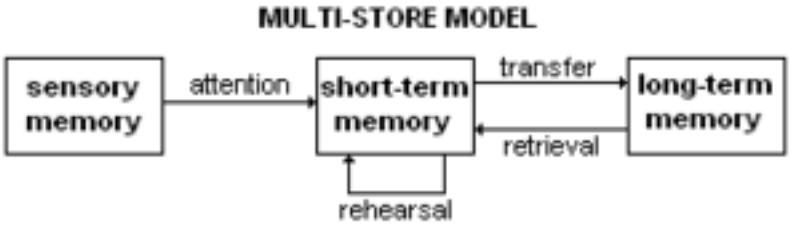
THE MULTI-STORE MODEL OF MEMORY

Introduction

The first attempt at developing a general model of memory was proposed by **Atkinson & Shiffrin (1968)**. Their model proposes that memory consists of **three separate and distinct storage systems**. For this reason, the model is called the **multi-store model** (**MSM**).

How does the multi-store model view memory?

According to the model, information flows from the senses (eyes, ears, etc.) to a storage system called **sensory memory**. From there, some of the information is passed on to a storage system called **short-term memory**. If the information in short-term memory is **rehearsed** (repeated over and over again), then it will eventually find its way into a storage system called **long-term memory**, where it will be permanently stored.



Sensory memory (SM) is the first place where information from the environment is registered. Research shows that it stores information in the form in which it is received (e.g. auditory information is stored or **encoded** as a 'sound'). However, SM cannot hold much information (it has a very limited **capacity**), and it cannot hold it for very long (it has a very limited **duration**). Thus, a large amount of information that we receive from our senses is actually lost very quickly.

However, some information is passed on to short-term memory (**STM**), and from there to long-term memory (**LTM**). It is these two storage systems that have been researched most by cognitive psychologists.

What has research told us about the nature of short-term memory (STM)?

The MSM sees STM as a system that temporarily holds the information passed to it from SM. This is the information we are currently thinking about (our 'conscious experience').

The capacity of STM

The term **capacity** refers to **how much** information STM can hold. **Miller (1956)** used the **forward digit span procedure** to investigate STM's capacity. In this, lists of random digits are constructed, beginning with two digits (e.g. 4, 8), then three, and so on, up to about ten digits. Beginning with two digits, a participant is required to repeat them back in the order they were heard. This continues until the participant is incorrect on two occasions. The number of digits that the participant correctly recalled is his/her **forward digit span**.

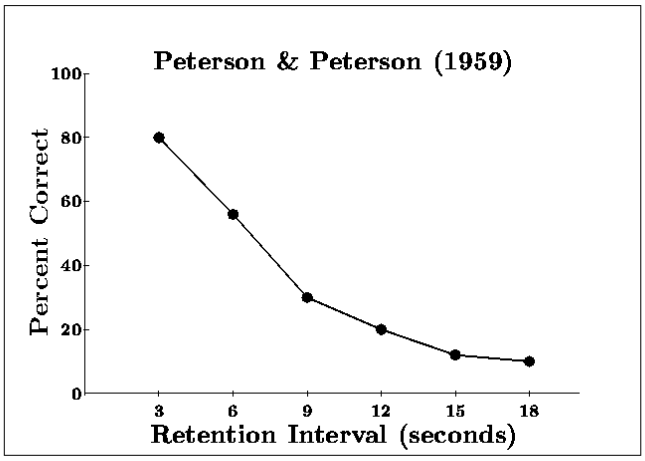
Miller found that most people could recall 7 unrelated digits (items) + or – 2 (i.e. normal forward digit span is between 5 and 9). Miller therefore concluded that STM is **capacity limited**. He called the capacity of STM 'the magic number seven'. However, Miller's method assumes that the digits are unrelated. If they are not, then information can be grouped into a larger piece of information called a '**chunk**' (and Miller called this process '**chunking**'). As a result, STM's capacity can seemingly be increased.

The duration of STM

The term **duration** refers to **how long** STM can hold information for. This was studied by **Peterson & Peterson (1959)**. The MSM sees STM as a temporary store, which can hold information indefinitely if it is continually rehearsed (e.g. saying an unfamiliar telephone number over and over). So, to measure the duration of 'pure' STM the Petersons had to find a way of preventing rehearsal.

Their method involved presenting participants with a **trigram** (e.g. XPT), and then a three digit number (e.g. 251). When the participant heard the number s/he had to start counting out loud backwards in threes from it (e.g. 248, 245, 241, etc.). After a period of time (e.g. 3 seconds, 6

seconds, etc.) the participant heard the experimenter say 'recall'. The participant then had to recall the trigram s/he had been presented with.



As shown above, recall is poorer the longer it is delayed for. In fact, it has dropped to 5% after just 18 seconds delay. The Petersons concluded that STM has a very short duration (somewhere between 1 and 30 seconds), and that rehearsal must be used if information is to be held for longer periods of time than this.

The encoding of information in STM

The term **encoding** refers to **the form** in which STM holds information. This was first studied by **Conrad (1964)**. In his experiment, participants were shown 6 consonants one at a time using a 'memory drum'. Each consonant was seen for 0.75 seconds, and the consonants were randomly chosen from B C P T V F M N S X. Once the consonants had been presented, participants then wrote them down in the order they had seen them.

