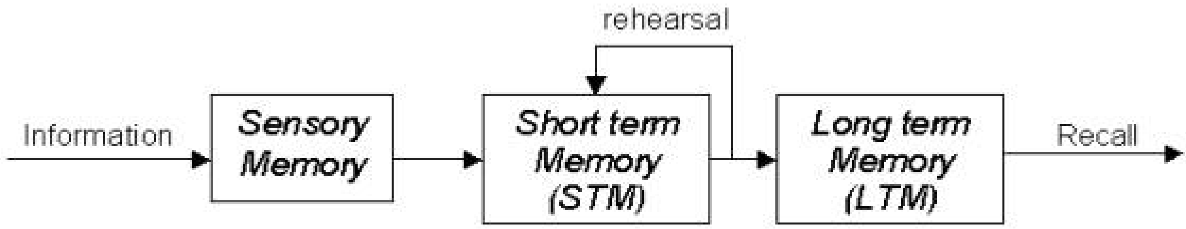
Remembering and Forgetting

Models of Memory

o **Multi-Store Model (Atkinson and Shiffrin, 1968)**

Atkinson and Shiffrin (1968) suggest that memory is made up of a series of stores.



Encoding	Sense Specific	Auditory	Semantic
Capacity	v. Large	7 +/- 2 items	Unlimited
Duration	¼ to ½ second	0 – 18 Seconds	Unlimited

This model describes memory in terms of information flowing through a system. Information is detected by the sense organs and enters the **sensory memory**. If **attended** to this information is encoded and enters the short-term memory (STM). Information from the STM is transferred and encoded to the long-term memory only if that information is **rehearsed**. If rehearsal does not occur, then information is forgotten, lost from STM through the processes of displacement or trace decay. Rehearsal basically means that information is repeated.

Most adults can store between 5 and 9 items in their short-term memory. This idea was put forward by **Miller (1956)** and he called it the **magic number 7**. He though that short-term memory could hold 7 (plus or minus 2 items) because it only had a certain number of "slots" in which items could be stored. However, Miller didn't specify the amount of information that can be held in each slot. Indeed, if we can "chunk" information together we can store a lot more information in our short-term memory.

Miller's theory is supported by evidence from various studies, such as **Jacobs** (1887). He used the digit span test with every letter in the alphabet and numbers apart from "w" and "7" because they had two syllables. He found out that people find it easier to recall numbers rather than letters. The average span for letters was 7.3 and for numbers it was 9.3.

Key Study: Murdock (1962) – Primacy Recency Effect

Aim: To investigate if there are separate memory stores (STM and LTM).

Method: A lab experiment was conducted. Participants were presented with a list of words at the rate of one per second. Immediately after, partipcants were asked to recall them in any order (free recall).

Results: Murdock found that words presented either early in the list or at the end were more often recalled, but the ones in the middle were more often forgotten.

Conclusions: Murdock suggested that words early in the list were put into LTM **(primacy effect)** because the person has time to rehearse the word, and words from the end went into STM **(recency effect)**. Words in the middle of the list had been there too long to be held in STM (due to displacement) and not long enough to be put into LTM.

Multi-Store Model Evaluation

The model is **oversimplified**, in particular when it suggests that both short-term and long-term memory each operates in a single, uniform fashion. **Working memory** shows that STM is more than one store. E.g. there are separate STM stores for visual and auditory information (e.g. phonological loop).

There is **more than one LTM store** (e.g. episodic, semantic, procedural) for different types of information. LTM is more complicated that the multi-store model describes.

The model looks at the physical structure of memory (e.g. STM, LTM) and **ignores memory as a type of (information) process** (e.g. deep and shallow).

The model suggests **rehearsal** helps to transfer information from STM into LTM - but this does not apply to real life situations. Why are we able to recall information which we did not rehearse (e.g. a song on the radio) yet unable to recall information which we have rehearsed (e.g. reading your notes while revising).

Finally, there is the general problem of memory experiments having **low ecological validity** (due to the control of extraneous variables such as background noise).

