Multi-Store Model

AQA specification for Topic 2: Memory

- The multi-store model of memory, sensory register, short-term memory and long-term memory. Features of each store: coding, capacity and duration.

Key terms for multi-store model

Before we look at the multi-store model of memory, it is important to become familiar with these key terms that make up the multi-store model.

- **Memory:** This is a mental process where information is coded, stored, and retrieved when requested. Memory can be distinguished between the sensory register (store of sensory memory), short-term memory (STM) and long-term memory (LTM). These storage systems differ in terms of how the information is coded, the amount stored (capacity) and the length of time held (duration).
- **Sensory register:** This storage system (also known as sensory memory or SM) receives information from the environment through the senses (e.g. eyes, ear, etc.), and has a very high capacity for storing information and a very limited duration of 250 milliseconds – 2 seconds.
- **Short-term memory (STM):** A storage system that holds information for a very short period of time. Duration of information in STM is approximately about 18-30 seconds if the information does not receive attention, e.g. it has not been rehearsed. STM also has a limited capacity, of approximately 7±2 digits.
- **Long-term memory (LTM):** A memory storage system where information is held for a long time, or permanently. LTM differs from STM, as it has potentially unlimited capacity and a duration that can last for a lifetime.
- **Multi-store model (MSM):** The multi-store model attempts to explain how information is processed, retained and recalled in the brain. It is called the multi-store model because it suggests that memory consists of several different mental storage systems. This model was developed by Richard Atkinson and Richard Shiffrin in 1968.
- **Coding:** This is the process of converting information into memory traces (code) so it can be stored and remembered successfully (e.g. like changing a Microsoft Word document file into a Portable Document Format (PDF).). Research suggests that the sensory register is modality-specific: information remains in the same form as it entered the senses. Short-term memory tends to code information acoustically (i.e. information is stored as sounds). In long-term memory, information tends to be coded semantically rather than acoustically.
- **Capacity:** This refers to how much information can be held in the memory store. The STM has a limited capacity, 7±2 digits or items, whereas the LTM has an unlimited capacity.
- **Duration:** This is the amount of time the information is held in the memory store. The STM has a very limited duration, up to 18-30 seconds, whereas the LTM has a very long duration, possibly permanent.

Multi-store model

Atkinson and Shiffrin (1968) first proposed the multi-store model (MSM) to explain how information is processed and flows from one memory store to another.

This theory of memory suggests that information must be successfully processed through all three storage systems in order to be stored and recalled over long periods of time. According to this theory, SM, STM and LTM differ in terms of:

- **Encoding** – How information is converted as a code to be stored successfully in memory.
- **Duration** – The length of time the information is stored for.
- **Capacity** – The amount of information that is stored.

The three different memory storage systems in the MSM are:

The sensory register

Information initially enters memory through the **sensory register** (also know as the sensory memory or SM). We hold an exact copy of what we saw or heard for a few seconds, or less, before it decays (fades). For example, if you look at an object such as a car and then close your eyes, you will see an image of the car for about half a second before it fades away.

Coding

- Atkinson and Shiffrin (1968) suggested that encoding of information in the SM is modality-specific, that is, information is stored in the way it is received. The main forms of modality-specific encoding are iconic storage (of visual memories) and echoic storage (of auditory memories). Information in the SM is retained in separate stores for a very brief time and then fades if we do not give it attention. If we do, then the information is transferred into the STM.

Capacity

- The amount of information stored in the SM is claimed to be very high because it needs to register virtually all the incoming information from the senses.

Duration

- Information is stored in the SM for the shortest time of any memory system in this theory, between 0.25 milliseconds and 2 seconds.

Short-term memory

Once information is transferred from SM to STM, it is processed again. Psychologists have carried out numerous experiments to show how information is processed in STM.

Duration

- The STM store tends to encode information **acoustically** (as sound) even when the information is presented *visually*.

Capacity

- Research suggests that the amount of information that STM can hold is limited.

Duration

- Information cannot remain in the STM for very long without verbal rehearsal (without repeating it).

