Memory - Encoding and Storage

weekly_readings #week-4

Contents

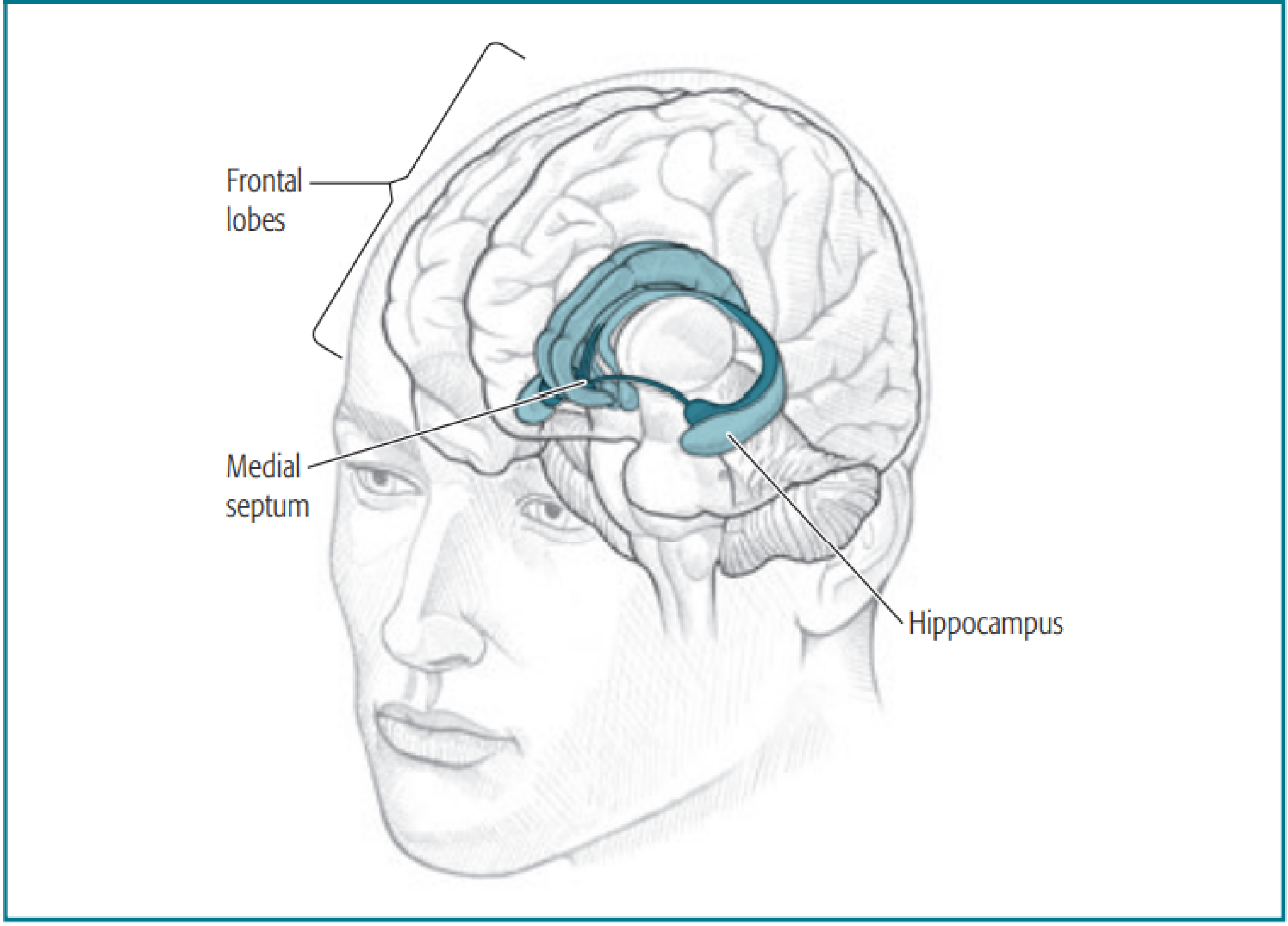
> Taken from John Anderson - Cognitive Psychology and Its Implications (2015, Freeman_Worth) - libgen.li.pdf
> Ch-6

Memory and Brain

Two main regions of brain involved in memory:

1. **storage of new memories** - A region within the Temporal Cortex (hippocampus & surrounding regions)
2. **encoding of new memories, retrieval of old memories** - Prefrontal regions

Brain Structures



Sensory Memory

- Before reaching the structures in Figure 6.1, information must be processed by perceptual systems, and these systems display a brief memory for the incoming information.
- **Sensory information** is held *briefly* in **cortical sensory memories** so that we can *process* it.

