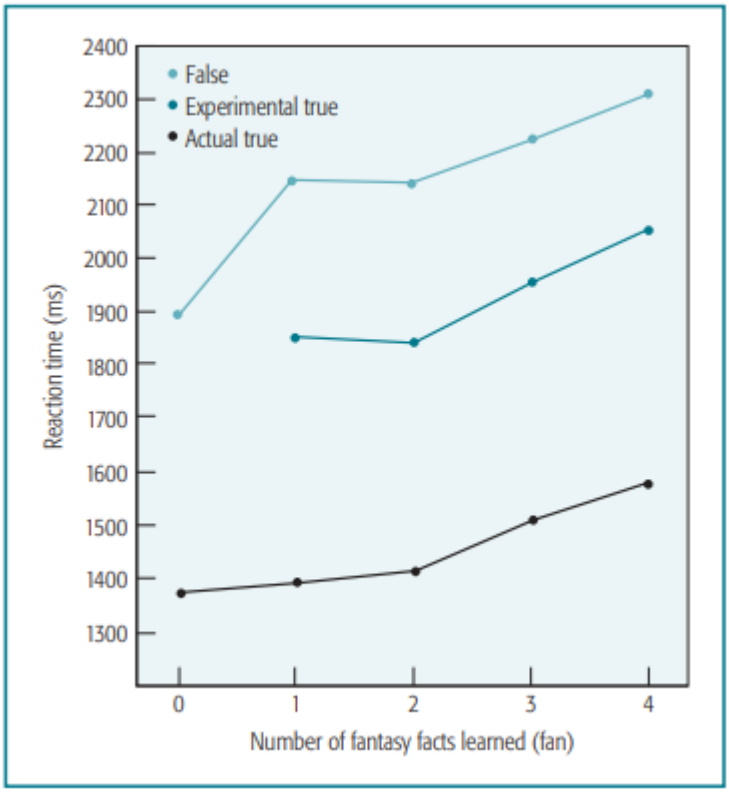
- And asked to reply TRUE for cases:(1) and (2) and FALSE for case:3

Observation:

- Reaction time decreased with num of fantasy facts
- This happened not only for (1) but also for (2)
- However, overall recognition time (for a given fan-in) followed the order: False > ExpTrue > ActTrue
- ExpTrue < ActTrue ... REASON: actual facts are more strongly encoded in memory than the fantasy facts

Conclusion:

- Material learned in the laboratory can interfere with material learned outside of the laboratory as well



Controversy over Interference and Delay

Speculation against Decay Theory:

- CLAIM: Memories appear to decay during the retention period due to constant interference with additional memories.
- So lets check whether retention is better during sleep (since, at that time there is no/min. intrference)

- **Ekstrand (1972)** reviewed a great deal of research **consistent with the conclusion** that less is forgotten during the period of sleep.

Arguments the speculations:

- However, it appears that critical variable is not sleep, but time of day
- **Hockey, Davies, and Gray (1972)** found that participants in general better remembered material that they learned at night, even if they were kept up during the night and slept during the day. REASON: most UG participants are highly aroused during early evening, and retention is better in a high-arousal state

Drawbacks of Decay Theory:

- only consider time as a factor for forgetting, and does not consider psychological effects

However, it may be possible that there is no purely psychological level explanation to forgetting. Explanations maybe only physiological (eg- LTP data)

Conclusion:

- Dono ("decay" & "interference") sahi hai bhai

An inhibitory explanation of Forgetting?

> Interference Effects are due to an "**inhibition-process**" that actively suppresses competing memories, rather than a passive side-effect of storing memories
>
> It has been argued that forgetting may also be produced by **active suppression of memories**, but the evidence is inclusive.