The **H.M. case study** supports the multi-store model. H.M. had brain surgery to control his epilepsy. After the operation his LTM was unaffected, but his STM was affected, as he couldn't recall any recent information. This shows that there are separate STM and LTM memory stores.

- **Working Memory Model (Baddeley and Hitch, 1974)**

Baddeley and Hitch (1974) argue that the picture of STM provided by the Multi-Store Model is far too simple. According to the Multi-Store Model, STM holds limited amounts of information for short periods of time with relatively little processing. It is a unitary system. This means it is a single system (or store) without any subsystems. Working Memory is not a unitary store.

Working memory is STM. Instead of all information going into one single store, there are different systems for different types of information. Working memory consists of a **central executive** which controls and co-ordinates the operation of two subsystems: the **phonological loop** and the **visuo-spatial sketchpad**.

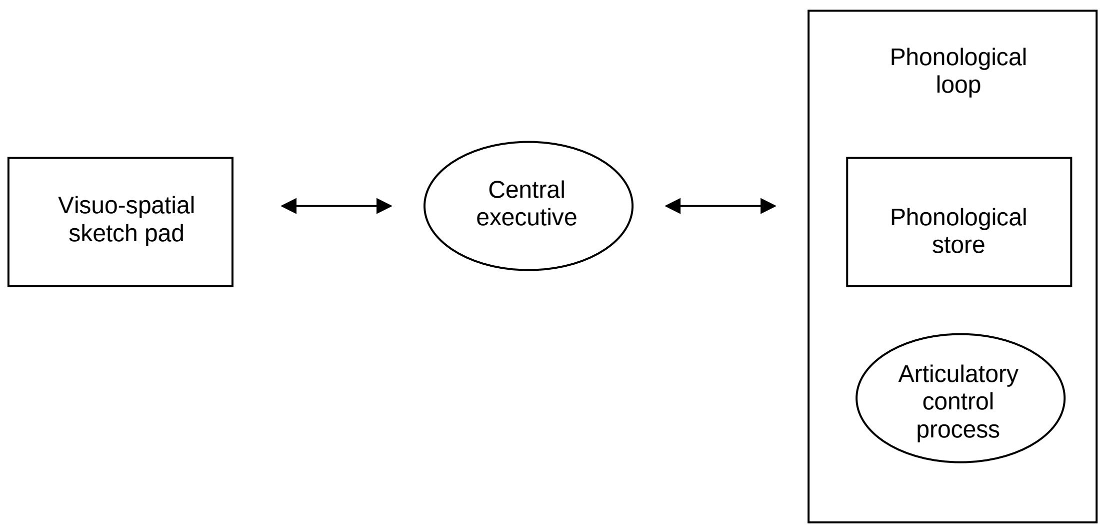
Central Executive: Drives the whole system (e.g. the boss of working memory) and allocates data to the subsystems (VSS & PL). It also deals with cognitive tasks such as mental arithmetic and problem solving.

Visuo-Spatial Sketch Pad (inner eye): Stores and processes information in a visual or spatial form. The VSS is used for navigation.

The phonological loop is the part of working memory that deals with spoken and written material. It can be used to remember a phone number. It consists of two parts

- **Phonological Store** (inner ear) – Linked to speech perception Holds information in speech-based form (i.e. spoken words) for 1-2 seconds.

- **Articulatory control process** (inner voice) – Linked to speech production. Used to rehearse and store verbal information from the phonological store.



The working memory model makes the following two predictions:

1. If two tasks make use of the same component (of working memory), they cannot be performed successfully together.

2. If two tasks make use of different components, it should be possible to perform them as well as together as separately.

Key Study: Baddeley and Hitch (1976)

Aim: To investigate if participants can use different parts of working memory at the same time.

Method: Conducted an experiment in which participants were asked to perform two tasks at the same time (dual task technique) - a digit span task which required them to repeat a list of numbers, and a verbal reasoning task which required them to answer true or false to various questions (e.g. B is followed by A?).

Results: As the number of digits increased in the digit span tasks, participants took longer to answer the reasoning questions, but not much longer - only fractions of a second. And, they didn't make any more errors in the verbal reasoning tasks as the number of digits increased.