Conrad found that people make certain kinds of mistake in this experiment. For example, if they were shown a C, they might write down a P or V, but not an S or X. Equally, if they were shown an F, they might write down an S or X, but not a T or P. Conrad noticed that the incorrect letters **sounded** like the correct letters, rather than looked like them. He calls these **acoustic confusion errors**.

Since Conrad's participants saw rather than heard the consonants, but they made mistakes according to what the consonants sounded like, Conrad concluded that STM must have **transformed** (or **recoded**) what

the consonants looked like into what they sounded like. This suggests that when it is possible, STM prefers to hold information as a sound or acoustic representation. Conrad called this **acoustic encoding**. The word 'prefer' is important: some types of information are not letters or words, in which case STM does have to store them in some other form (e.g. as a visual image). However, when it can, STM *prefers* to use acoustic encoding.

What has research told us about the nature of long-term memory (LTM)?

The MSM says that if information is rehearsed, then it will be passed from STM to LTM. The model assumes that the more rehearsal that takes place the more likely it is that information will be stored in LTM.

The capacity of LTM

The **capacity** of LTM is impossible to test experimentally, but a lot of psychologists believe that LTM has an effectively **unlimited capacity**. Since the number of possible neural connections is 1 to the power of 8 million miles of zeros, this seems a reasonable assumption to make.

The duration of LTM

The **duration** of LTM has been investigated experimentally, even though we don't really need to do an experiment to measure it (You only have to ask an elderly person about their childhood to appreciate that some memories can be stored for a lifetime). In **Bahrick et al's (1975)** study, nearly 400 Americans, who had graduated from high school anywhere from one year previously to fifty years previously, were shown photographs from their high-school yearbook. Some were given the names of people and asked to match a name with a photograph (**recognition memory**). Others were asked to try and remember names (**recall memory**).

The researchers found that whilst recognition accuracy declined over time, even those who left school nearly fifty years ago were 60% accurate. Recall also declined over time, but the effect was much more dramatic since there was only 20% accuracy for those who left school nearly fifty years ago. This study confirms what most people tell us: LTM

can hold information for very long periods of time, but recognition memory tends to be better preserved than recall memory.

The encoding of information in LTM

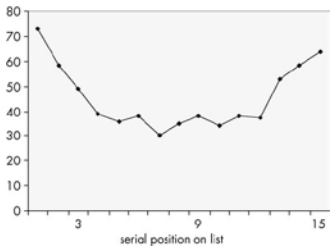
The **encoding** of information in LTM was studied by **Baddeley (1966)**. He asked participants in one group to read a list of semantically related words (e.g. big, great, broad). A second group was asked to read a list of acoustically related words (e.g. mad, man, map). Recall for both groups was tested 20 minutes after presentation. The second group recalled significantly more words than the first group.

The second group's words were not semantically related whereas the first group's were. Because the first group recalled fewer words, Baddeley concluded that when words with a similar meaning have to be recalled, LTM gets confused possibly because words with a similar meaning are stored in the same area of memory. Baddeley called this **semantic confusion**. This finding suggests that with verbal material LTM prefers to code material according to what it means. This is called **semantic encoding**.

EVALUATION: What are the strengths and limitations of the MSM?

The MSM proposes that STM and LTM are separate and distinct storage systems, probably located in different parts of the brain. One **strength** of the MSM is that research suggests that this proposal is correct.

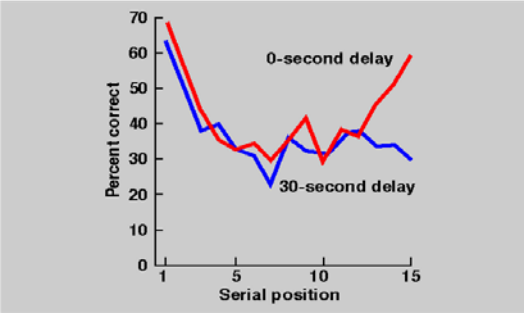
For example, **Murdock (1962)** conducted a very simple study in which participants heard a list of 15 words. Immediately after the last word, the experimenter said 'Recall', and the participants had to write down as many of the words as they could remember in any order they liked (**free recall)**. Murdock found that whether a word was recalled or not depended on its position in the list – people tended to recall the first few words on the list and the last few words on the list. The words in the middle of the list were much less likely to be remembered:



Murdock called this the **serial position curve** (**SPC**). The tendency to recall the first few words is called the **primacy effect**, and the tendency to recall the last few words is called the **recency effect**. Murdock believed that the SPC showed that STM and LTM really were different storage systems.

He argued that the first few words we hear are subjected to rehearsal, and as a result of that are transferred to LTM. We are therefore able to remember those words because we are recalling them from that storage system. The last few words are still in STM, and so they are recalled from that storage system. The words in the middle of the list are assumed to have been 'pushed out' of STM (to make way for other words) but because they have not been rehearsed, they have not found their way into LTM. That is why they are less likely to be remembered.