M. C. Anderson & Spellman, 1995

Task:

- Participants given a list of "category-exemplar" pairs (there can be mult. instances of a given category)
- Intial Study of all the pairs
- Practice on only some of the pairs.
- Recall Tes: given cat name recall all the items assosciated to it

Observations:

Red–Blood (practiced)	(74%)
Red–Tomato	(22%)
Food–Strawberry	(22%)
Food–Cracker	(36%)

- red-blood has good recall due to practise
- red-tomato has poor recall: can be also explained with other interfering theories (eg- competition from red-blood)
- food-strawberry has poor recall: .....???..... (was not even categorized as red)

Explanation:

- while practicing red-blood, participants were inhibiting all other items which were red (tomato, strawberry)

M. C. Anderson & Green, 2001

think / no-think paradigm

---- fake reports ---

retireval induced suppression

Redundancy Protects against Interference

> Interference only occurs when multiple pieces of information have no intrinsic relationship to one another.
>
> It does not occur if the info are meaningfully related.

Bradshaw and Anderson 1982

Task:

- Participants learned under 3 conditions:
  1. (single condition) : Target fact
  2. (irrelev condition) : Target fact + 2 unrelated facts
  3. (relev conditions) : Target fact + 2 facts causally related to target fact
- Tested for **ability to remember target fact** given the name of the person:
  - immediately
  - after a week

Observations:

TABLE 7.3 The Contrasting Effects of Relevant and Irrelevant Information

	Recall (%)	
Condition	**Immediate Recall**	**Recall at 1 Week**
Single fact	92	62
Irrelevant facts	80	45
Relevant facts	94	73

- Here, comp: (single, irrelev) -> standard interference effect
- But, comp: (single, relev) - after a week's time -> relev% is better

Explanations:

- Recall was better even when more facts were learned, but it was so because the facts were causally related to the target fact

Retrieval and Inference

> Often, when people cannot remember a particular fact, they are able to retrieve related facts and so infer the target fact on the basis of the related facts.
>
> In trying to remember material, people will use what they can re member to infer what else they might have studied.
>
> people make such inferences at the time of recall.

Bransford, Barclay, and Franks (1972)

- how interference leads to incorrect recall

Task:

They had participants study one of the following sentences:
(1) Three turtles rested beside a floating log, and a fish swam beneath them.
(2) Three turtles rested on a floating log, and a fish swam beneath them.

Participants who had studied 1 were later asked whether they had studied this sentence:
(3) Three turtles rested beside a floating log, and a fish swam beneath it.

Participants who had studied sentence 2 were tested with
(4) Three turtles rested on a floating log, and a fish swam beneath it.

```
NOTE in Actual:

----------------------
(1) and (2) have "them"
(3) and (4) have "it"
----------------------
(1) - turtles resting "beside" log
(2) - turtles resting "on" log
----------------------

Now, By Logic:

(1) !=> (3)
(2) ==> (4)

And in terms of actual,

(1) != (3)
(2) != (4)

----------------------

Let's see if participants report by "actual fact" or by "inference"
```

Observations:

- Let x = partipants who studied (1) and said YES to (3)
- Let y = partipants who studied (2) and said YES to (4)
- x < y

Explanations

- Participants used inference rather than recall the exact fact.
- For, had it been the case of exact recall, then x same as y

Sulin and Dooling 1974

How, inference can bias mem for a text.

Carol Harris's Need for Professional Help
Carol Harris was a problem child from birth. She was wild, stubborn, and violent. By the time Carol turned eight, she was still unmanageable. Her parents were very concerned about her mental health. There was no good institution for her problem in her state. Her parents finally decided to take some action. They hired a private teacher for Carol.

Setting & Task:

- Participants divided into 2 groups:
  - G-1: gave the text to read
  - G-2: gave the text to read (but subst. Carol Harris -> Helen Keller)
- After a week's time, they were given test sentences and asked whether they had occured in the passage or not.
- Included sentence like S' - "She was deaf, dumb, and blind"

Observations:

- Only 5% from G-1 said YES to S'
- While 50% from G-2 said YES to S'

> **NOTE:**
> With increased delay (between study and test) the tendency for inference increased.
> This also suggests that, inference was made during recall time rather than while studying