Conclusion: The verbal reasoning task made use of the central executive and the digit span task made use of the phonological loop.

Working Memory Model Evaluation (use alternative models to evaluate)

The working memory model explains a lot more than the multi-store model. It makes sense of a range of real life tasks - verbal reasoning, comprehension, problem solving (all use the central executive) and visual and spatial processing can be used (by the sketchpad) for navigation.

The **KF Case Study** supports the Working Memory Model. KF suffered brain damage from a motorcycle accident that damaged his short-term memory. KF's impairment was mainly for verbal information - his memory for visual information was largely unaffected. This shows that there are separate STM components for visual information (VSS) and verbal information (phonological loop).

There is little direct evidence for how the central executive works and what it does. However, the idea of a central executive 'makes sense' in terms of the working memory model. In any system made up of different parts, something must activate, coordinate and control the parts.

o **Craik and Lockhart's Levels of Processing Theory (1972)**

The LOP theory was put forward by partly as a result of the criticism levelled at the multi-store model. Instead of concentrating on the physical stores/structures involved in memory (i.e. STM & LTM), this theory concentrates on the processes involved in memory. Unlike the multi-store model it is a non-structured approach.

The basic idea is that memory is really just what happens as a result of processing information. They propose that memory is just a by-product of the depth of processing of information and there is no clear distinction between STM & LTM. "Depth" is defined as the meaningfulness extracted from the stimulus rather than in terms of the number of analyses performed upon it."

We can process information in 3 ways:

Shallow processing – This takes **two forms**

1. **Structural processing** (appearance) which is when we encode only the physical qualities of something. E.g. the typeface of a word or how the letters look.

2. **Phonemic processing** – which is when we encode its **sound**.

Shallow processing only involves **maintenance rehearsal** (repetition to help us hold something in the STM) and leads to fairly **short-term retention of information.** This is the only type of rehearsal to take place within the multi-store model.

Deep Processing - This involves

3. **Semantic processing,** which happens when we encode the meaning of a word and relate it to similar words with similar meaning.

Deep processing involves **elaboration rehearsal** which involves a more meaningful analysis (e.g. images, thinking, associations etc.) of information and leads to better recall. For example, giving words a meaning or linking them with previous knowledge.

Key Study: Craik and Tulving (1975)

Aim: To investigate how deep and shallow processing affects memory recall.

Method: Participants were presented with a series of 60 words about which they had to answer one of three questions. Some questions required the participants to process the word in a deep way (e.g. semantic) and others in a shallow way (e.g. structural and phonemic). For example:

Structural / visual processing: 'Is the word in capital letters or small letters?
Phonemic / auditory processing: 'Does the word rhyme with . . .?'
Semantic processing: 'Does the word go in this sentence . . . . ?

Participants were then given a long list of 180 words into which the original words had been mixed. They were asked to pick out the original words.

Results: Participants recalled more words that were semantically processed compared to phonemically and visually processed words.

Conclusion: Semantically processed words involve elaboration rehearsal and deep processing which results in more accurate recall. Phonemic and visually processed words involve shallow processing and less accurate recall.

Levels of Processing Evaluation (use alternative models to evaluate)

This explanation of memory is useful in everyday life because it highlights the way in which elaboration, which requires deeper processing of information, can aid memory. For example, **reworking** – putting information in your own words or talking about it with someone else or using **mind maps** to revise AS psychology.

Despite these strengths, there are a number of **criticisms** of the LOP theory:

It does not explain how the deeper processing results in better memories. Deeper processing takes more effort than shallow processing and it could be this, rather than the depth of processing that makes it more likely people will remember something.

The concept of depth is vague and cannot be observed. Therefore, it cannot be objectively measured (re: Skinner).

The LOP theory focuses on the <u>processes</u> involved in memory, and thus ignores the <u>structures</u> (STM and LTM supported by H.M. case study and serial position effect (e.g. primacy – recency studies).

o Episodic, Semantic and Procedural Long-Term Memory

The multi-store model of memory proposed by Atkinson and Shiffrin (1968) makes a distinction between relatively short-term memory (working memory) and long-term memory. It also views LTM as a single store. Research shows that this is not so. Our long-term memory consists of a range of different types of knowledge.