Visual Sensory Memory (iconic memory)

Earlier Experiments (whole-report procedure)

- Participants presented a visual array/matrix of items (3 x 4), and then asked to recall.
- Could report only 4-5
- But participants said that they remembered more items, but it faded away by the time they answered

Sperling 1960 (partial-report procedure)

Setting: Participants presented 3 rows of 4 letters each (*stimulus*)
Task: After the stimulus was turned-off, a tone was presented to report letters from a given row (lo: 1st, med: 2nd, hi: 3rd)
Observations: Able to recall all or most of the items in a given row
Graph: added delay in presenting the tones. %recall decayed with delay

Here, since

- the tone was presented relatively (wrt whole-report exp) immediately.
- The participants were unaware (unprepared) that which row they have to report.
  so the data must have been saved in some kind of ***short-term visual memory (sensory)***

Iconic Memory: while info is present in this store, subject can attend to it and report it, but if its is not attended and not processed further, then it will be lost

Auditory Sensory Memory (echoic memory)

Experiments similar to that of Sperling:

- Moray, Bates, & Barnett, 1965
- Darwin, Turvey, & Crowder, 1972
- Glucksberg & Cowan, 1970

Sams, Hari, Rif, and Knuutila (1993)

One of the more interesting *measures of auditory sensory memor*y involves an **ERP measure** called the "mismatch negativity"

Setting: presented one tone followed by the other at various intervals.
Observation:
A mismatch-negativity was produced when:

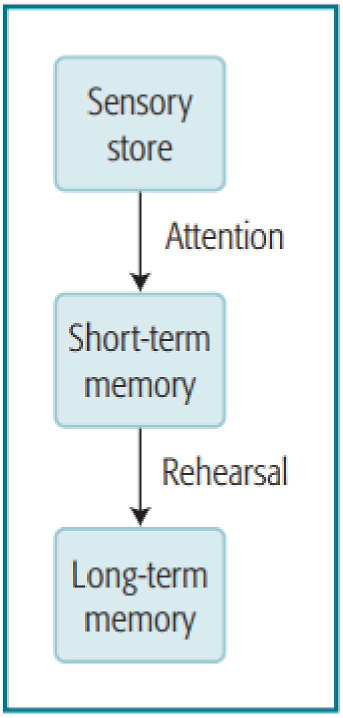
- Delay < 10s, and
- second tone was different from prev tone
  The source of this neural response ws near the "primary auditory cortex"
  Conclusion:
  There is some kind of auditory sensory mem

Short-Term Memory

> ***Overview***

> **Broadbent (1958)** had anticipated the theory of short-term memory,
> **Waugh and Norman (1965)** gave an influential formulation of the theory
>
> **Atkinson and Shiffrin (1968)** who gave the theory its most systematic development
>
> Experiment by **Shepard and Teghtsoonian (1961)** is a good illustration of these ideas
>
> **Rundus (1971)** showed that more rehearsal increases likelihood of being remembered
>
> **Craik and Lockhart (1972)** argued, depth of processing is more critical than duration of rehearsal
>
> Study by **Glenberg, Smith, and Green (1977)** proved the above argument

Theory on STM by Atkinson and Shiffrin (1968)

- Information coming in from the environment tends to be held in **transient sensory stores** from which it is *lost unless attended to*.
- "*Attended information*" went into an **intermediate short-term memory system** where it had to be "*rehearsed*" before it could go into a **relatively permanent long-term memory**
- *Short-term memory had a limited capacity* to hold information (sometimes identified with the "memory-span" 7 dig; Broadbent-1975 proposed that the capacity was smaller)
- If item left STM before its representation was made in LTM, that item will be lost
- 

Experiment by Shepard and Teghtsoonian (1961)

Setting:
presented participants with a long sequence of 200 three-digit numbers.
Some numbers were repeated.
number of words between 2 same words was called 'lag'

Task:
To identify when a number was repeated

Observations:
good recognition for short-lags. But mem. got progressively worse as lag increased.
recall for no. with Long-lags would reflect the amt. of info that got into LTM

Explanations:
Due to the setting, no time to rehearse
STM had a limited capacity, so new info pushed out the old info

Experiment by Rundus (1971)

- Asked participants to rehearse out loud and showed that the more participants rehearsed an item, the more likely they were to remember it.