Plausible Retrieval

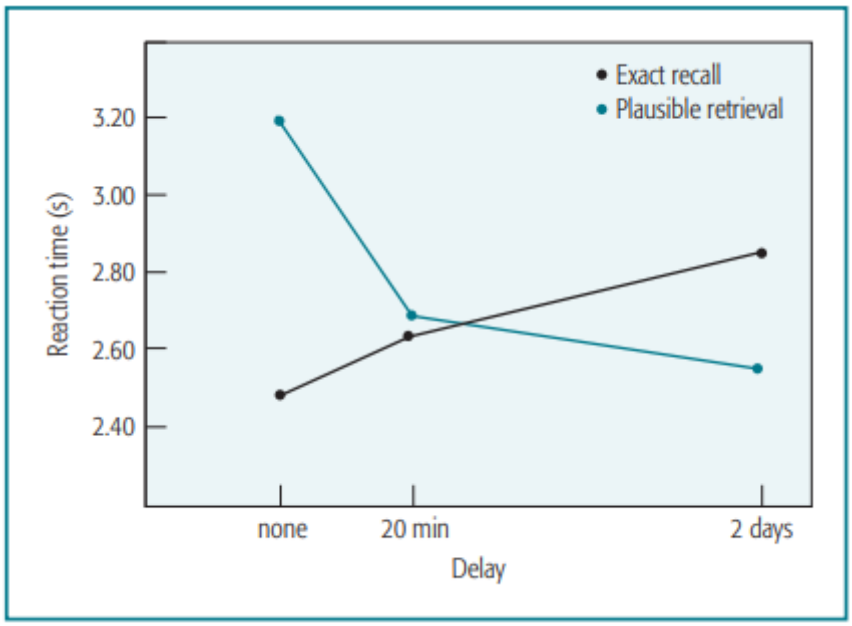
> People will often judge what plausibly might be true rather than try to retrieve exact facts.

Reder

Setting & Task:

- Partipants to study a text
- Then asked to recognise whether some test sentences were true or not.
- Test sentences were of 3 types: (1) exactly true (2) plausibly true (3) neither
- There was 2 types of tasks:
  - (Exact Recall): say TRUE - {1}, FALSE - {2, 3}
  - (plausible retrieval) say TRUE - {1, 2}, FALSE - {3}

Observations:

- initially took more time for plausible recall task. But as delay increased, exact recall task took more time
- 

Explanations:

- As delay increased, they no longer tried to recall the exact facts. Inference was dominant.
- Plausible recall (since does not depend on a particular trace) is not vulnerable to forgetting

> **Reder and Ross 1983** compared exact and plausible judgements in another study

Interaction of Elaboration and Inferential Reconstruction

> **semantic elaborations** should facilitate the process of inference by providing **more material from which to infer**.
>
> Thus, we expect elaborative processing to lead to both an **increased recall** of what was studied and an **increase in the number of inferences recalled**.

Bower, and Black (1979)

Setting & Task:

- 2 groups of Participants studied a story:
  - G-1: Only the story

    - G-2: A themed additional info + the story
- After 24 hours, both were asked to recall the story

Observations:

- For each of the groups, the propositions (facts) can be of 2 types: **studied** and **inferred**
-

	Number of Propositions Recalled	
	Theme Condition	***Neutral Condition***
Studied propositions	29.2	20.3
Inferred propositions	15.2	3.7

- G-1 (group with themed condition) not only had reported **more inferred facts** but also **more studied facts**, compared to G-2 (neutral condition)

Explanations & Conclusions:

- When participants elaborate on material while studying it, they tend to recall **more of what they studied** and also tend to recall the **inferences that they did not study** (but made themselves).

Eyewitness Testimony & False Memory Controversy

The ability to make inferences from info, both during study and during recall is essential in our using memory successfully.

However, there are cases when we need to separate what we actually saw or heard from our inferences. Failing to do so, can cause **false-memories**

> Serious errors of memory can occur because people fail to separate what they actually experienced from what they inferred, imagined, or were told

Eye-witness testimony - Loftus, Miller & Burns 1978

- asked participants who had witnessed a traffic accident about the speed of car when it passed a Yield signal.
- Although in truth, there was no Yield signal, but most of them, subsequently remembered having one.
- Hence, subsequent information can make us to infer the existence of facts which never actually existed

False-memory syndrome - Schacter, 2001

- Many claim to recover memories of childhood abuse (that they had suppressed) during thrapy.
- However, it is critized that many of these reported events (so called "recovered memories") never actually occured.
- They were created due to (out of) the suggestions of the therapist.