Key Definitions:

Procedural memory is a part of the long-term memory (1) responsible for knowing how to do things, i.e. memory of motor skills (1). It does not involve conscious (i.e. it's unconscious - automatic) thought is not declarative (1). For example, procedural memory would involve knowledge of how to ride a bicycle (1).

Semantic memory is a part of the long-term memory (1) responsible for storing information about the world (1). This includes knowledge about the meaning of words, as well as general knowledge. For example, London is the capital of England. It involves conscious thought and is declarative (1)

Episodic memory is a part of the long-term memory (1) responsible for storing information about events (i.e. episodes) that we have experienced in out lives (1). It involves conscious thought and is declarative (1). An example would be a memory of our 1^{st} day at school (1).

Cohen and Squire (1980) drew a distinction between declarative knowledge and procedural knowledge. **Procedural** knowledge involves "knowing how" to do things. It included skills, such as "knowing how" to playing the piano, ride a bike; tie your shoes and other motor skills. It does not involve conscious thought. For example, we brush our teeth with little or no awareness of the skills involved.

Whereas, **declarative** knowledge involves "knowing that", for example London is the capital of England, zebras are animals, your mums birthday etc. Recalling information from declarative memory involves some degree of conscious effort – information is consciously brought to mind and "declared".

Evidence for the distinction between declarative and procedural memory has come from research on patients with amnesia. Their memory for events and knowledge acquired before the onset of the condition tends to remain intact, but they can't store new episodic or semantic memories (e.g. declarative knowledge). However, their procedural memory appears to be largely unaffected. They can recall skills they have already learned (e.g. riding a bike) and acquire new skills (e.g. learning to drive). This shows there are different types of LTM stores.

Explanations of Forgetting

- **Trace Decay (STM)**

This theory suggests STM can only hold information for between 0 and 18 seconds unless it is rehearsed. After this time the information **decays** (fades away). This explanation of forgetting in short-term memory assumes that memories leave a physical trace in the brain. A trace is some form of physical and/or chemical change in the nervous system. Trace decay theory states that forgetting occurs as a result of the automatic decay or fading of the memory trace. Trace decay theory focuses on time and the limited duration of STM.

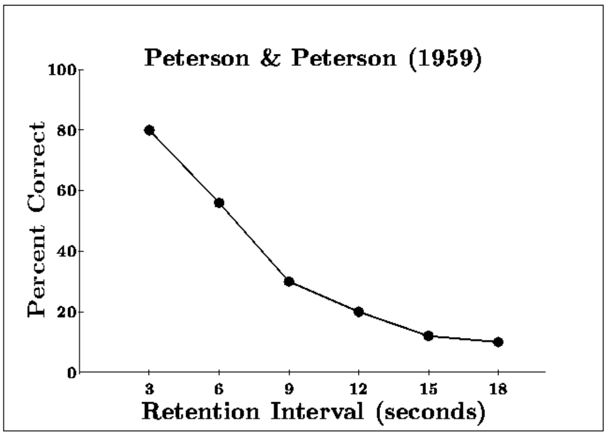
Support for the idea that forgetting from short-term memory might be the result of decay over time came from research carried out by Brown (1958) in the United Kingdom, and Peterson and Peterson (1959) in the United States. The technique they developed has become known as the **Brown-Peterson task**.

Key Study: Peterson and Peterson (1959) (also can be used for duration of STM)

Aim: To investigate if information is lost from STM through decay over time.

Method: Participants were presented with sets of **trigrams** (nonsense syllables in sets of three, e.g. BCM) which they were then asked to recall in order after a delay of 3, 6, 9, 12, 15 and 18 seconds. An experimental method was used: The **IV** was the time delay, and the **DV** was the number of trigrams recalled.

Participants were given an interference task of counting backwards in threes from a random three-digit number to prevent rehearsal (known as the **Brown-Peterson technique**). Recall had to be 100% accurate and in the correct order in order for it to count as correctly recalled.