Depth of processing - by Craik and Lockhart (1972)

- Argued that what was critical was not how long information is rehearsed, but rather the depth to which it is processed.
- Rehearsal improves memory **ONLY IF** the material is rehearsed in a deep and meaningful way.

Experiment by Glenberg, Smith, and Green (1977)

Setting:

- participants to study a four-digit number for 2 s, then rehearse a word for 2, 6, or 18 s, and then recall the four digits

Surprise Task:

- They were asked to recall the words (instead of the 4-digit numbers)

Observations:

- random recalls for words (irrepective of 2s, 6s, 8s rehearsal)

Explanations

- Since, participants tought that their task is to remember the 4-fig number, so they did not process the words deeply enough (even though they have rehearsed it for k seconds)
- Non correlation between the duration of rehearsal and recall% for words showed that "level of processing" matters more than duration of rehearsal

Working Memory

Baddeley's Theory of Working Memory

theory of the rehearsal processes that did not tie them to storage in long-term memory

- A **central executives** coordinate a set of "slave systems".
- Baddeley claimed that the central executive needs its own temporary store of information to make decisions about how to control the slave systems
- slave systems - **visuospatial sketchpad** and **phonological loop** (there can be more)
- The "phonological-loop" has many components:
    1. **articulatory loop** -- "inner voice" -- Broca's area in frontal region
    2. **phonological store** -- "inner ear" -- parietal temporal region

Word length effect - Baddeley, Thomson, & Buchanan, 1975

Evidence for the existence of the articulatory loop is the "word length effect"

Setting:
2 sets of 5 words: {wit, sum, harm, bay, top}, {university, opportunity, hippopotamus, constitutional, auditorium}

Task:
To recall the words

Observations
Recall was better for the words with less syllables.

Conclusions
The crucial factor appears to be how long it takes to say the word

Vallar and Baddeley (1982) looked at the recall vary with number of syllables

- As (num of syll) inc. => (reading time) inc. => (recall) dec.

Explanations

- If we try to keep too many items in working memory, by the time we get back to rehearse the first one, it will have decayed to the point that it takes too long to retrieve and re-rehearse.
- We can keep1.5 to 2.0 seconds *worth of material rehearsed* in the articulatory loop.

The Frontal cortex and the Primate Working Memory

The frontal cortex gets larger in the progression from lower mammals, such as the rat, to higher mammals, such as the monkey, and it shows an even greater development between the monkey and the human

- Goldman-Rakic, (1988)
- Funahashi, Bruce, & Goldman-Rakic, 1991
- Goldman-Rakic (1992)
- Funahashi, Bruce, and Goldman-Rakic (1993)
- E. E. Smith and Jonides (1995)

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Episodic Buffer:
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The episodic buffer is a component of Alan Baddeley's working memory model,
which was proposed in 2000 as an extension of his earlier model from 1974.

The episodic buffer is a temporary storage system that serves as a backup
for the phonological loop and the visuospatial sketchpad

It is responsible for integrating information from these two systems, as
well as information from long-term memory, into a single, unified
representation

Term first used by Baddeley himself, along with his colleagues Graham Hitch
and Juan-Luciano Camos, in a paper published in 2000 titled "Working
Memory: The Multiple-Component Model"
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Activation and Long Term Memory

Working mem. gets info from:

1. (Not ony) the environment
2. (But also) the LTM

Ericcson and Kintsch (1995)

- part of our working memory is formed by information we can quickly access from long-term memory
- which they called "Long-term working memory"

Nelson Cowan (2005)

- argues that working memory includes the activated subset of long-term memory
- *COWAN's Model - originally proposed in 1980*
- There is no separate kind of mem. for vision, sound, etc.
- Components:
    1. Central Exec (attention & voluntary processing)
    2. Long term store
    3. Brief Sensory Registers
- STM is a subset of info (active portions) in LTM
- A subset of info in STM are the "current focus of attention" (limited capacity)

Potter and Lombardi 1990

- The ability to bolster our working memory with long-term memory information helps explain why the memory span for meaningful sentences is about twice the span for unrelated words