Loftus and Pickerall, 1995

- Suggestive interview techniques can create false memories.
- Asked elder relatives of adult partipants to report 4 childhood incidents (3T, 1F- lost in a mall).
- 25% Participants claimed that they remembered "lost in mall" event.

Similar experiment by **Wade, Garry, Read, and Lindsay (2002)** in which participants were shown a *false picture of childhoon on a hot-air balloon*

False Memories and The Brain

> The hippocampus responds to false memories with as high activation as it responds to true memories and so fails to discriminate be tween what was experienced and what was imagined.

Deese-Roediger-McDermott paradigm

- originally invented by **Deese (1959)** and elaborated by **Roediger and McDermott (1995)**
- Participants given list of words - (thread, pin, eye, sewing, sharp, point,...) or (bed, rest, awake, tired, dream, ...)
- The they were tested on some list of test words which can be of three types:
- (1) **True** - which were present in the lists (2) **False** - not present but closely related (3) **New**
- Participants *accepted most of True* and *rejected most of New*. But *difficulty in rejecting False*

Cabeza, Rao, Wagner, Mayer, and Schacter (2001)

- found that 88% of the true items and only 12% of the new items were accepted, but 80% of the false items were also accepted—almost as many as the true items

Cabeza et al.

- Examined the activation patterns for these types of words
    1. In **hippocampus proper** - True and False produced almost identical fMRI responses
    2. In **parahippocampal gyrus** - False and New items produced similar fMRI responses
- *Hippocampus* maintains a **more abstract representation**. But *parahippocampal gyrus* is closely connected to the sensory regions of the brain and tends to retain **more of the original sensory experience**
- *people can be trained to pay more attention to these distinctive sensory features and so improve their resistance to false memories* eg- Elder dults

Associative Structures and Retrieval

The spreading-activation theory described in Chapter 6 implies that we can improve our memory by providing prompts that are closely associated with a particular memory

Eg- while trying to remember name of some old classmate, we try to remember other classmates or memories of things we did with that classmate.

Tulving and Pearlstone (1966)

- **Study:** participants learn lists of 48 words that contained categories such as dog, cat, horse, and cow, which were mammal category
- **Test:** They were tested for recall of these words
- **Obs:** Recall was better when they were given the prompt: "mammal"
- **Explanation:** It served as a "cue" for those words.

Effects of Encoding Contexts

> **(1) Physical Context:**
>
> - Smith, Glenberg, and Bjork (1978) - importance of phy ctx
> - Godden and Baddeley (1975) - extreme phy ctx - (divers exp)
> - Eich (1985) - magnitude of phy ctx effect
>
> **(2) Emotional Context:**
>
> - Bower, Monteiro, and Gilligan (1978) - importance of emotion/mood ctx
> - Eich and Metcalfe (1989) - magnitude of mood ctx effect

> **(3) Mood Congruence:**
>
> - Teasdale and Russell (1983) - (+ve, -ve and neutral mem.)
>
> **(4) State-dependent Learning:**
>
> - Eich, Weingartner, Stillman, & Gillin (1975) - marijuana exp

Smith, Glenberg, and Bjork (1978)

Study:

- Participants learned two lists of paired associates on different days and in different physical settings.
  - S-1: neat room, well groomed experimenter, slides presented
  - S-2: untidy room, shabby experimenter, tape recorder presented

Test:

- A Day later, asked to recall half of paired associates in one setting, half in other

Obs:

- 59% recall in same setting, 46% recall in different setting

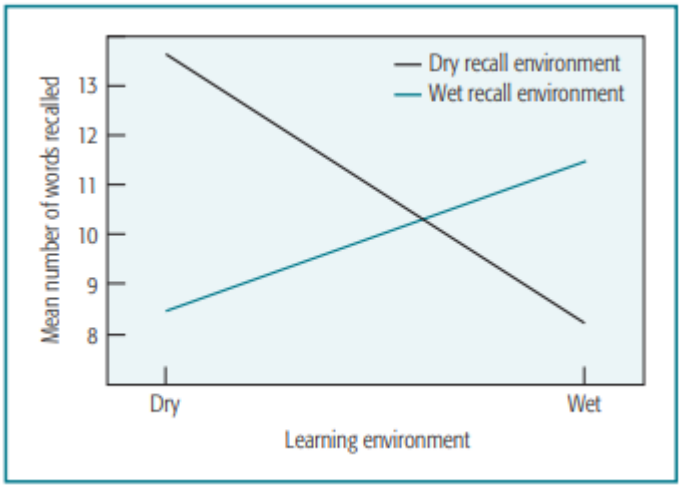
Explanations

- Since, effect of cleanliness of rooms didn't play any effect.
- It was physical context similarity between study and test phases

Godden and Baddeley (1975)

- They had divers learn a list of 40 unrelated words either on the shore or 20 feet under the sea. The divers were then asked to recall the list either in the same environment or in the other environment.

- Recall was better in same env conditions



> Many experiments failed to show any context dependence

Eich (1985)

- Argued that the magnitude of such contextual effects depends on the degree to which the participant integrates the context with memories
- **Study:** read list of nouns (eg- kite) to 2 groups.
  - G-1: asked to imagine just the noun.
  - G-2: imagine the noun in the context of env. (eg- kite is on this table)
- They were tested for recall.
- **Result:** the Effect of Physical Context (increase or decrease in recall depending upon same or diff env between study and test) was more for G-2 than G-1.
- Since, for G-2, the env was more integrated with the target memory
- **Conclusion:** *Thus, physical context effects occur only in special study situations*

Bower, Monteiro, and Gilligan (1978)

- **Study:** instructed participants to learn two lists. For one list, they hypnotically induced a positive state by having participants review a pleasant episode in their lives; for the other, they hypnotically induced a negative state by having participants review a traumatic event
- **Recall Test:** under wither +ve or -ve emotional state (again hypnotically induced).
- **Results:** recall better when same emotional state between study and test

Eich and Metcalfe 1989

- found that mood-dependent effects tend to be obtained only when participants integrate what they are studying with mood information.
- *Thus, mood-dependent effects occur only in special study situations*

MOOD CONGRUENCE

- easy to happy memories when happy and sad memories when sad

Difference with Mood-effect

- ***Mood-Effect:*** relation between mood during study and mood during test
- ***Mood-congruence-effect:*** relation between content of memory (in terms of mood) and mood during test

Teasdale and Russell (1983)

- **Study:** participants to learn a list of +ve, -ve ane neutral words a neutral-mood study condition
- **Test:** reacall those words in different mood stages
- **Obs:** given a mood-stage recalled more words (whose mood) that matched that stage
- **Explanations:** When a certrain mood-stage is created, elements of that mood will "prime" (*priming*) memories (words) that share these elements.

STATE-DEPENDENT LEARNING

- focuses on the internal state (physical + emotional) of the subjects
- People find it easier to recall information if they can return to the same **emotional and physical state** they were in when they learned the information

Example:

- *It is often casually claimed that when heavy drinkers are sober, they are unable to remember where they **hid their alcohol** when drunk, and when drunk, they are unable to remember where they **hid their money** when sober.*

Eich, Weingartner, Stillman, & Gillin, 1975

- **Study:** participants learned a free-recall list after smoking, either
  - (1) a marijuana cigarette (intoxicated), or
  - (2) an ordinary cigarette (non-intoxicated)
- **Test:** tested 4 hours later, again after smoking either a marijuana cigarette or a regular cigarette
- **Obs:** *effects of psychoactive drugs on memory*
  1. **State-dependent effect:** recall better when state at test time matched with study time

2. Overall high level recall when "studied" (not "tested") under non-intoxicated state

At Study	At Test (% correct)		
	Ordinary Cigarette	Marijuana Cigarette	Average
Ordinary cigarette	25	20	23
Marijuana cigarette	12	23	18