Murdock was supported by an experiment conducted by **Glanzer & Cunitz (1966)**. They repeated Murdock's experiment, but instead of having participants write down what they could remember immediately, they were asked to count backwards in threes, out loud, for 30 seconds:



The recency effect has disappeared, because the counting task occupied STM. However, because the primacy effect is still present, this must mean that the first words are being recalled from a different storage system, namely LTM.

The MSM's claim that STM and LTM are separate and distinct storage systems is also supported by some studies of **clinical amnesiacs**. Most amnesias are a result of brain damage. The argument here is that if memory consisted of just a single storage system, then brain damage would affect <u>all</u> of memory. However, if STM and LTM were separate systems, then people with some kinds of brain damage might have their LTM affected but not their STM affected.

This is exactly what some **case studies** of amnesiacs have found. For example, an amnesiac known as 'H.M.' had a normal STM as measured by the forward digit span test, but a few minutes later he could not remember having done the test. 'H.M.' had suffered damage to a brain structure called the **hippocampus**, and psychologists believe that this structure enables us to transfer what is happening now into LTM. If the hippocampus is damaged, this cannot happen. The same effect is shown in the famous amnesiac Clive Wearing.

Studies of non-amnesiacs using brain scanners have confirmed that the hippocampus is important in memory. In one canning method, a small amount of radioactive Gold is injected into the bloodstream. When a particular brain structure is active, there is increased blood flow to it, and the scanner detected where the radioactive Gold is. With tasks involving STM, the hippocampus becomes active. However, with tasks involving LTM, different parts of the **cerebral cortex** and a structure called the **cerebellum** become active depending on what kind of LTM is being used (see below).

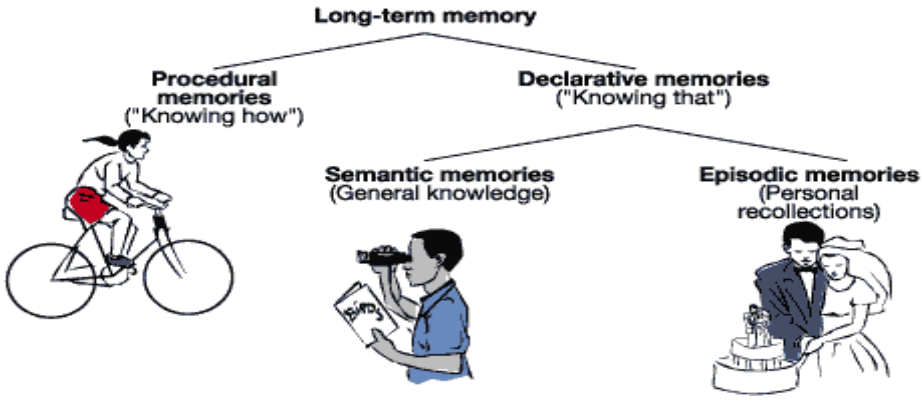
Note also that the MSM's idea that **rehearsal** is important is also supported by the fact that at least some of use this as a way of revising for examinations! Even though it has been challenged, the MSM remains an influential model of memory, and psychologists still find it useful to talk about STM, LTM, and rehearsal.

However, and in connection with the above one of the **weaknesses** of the MSM is its emphasis on the importance of rehearsal. As noted, the model says that the more material is rehearsed, the more likely it is to be transferred to LTM. However, whilst this is true for some material, it isn't for other material. For example, a long time ago when BBC Radio changed its wavelengths, the BBC advertised this fact continuously. However, despite having heard this information on average over a thousand times, some people could still not remember what the new wavelengths were. Therefore, the amount of rehearsal doesn't guarantee material will be transferred from STM to LTM. Equally, there are some things that find their way into LTM without any rehearsal taking place. This is also difficult for the MSM to explain.

Another **weakness** of the MSM is that it is **too simplistic**. For example, the **chunking** of information can only be done by using knowledge stored in LTM and applying it to the information that is entering STM. This can

only be done if information is able to flow from LTM to STM as well as from STM to LTM. In their original model, Atkinson and Shiffrin only had information travelling from STM to LTM. However, later on they accepted that information can travel from LTM to STM.

Another way in which the MSM is too simplistic is that it sees LTM as being a single storage system. However, there is lots of evidence that there are in fact **different types of LTM**. As noted previously, some types of LTM are stored in the **cerebral cortex**, whilst other types are stored in the **cerebellum**:



Yet another **weakness** of the MSM is that it has difficulty explaining some types of amnesia. For example, 'K.F.' suffered brain damage following a motor cycle accident. When tested on forward digit span, he could only remember one or two numbers, indicating that his STM was severely impaired. However, his LTM appeared to be normal, and he could store new memories of things that had happened after his accident. According to the MSM, this cannot happen since information gets into LTM by passing through STM.

However, it turns out that whilst 'K.F.' had an impaired memory for verbal material (such as spoken letters, words or numbers), his STM for visual material and meaningful sounds (such as a telephone ringing) was largely unaffected. This suggests that the MSM also has a too simplistic view of STM. Rather than being a passive stopping off point for information on its way to LTM, STM may be more of a '**working memory**' made up of different components.