Results: The percentage recall was:

After **3 seconds = 80%**
After **6 seconds = 50%**
After **18 seconds = less than 10%**

Conclusion: Peterson and Peterson (1959) explained this rapid loss in terms of trace decay. The memory trace fades over time until it disappears completely. At this point, information is forgotten (usually around 18 seconds on average).

o **Displacement (STM)**

Displacement theory provides a very simple explanation of forgetting. Because of its limited capacity (suggested by Miller to be 7+/- 2 items), STM can only hold small amounts of information. When STM is 'full', new information displaces or 'pushes out' old information and takes its place. The old information which is displaced is forgotten from STM.

Support for the view that displacement was responsible for the loss of information from STM came from studies using the '**free-recall**' method. A typical study would use the following procedure: participants listen to a list of words read out a steady rate, they are then asked to recall as many of words as possible. They are free to recall the words in any order, hence the term 'free recall'.

The findings from studies using free recall are fairly reliable and they produce similar results on each occasion. If you take each item in the list and calculate the probability of participants recalling it and plot this against the item's position in the list, it results in the **serial position curve** (Figure 1).

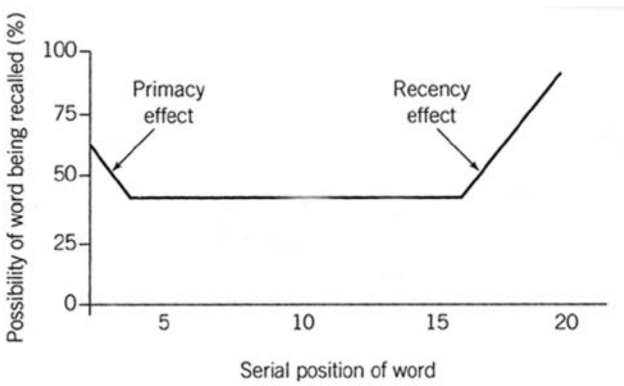


Fig 1. Simplified representation of the serial position curve for immediate recall

Good recall of items at the beginning of the list is referred to as the **primacy effect** and good recall if items at the end of the list are referred to as the **recency effect**. The displacement theory of forgetting from short-term memory can explain the recency effect quite easily. The last few words (14 – 20) that were presented in the list have not yet been displaced from short-term memory and so are available for recall. The first words in the list (0 – 6) have more time to be rehearsed because they are presented first. This means that words early in the list are more likely to be transferred to long-term memory. However, words in the middle (7 – 13) of the list used to be in short term memory until they were pushed out - or displaced by the words at the end of the list (14 – 20).

Key study: Use any study for primacy and recency (e.g. Murdock, 1962) to support this theory in an essay or for aim, method, results and conclusion questions.

o Interference (LTM)

Interference is thought to be more likely to occur where the memories are similar, for example: confusing old and new telephone numbers. Students who study similar subjects at the same time often experience interference. Starting French may affect our memory of previously learned Spanish vocabulary. There are two ways in which interference can cause forgetting in LTM:

1. **Proactive interference** (pro=forward) occurs when a person cannot remember new information because it has been confused with old information.

2. **Retroactive interference** (retro=backward) occurs when you cannot remember old information because new information has interfered with it.

Key study: Postman (1960)

Aim: To investigate how retroactive interference affects learning. In other words, to investigate whether information you have recently received interferes with the ability to recall something you learned earlier.

Method: A lab experiment was used. Participants were split into two groups. Both groups had to remember a list of paired words – e.g. cat - tree, jelly - moss, book - tractor. The experimental group also had to learn another list of words where the second paired word if different – e.g. cat – glass, jelly- time, book – revolver. The control group were not given the second list. All participants were asked to recall the words on the first list.

Results: The recall of the control group was more accurate than that of the experimental group.

Conclusion: This suggests that learning items in the second list interfered with participants' ability to recall the list. This is an example of retroactive interference.