People show better memory if their external context and their internal states are the same at the time of study and the time of the test

The Encoding-Specificity Principle

> In general, **recognition** is easier than **recall**.
> Eg- we perform better in MCQs than FITBs
>
> But making "test-context" similar to "study-context", we can increase the similarity of a word's encoding during test and study - called the "**Encoding Specificity Principle**"
>
> This factor when "armed to recall" can **make it better than** the "unarmed recognition"

Tulving & Thompson, 1973; Watkins & Tulving, 1975

- Experiment had 3 phases:
- (1) **Original Study:**
  - participants to learn pairs of words (eg- train-black)
  - and told to remember second word in the pair ("*to-be-remembered*")
- (2) Test-1: **Generate and Recognize:**
  - participants given word "white" and asked to gen. 4 associated words like- "snow", "black", "wool", "pure".
  - The stimuli chosen such that it has high probability to elicit the "*to-be-remembered*" word.
  - Participants then asked which of the 4 generated words (if at all) had the to-be-rem
  - They correctly chose it < 54% time
- (3) Test-3: **Cued Recall:**
  - participants presented with original context words (eg- train)

    - Asked to recall the to-be-rem.
    - They recalled it correctly 61% of the time
    - (even performed better than free-associates)
- **Conclusion:**
    - *People show better word memory if the words are tested in the context of the same words with which they were studied.*

Hippocampal Formation and Amnesia

- Damage to the hippocampal area also produces severe amnesia (memory loss) in humans.

- One common cause is a severe blow to the head, but other frequent causes include brain infections (such as **encephalitis**) and chronic alcoholism, which can result in a condition called **Korsakoff syndrome**.

- Such damage can result in two types of amnesia:

    1. **retrograde amnesia:** loss of memory for events that occurred before the injury
    2. **anterograde amnesia:** inability to learn new things.

Implicit vs Explicit Memories

British musicologist **Clive Wearing**, who suffered herpesviral encephalitis that attacked his brain particularly hippocampus.

He has no memory from his past, **but can play piano**

This illustrates the distinction between:

1. **explicit memory** - what we can ***consciously recall***, and
2. **implicit memory** - what we remember ***only in our actions***

Snyder, Ashitaka, Shimada, Ulrich, & Logan, 2014

- Many **proficient typists** *cannot recall the arrangement* of the keys except by *imagining themselves typing*
- Their fingers know where the keys are, but they have **no conscious access to this knowledge**

Graf, Squire, and Mandler (1984)

- Two types of participants (P-1) Amnesic, (P-2) Normal
- **Study:** a list of words (like- banana)
- **Test:** two types:
  - T-1 (**Free-recall**): Recall the studied words
  - T-2 (**Word-completion**): Shown first-three letters of the studied words (eg- ban___) then asked to make an English word out of it
- **Obs:**
  - T-1: performance better for normal people (P-2)
  - T-2:
    - Performance of both groups were similar, and
    - both came up with the studied word > 50% of time
- **Explanations:**
  - Amnesic patients too had a memory for the list of words
  - They could not access this memory in the *free-recall* task
  - But displayed implicit memory in *word-completion* task.

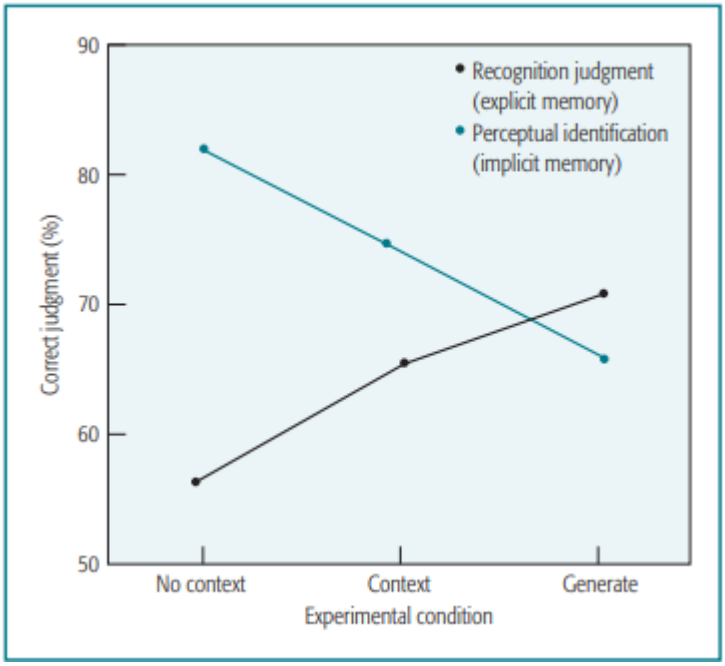
***Amnesic patients often cannot consciously recall a particular event but will show in implicit ways that they have some memory for the event.*