AN 'EYE' ON THE STUDY

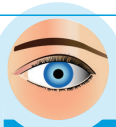
Coding in STM
(Conrad, 1964)

In this laboratory experiment, participants were quickly shown a sequence of six consonant letters of the alphabet that were acoustically similar (they sounded the same, e.g. D, P, T, B, L, V) or acoustically dissimilar (such as K, Z, W, R, Y, F). The participants had to immediately write down as many letters as possible in the order they were given. Conrad found that people made more mistakes recalling the order of acoustically similar letters but, acoustically dissimilar letters were remembered better. This is because when the letters sounded similar, it was harder to remember which of the similar sounds came first, for example, B was mistaken for V or D because they all sound like 'ee'. This study supports the MSM because it shows that STM attempts to code information acoustically – even when it is presented visually. This is known as the **acoustic similarity effect**.

AN 'EYE' ON THE STUDY

Capacity in STM
(Jacobs, 1887)

In this laboratory experiment, the capacity of STM was tested using the **serial digit span technique**. Participants were presented with a sequence of digits (numbers) and were required to repeat them back in the same order. The participants had to repeat one, then two, then three digits, and so on. When they made a mistake, the experimenter assessed them on additional sequences of the longest length they had correctly recalled. If they recalled 4-5 sequences correctly, this was considered their "digit span". Jacobs found that the average adult digit span is between five and nine digits. This is supported by Miller (1956) who claimed that STM can hold 7 ± 2 digits or items (e.g. between five and nine), whether those items are numbers, letters, or words. He called this "the magic number seven plus or minus two". Miller also found that if we chunk (group) items together in a meaningful way, we can increase the amount of information we can store in our STM. For example, recalling the sequence 1 9 5 8 1 9 6 7 1 9 7 0 as 12 separate numbers would be challenging to most people, but chunked as three meaningful items, such as three dates (1958, 1967, 1970), the sequence could have meaning, for example, if the three chunks related to the birth dates of family members. In this way you can effectively remember 12 individual numbers, but if they were unrelated you could only recall 7 ± 2 of them. Furthermore, Simon (1974), found that participants tended to recall fewer chunks if the chunks themselves were larger, and could recall more, smaller chunks. This suggests that the amount of information in each *chunk size* can affect the overall capacity in STM.



AN 'EYE' ON THE STUDY

Duration in STM
(Peterson and Peterson, 1959)

This experiment investigated how long information remains in STM without verbal rehearsal (without repeating it). In a laboratory experiment, 24 students were briefly presented with a nonsense trigram (e.g. three letters such as CLD, NWQ), immediately followed by a three-digit number (e.g. 882). They were then asked to count backwards in threes from the specified number (e.g. 882, 879, 876) until they were told to stop. This was to prevent them from repeating the three letters (maintenance rehearsal). After intervals of 3, 6, 9, 12, 15 or 18 seconds, participants were asked to recall the nonsense trigram in the correct order. They found that participants were able to correctly recall over 80% of the trigrams after a 3-second interval and 50% of them after a 6-second interval. After 18 seconds, fewer than 10% of trigrams were recalled correctly. Based on these results, Peterson and Peterson suggested that if verbal rehearsal is prevented, information in STM rapidly fades, and almost completely by 18 seconds. This study supports the MSM because it shows that memory is made up of separate memory stores. STM has a limited duration, while LTM arguably has an unlimited duration. This method of investigating duration is referred to as the **Brown–Peterson technique**.

Long-term memory

How do we remember information from the past if our STM has a limited capacity and duration? If the information in our STM is acted on, through **maintenance rehearsal** (repeating) for long enough, then the information can be transferred into our LTM. A more effective way of transferring information into LTM is through **elaborative rehearsal**, encoding information semantically (see Figure 4 on page 52). In terms of encoding, capacity and duration, LTM differs from STM in the following ways:

Coding

- Information from STM entering LTM tends to be transferred **semantically** (making the information meaningful) rather than acoustically. However, evidence has shown that LTM can also store information acoustically and in a visual form (Paivio, 1986).

Capacity

- Information storage in LTM seems to be unlimited, but it is very difficult, perhaps impossible, to test the true capacity of LTM using experimental methods.

Duration

Information in the LTM can potentially last a whole lifetime. See the study below.