Activation Calculations

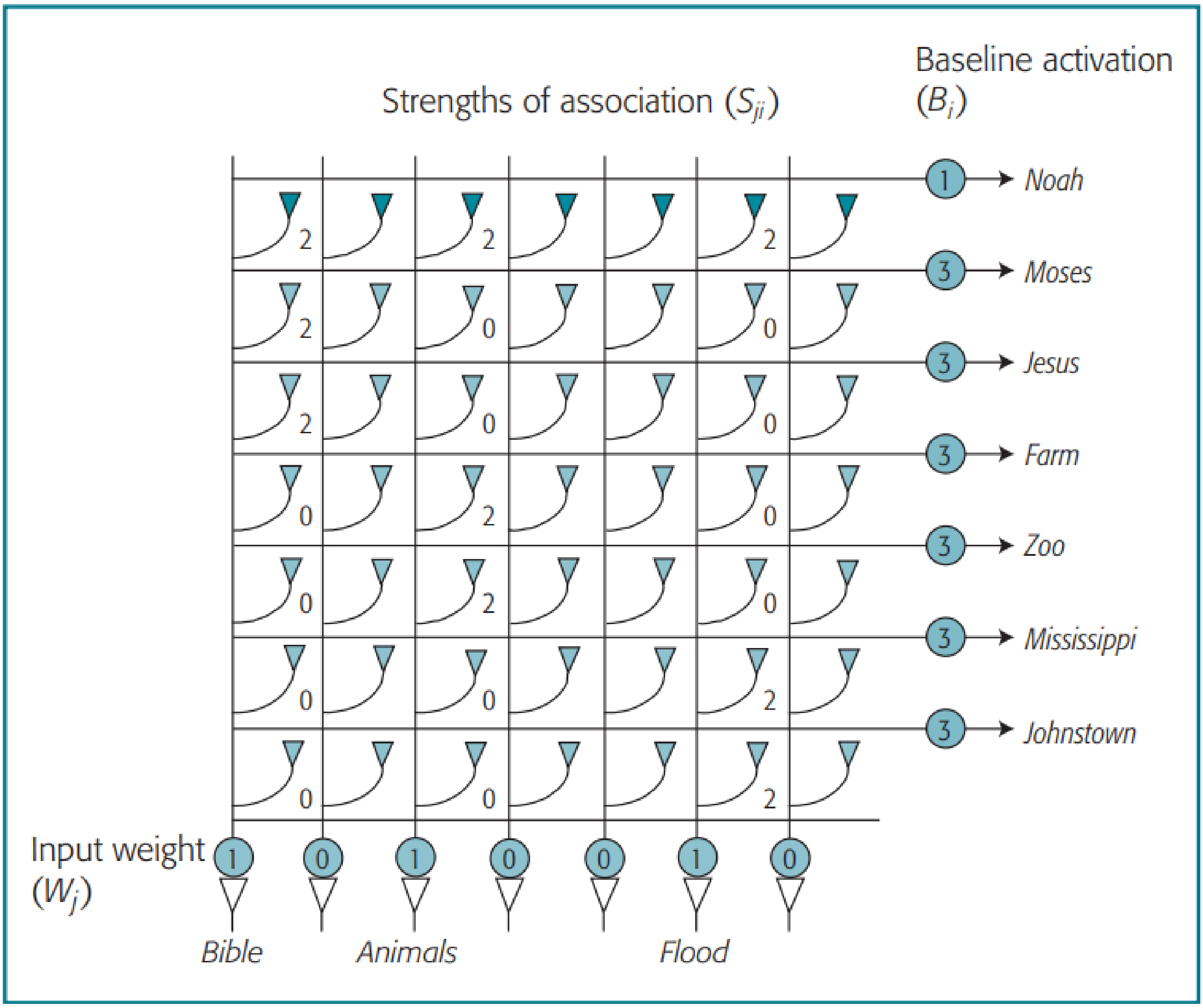
> **Terminologies used** - ACT (Adaptive control of thought) - J.R. Anderson, 2007

"ACTIVATION" *determines* both the **probability** that some given piece of information will be retrieved from long-term memory and the **speed** with which that retrieval will be accomplished

Levels of activations can be measured by "**Free-association technique**"