Implicit vs Explicit Memory in Normal Particpants

- Drammatic ***dissociation** in implicit and explicit memory* can be see in Amnesic patients.
- But, certain vatiables have diff effects on tests on explicit mem. than tests on implicit mem.

Jacoby 1983

- **Study:** study a word (say *woman*) under three conditions:
  - (C-1): The word alone (woman) - **No Context**
  - (C-2): In presence of an acronym (man-woman) - **Context**
  - (C-3): generate the target word of their own and remember it - **Generate**

- **Test:** in two ways:
  - (T-1): **Explicit memory Test** (Recognition Judgement)
    - presented with list of words, and asked to recognize the studied words
  - (T-2): **Implicit memory Test** (Perceptual Identification)
    - presented a word for brief period (40ms) - short enough to make consiouss judgement - and asked to identify the word (Studied? or not-studied?)
- **Obs:**
  - (T-1): Performance was best in the condition that involved more semantic and generative processing (C1 < C2 < C3)
  - (T-2): Performance showed opposite trend (C1 > C2 > C3)
- **Explanations:**
  - ***This Enhancement of perceptual recognition*** is referred to as "**priming**"
  - **greatest priming in the no-context (C-1) condition** because this is the study condition in which they had to *rely most on a perceptual encoding*
- 

Jacoby and Witherspoon (1982)

- **Aim:** whether participants would display more priming for words they could recognize than for words they could not.
- **Study:** participants studied list of words
- **Test:**
  - (T-1): try to recognize explicitly whether or not they had studied the words
  - (T-2): simply say what word they had seen after a very brief presentation (ppt words were either from the study list or were new)
- **Obs:**

    - NOTE: After T-1 There are now 2 pairs of words:
        - (studied | not-studied)
        - (recognized-in-T1 | not-recognized-in-T1)
    - It was seen that performance in T-2:
        - better in case of studied words than not-studied ones.
        - independent of whether they had been recog-in-T1 or not
- **Conclusion:**
    - exposure to a word improves normal participants' ability to perceive that word (success of implicit memory), even when they cannot recall having studied the word (failure of explicit memory)
    - -----> success/failure of explicit memory has little to do with success of implicit memory (which depends on whether it has been previously perceived or not)

Neuroimaging Studies

- **Implicit memories** are stored in the **cortex**

- **Priming produced decreased activation** in visual areas responsible for the recognition of pictures

- The decreased activation that we see with priming reflects the fact that it is *easier to recognize the primed items*.

- The brain regions responsible for the perceptual processing have to work less and so produce a ***weaker fMRI response***.

- A general interpretation of these results would seem to be that:
    - new explicit memories are formed in the hippocampus;
    - but with experience, this information is transferred to the cortex.
    - That is why *hippocampal damage does not eliminate old memories* formed before the damage

Procedural Memory

Implicit memory is defined as memory without conscious awareness.