AN 'EYE' ON THE STUDY

Capacity in LTM
(Bahrick et al., 1975)

Bahrick et al. (1975) conducted a natural experiment to investigate how long information is held in LTM. This study used a sample of nearly 400 Americans who all attended the same high school and had left between 3 months and 48 years ago (the age of ex-students varied between 17 years to 74 years). The students were shown photographs from their high-school yearbook. The participants were organised into two groups:

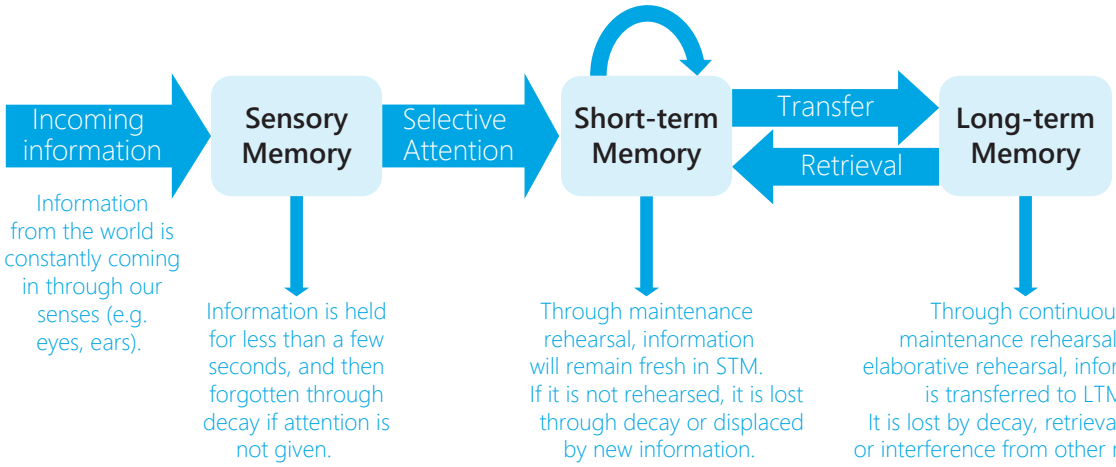
- **Recall group** – The participants carried out a **free recall test** in which they were asked to remember and list as many names of their ex-classmates as possible.
- **Recognition group** – The participants were given a **name-matching recognition test**. They were given the names of their ex-classmates and asked to match the names with the photos.

Bahrick et al. found that participants in the recognition group were 90% correct even 15 years after graduation. Those who had graduated 48 years before accurately matched 80% of the names to faces. In the recall group, memory performance was significantly worse: 60% correct after 15 years and only 30% after 48 years. These results provide strong evidence that information is held in LTM for a very long time. It also shows that there is some memory loss over time, especially when attempting to freely recall information (such as remembering names). However, memory recall is better when presented with a visual memory cue (as demonstrated by the photo recognition test).

According to Atkinson and Shiffrin (1968), the multi-store model consists of three memory stores: the sensory register (also known as sensory memory or SM), short-term (STM) and long-term memory (LTM). Their model explains how information is processed and transferred from one store to another. This process also tells us how information is remembered and forgotten.

- In SM, encoding of information tends to be modality-specific (stored in the way format it is received). The SM has unlimited capacity, but a limited duration (250 milliseconds to 2 seconds) before it fades out. Information constantly enters the SM for a very brief amount of time and quickly fades if attention is not given to it. If attention is directed toward the information, it is then transferred to short-term memory STM. This is the first process step of remembering encoding information.
- For information to be successfully transferred from SM to STM it needs to be encoded acoustically, turning images or written words into a verbal code (sound). To prevent information fading in STM, a process of maintenance (verbal) rehearsal (verbal rehearsal) is needed. If it is not encoded correctly or verbally rehearsed sufficiently, the information will quickly fade away, often within 18 seconds or so, showing that STM has a limited duration. This can be seen as the second process step of remembering encoding for a short period of time. Research evidence also suggests that STM has a limited capacity of between five and nine items of information, which. This can be increased by breaking the information into meaningful chunks.
- Information can be transferred to LTM if it has been sufficiently rehearsed/repeated the information in STM has been continuously rehearsed. It can also be transferred by elaborative rehearsal, where the information is remembered in a meaningful way. This is the final stage step of remembering encoding information for a long period of time. Evidence also shows that, in the absence of injury or disease, LTM has unlimited capacity and unlimited duration of up to a lifetime.