In free association, a person is presented with information (e.g., one or more words) and is asked to free-associate by responding with whatever first comes to mind

The speed and probability of accessing a memory are determined by the memory's level of activation



Bible -> Jesus, Animals -> Farm, Flood -> Mississippi
But (Bible, Animals, Flood) -> Noah

The table represents:

1. **Potential responses:** terms that are currently active in long-term memory and so could potentially come to mind. *Noah, Moses, Jesus, farm, zoo, Mississippi, and Johnstown.*
2. **Potential primes:** terms that might be used to elicit responses from long term memory. *Bible, animals, and flood.*
3. The **strength of the association** between each "potential prime" and each "potential response"

$$A_i = B_i + \sum_j W_j S_{ji}$$

where,

> A(i) = Activation of potential response i
> B(i) = Base level activation of potential response i before priming
> W(j) = Weight given to each potential prime (in this case: 1 - present, 0 - absent)
> S(j, i) = strength of association between potential prime j and potential response i

Spreading Activation

Spreading activation is the term often used to refer to the process by which currently attended items can make associated memories more available

Meyer and Schvaneveldt 1971

Setting: presented pairs of words maybe actual or non-sense.
Task: To judge whether both items were actual words or not
Observations:

Positive Pairs		Negative Pairs		
Unrelated	Related	Nonword First	Nonword Second	Both Nonwords
Nurse	Bread	Plame	Wine	Plame
Butter	Butter	Wine	Plame	Reab
940 ms	855 ms	904 ms	1,087 ms	884 ms

Interest in +ve pairs - Participants were 85 ms faster on the related pairs

Explanations:
explained by a spreading-activation analysis. When the participant read the first word in the related pair, activation would spread from it to the second word, making that word easier to judge