Evaluation of Interference

There are a number of problems with interference theory as an explanation of forgetting. First, interference theory tells us little about the cognitive (mediational) processes involved in forgetting. Secondly, the majority of research into the role of interference in forgetting has been carried out in a laboratory using lists of words, a situation which is likely to occur fairly infrequently in everyday life (i.e. **low ecological validity**). As a result, it may not be possible to generalise from the findings. Baddeley (1990) states that the tasks given to participants are too close to each other and, in real life; these kinds of events are more spaced out.

o **Retrieval Failure Theory (LTM)**

Retrieval failure is where the information is in LTM memory, but cannot be accessed. Such information is said to be available (i.e. it is still stored) but not accessible (i.e. it cannot be retrieved). It cannot be accessed because the retrieval cues are not present. When we store a new memory we also store information about the situation (e.g. a song on the radio) and these are known as retrieval cues. When we come into the same situation again, these retrieval cues can trigger the memory of the situation. A retrieval cue is a hint or clue that can help retrieval. Retrieval cues can be:

State Cues - inside of us, e.g. physical, emotional, mood, being drunk etc.

Context Cues – in the external environment, e.g. smell, song, room, weather etc.

There is considerable evidence that information is more likely to be retrieved from long-term memory if appropriate retrieval (state or context) cues are present.

Key Study: Baddeley (1975)

Aim: To investigate if context dependent forgetting can be aided using retrieval cues.

Method: Baddeley asked deep-sea divers to memorise a list of words. One group did this on the beach and the other group underwater. When they were asked to remember the words half of the beach learners remained on the beach, the rest had to recall underwater. Half of the underwater group remained there and the others had to recall on the beach.

Results: The divers who learnt the words underwater recalled more words when tested underwater. The divers who learnt the words on the beach recalled more words when tested on the beach.

Conclusion: This suggests that the retrieval of information is improved if it occurs in the (external) context in which it was learned.

There is considerable evidence to support this theory of forgetting from laboratory experiments. The ecological validity of these experiments can be questioned, but their findings are supported by evidence from outside the laboratory. For example, many people say they can't remember much about their childhood or their schooldays. But returning to the house in which they spent their childhood or attending a school reunion often provides retrieval cues which trigger a flood of memories.

o **Lack of Consolidation (LTM)**

The previous accounts of forgetting have focused primarily on psychological evidence, but memory also relies on biological processes.

When we take in new information, a certain amount of time is necessary for changes to the nervous system to take place – the consolidation process – so that it is properly recorded. During this period information is moved from STM to the more permanent LTM.

The brain consists of a vast number of cells called neurons, connected to each other by synapses. Synapses enable chemicals to be passed from one neuron to another. These chemicals, called neurotransmitters, can either inhibit or stimulate the performance of neurons. So if you can imagine a network of neurons all connected via synapses, there will be a pattern of stimulation and inhibition. It has been suggested that this pattern of inhibition and stimulation can be used as a basis for storing information. This process of modifying neurons in order form new permanent memories is referred to as **consolidation** (Parkin, 1993).

There is evidence that the consolidation process is impaired if there is damage to the **hippocampus** (a region of the brain). In 1953, **HM** had brain surgery to treat his epilepsy, which had become extremely severe. The surgery removed parts of his brain and destroyed the hippocampus, and although it relieved his epilepsy, it left him with a range of memory problems.

The main problem experienced by HM is his inability to remember and learn new things. He was unable to process information from STM into LTM.

However, of interest in our understanding of the duration of the process of consolidation is HM's memory for events before his surgery. In general, his LTM for events before the surgery remains intact, but he does have some memory loss for events which occurred in the two years leading up to surgery. Pinel (1993) suggests that this challenges Hebb's (1949) idea that the process of consolidation takes approximately 30 minutes. The fact that HM's memory is disrupted for the two-year period leading up to the surgery indicates that the process of consolidation continues for a number of years.

Finally, aging can also impair our ability to consolidate information.

<u>**Evaluation**</u>

The research into the processes involved in consolidation reminds us that memory relies on biological processes, although the exact manner by which neurons are altered during the formation of new memories has not yet been fully explained.