- These memories can cause priming effects,
- can also involve knowledge of how to perform a task

An important type of Implicit memory involves **Procedural knowledge** eg- *riding a bike*

Berry and Broadbent 1984

- **Setting & Task:** participants to control a virtual (hypothetical) sugar factory. They have to vary W (workforce) and the system will output the production S for that month. Oxford graduates were given 60 trials.
- **Obs:** They got proficient at control, but when asked they could report any rule. They claimed that they had "some sort of intuition" or "felt right"
- **Conclusion:** Participants were able to acquire the implicit knowledge without acquiring the corresponding explicit knowledge.
- ***Amnesic patients are also capable of learning this information***

Sequence Learning - Curran 1995

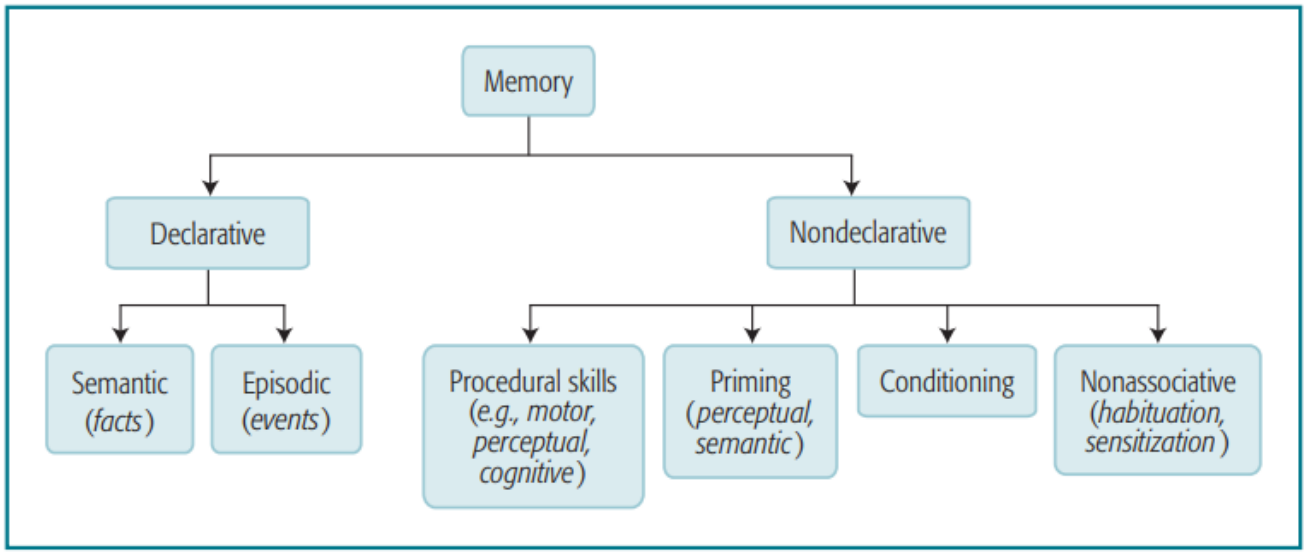
- **Setting & Task**: there were 4 lights with a button under each of them. Lights would flash in (1) in some sequence (2) random order. Particpants have to press the buttons in the same order.
- **Obs:** People are faster with a repeating sequence.
- **Ques:** Are the participants aware of the repeating sequence? (does it play a role?)
- **Ans:** in some Yes, in some not. However, that does not make a difference. In any case they are faster in case of "*repeating sequence*".
- ***Amnesic also show advantage in repeating sequence***
    - This means hippocampus is not critical to this skill

> A set of *subcortical structures*, collectively called the **basal ganglia (long known to be critical for motor controls)** does appear to be critical for sequence learning.
>
> They have been shown to be active during the learning of a number of skills, including sequence learning
>
> All in all, the evidence is pretty compelling that procedural learning involves structures different from those involved in explicit learning

Procedural learning is another type of implicit learning and is supported by the "basal ganglia"

CONCLUSION - The Varieties of Memory

Squire (1987) proposed that there are many different varieties of memory.



- **Declarative memory** - factual memories - explicitly recall - hippocampus
    1. **Episodic memory** - information about where and when they were learned (Ch-6,7)
    2. **Semantic memory** - general knowledge of the world (Ch-5)
- **No-declarative memory** - implicit mem. - basal ganglia & cerebellum
    1. Procedural skills
    2. Priming
    3. Conditioning
    4. Non-associative