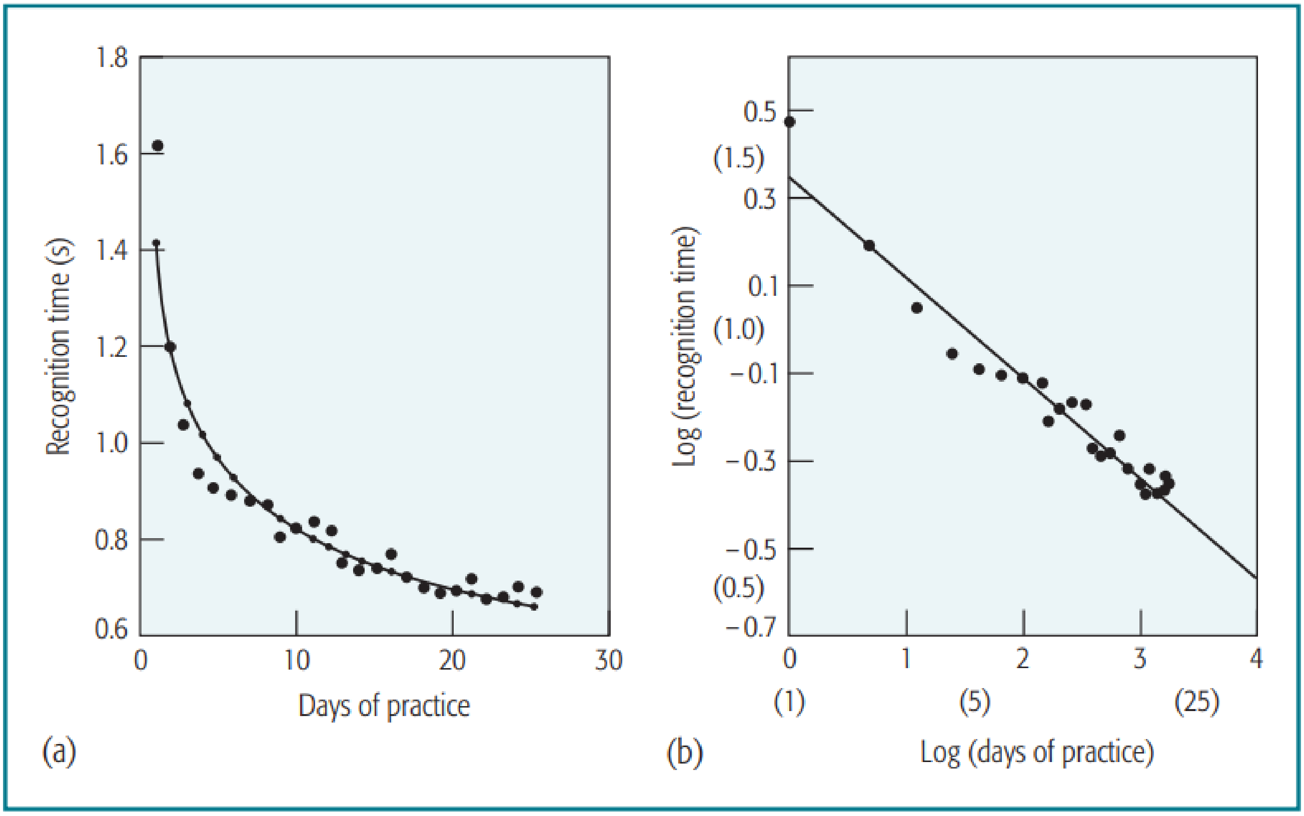
Practice and Memory Strength

- Spreading activation concerns how the context can make some memories more available
- However, some memories are just more available (eg- names of ur close friends)
- The quantity that determines this inherent avail. is **strength** (same as Base-Level activation in ACT-R)
- Each time we use a memory trace, it increases a little in strength

Power Law of Learning

Pirolli and Anderson 1985

Taught participants a set of facts and had them practice the facts for 25 days



T = recognition time, P = number of days of practice

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T = 1.40 P ^ (-0.24)

OR

ln(T) = 0.34 - 0.24 ln(P)
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This is called the **power function**

Newell and Rosenbloom (1981) refer to the way that memory performance improves as a function of practice as the **power law of learning**

- With practise, memory trace becomes stronger.
- As memory traces become stronger, they can reach higher levels of activation and so can be retrieved more rapidly

Neural Correlates of the Power Law of Learning

Long-term potentiation (LTP), which occurs in the hippocampus and cortical areas. When a pathway is stimulated with a high-frequency electric current, cells along that pathway show increased sensitivity to further stimulation

Barnes (1979) looked at LTP in rats by stimulating the hippocampus for 11 days and obs an increased in base level EPSP

Damage to the hippocampal region cause "amnesia"

The relationship between the hippocampus and prefrontal cortex is interesting

1. Study by Kahn and Wagner
    - in normal participants they both are active at the same time.
2. Paller and Wagner 2002
    - processing activity in prefrontal regions regulates input to hippocampal regions that store the memories
3. R. L. Buckner, personal communication, 1998
    - Patients with hippocampal damage show the same prefrontal activation as normal people do, but because of the hippocampal damage, they fail to store these memories

Factors influencing Memory

(1) Elaborative Processing

Elaborative processing involves thinking of information that relates to and expands on the information that needs to be remembered

Series of Experiments by B. S. Stein and Bransford (1979)

Setting and Task:

- Participants asked to remember 10 sentences
- four conditions of study:
    1. Base: study just the sentence
    2. Self-generated elaboration
    3. Imprecise elaboration given by the experimenter
    4. Precise elaboration given by the experimenter

Observations:

- Out of 10 recall score was: (4.2, 5.8, 2.2, 7.8)

Conclusion:

- (2) and (4) both leads to better recall

- But since, experimenter carefully chosed the words (probably better than the particpants themselves). So recall was better in case (4)
- Hence, does not matter whether the participants themselves generated the elaboration or not

(2) Techniques for Studying Textual Material

Find answers to advances questions before reading the text

(3) Incidental vs Intentional Learning

It does not seem to matter whether people intend to learn the material; what is important is how they process it

Experiment by Hyde and Jenkins 1973

Setting:

- List of words presented.

Task:

- 4 types of tasks (CT, CT', PT, PT') based on 2 variables:
    1. Var-1 (C / P) asked to check whether 'e' or 'g' was present in the words - "checking" OR asked to give a pleasantness rating to the words - "pleasantness"
    2. Var-2 (T / T')Users were told of the true purpose of the experiment (which was to recall as much words as possible)
- Next, asked to recall the words

Observations:

- Pleasantness task had better performance irrespective of whether they new the true purpose of experiment or not (intentional)

(3) Flashbulb Memories

Flashbulb memories: events so important that they seem to burn themselves into memory forever

People report better memories for particularly traumatic events, but these memories seem no different than other memories