Figure 4: Maintenance rehearsal



Differences between the memory stores

Memory	Encoding	Capacity	Duration
SM	**Modality-specific**	**Very large**	**Very brief** Less than 2 seconds
STM	**Acoustic (sound)** Acoustic similarity effect *(Conrad, 1964)*	**Limited (5–9 items)** Serial digit span technique *(Jacobs, 1887)* Chunking 7 ± 2 *(Miller, 1959)*	**Limited** Approx. 18 seconds *(Peterson and Peterson, 1959)*
LTM	**Semantic (meaning)**	**Unlimited**	**Unlimited** High school study *Bahrick et al. (1975)*

Evaluation

Strengths

✔ **Controlled experiments.** A strength of the MSM is that controlled laboratory studies (e.g. Peterson and Peterson) on capacity, duration, and coding, support the existence of separate short and long-term stores, which make up the MSM. Furthermore, neuroimaging studies have also demonstrated a difference between STM and LTM. For example, Beardsley (1997) found that the prefrontal cortex is active during STM tasks, but not during LTM tasks, and Squire et al. (1992) found the hippocampus is active when LTM is engaged.

✔ **Study to support STM and LTM are different memory stores.** The MSM is further supported by research showing STM and LTM are separate. For example, Conrad (1966) found that we tend to mix up words that sound similar when using STM. We also mix up words that have similar meanings when we use our long-term memory. This clearly shows that coding in STM is acoustic and in LTM it is semantic. This supports the MSM's view that these two memory stores are separate and independent.

Weaknesses

✘ **Low ecological validity.** Research evidence to support the MSM is based on laboratory experiments, which is an artificial setting, so it may lack mundane realism (that is, it does not reflect real life). Some of the memory tasks used artificial materials, such as the use of nonsense trigrams by the Peterson and Peterson study. These methods do not reflect how we use our memory in our day-to-day real life. The participants may have found this activity meaningless and may not have performed as well as they might have if the experiment was something they could relate to. In everyday life, we form memories related to all sorts of useful things – people's faces, their names, facts, places, etc. Research findings may reflect how memory works with meaningless material in laboratory testing but may not reflect how memory works in everyday life. Therefore, although there is evidence for the MSM, it mainly comes from artificial environments and may not stand true in the real world.

✘ **Elaborative rehearsal more effective than maintenance rehearsal.** A further criticism of the MSM is that it suggests that maintenance rehearsal determines the likelihood that the information will pass into the LTM. However, Craik and Watkins (1973) suggest that elaborative rehearsal is more effective in transferring information from the STM to the LTM. This is because the information that is processed more deeply/richly is more memorable than facts that are just repeated (maintenance rehearsal). Furthermore, a study by Tulving (1967) found that maintenance rehearsal is not necessary to transfer information to LTM. Overall, rehearsal in STM may be helpful but not essential to transfer information to LTM, and making links with existing knowledge is a more effective method.

✘ **Too simplistic.** A criticism of the MSM is that it is too simplistic. For example, the MSM oversimplifies LTM by saying it is a single unitary store; however, research shows that there are different storage systems within LTM, and each behaves differently. For instance, there are storage systems for procedural memories (e.g. how to ride a bike), semantic memories (e.g. the capital of France), and episodic memories (e.g. your eighth birthday party). This shows that the MSM is limited because it does not reflect these different types of LTM.

Practice exam questions

1. Explain what is meant by the terms 'encoding', 'capacity' and 'duration'. **[2 marks + 2 marks + 2 marks]**
2. Describe two differences between short-term and long-term memory. **[2 marks + 2 marks]**
3. Explain one strength of the multi-store model of memory. **[3 marks]**
4. Explain two weaknesses of the multi-store model of memory. **[3 marks + 3 marks]**
5. Describe one or more studies that investigated short-term memory. **[6 marks]**
6. Describe one or more studies that investigated long-term memory. **[6 marks]**
7. Tom was getting ready to go to the supermarket to shop for his mum. His older brother Adam shouted out 'Don't forget to buy Benny's chocolate chip cookies, otherwise, you're dead, you little squirt!' On his way to the shops, Tom kept on repeating to himself 'Benny's chocolate chip cookies'. At the pay counter, Tom just remembered that Adam also wanted something – but he could not for the life of him remember what it was! Using your knowledge of what you have learnt about the multi-store model, explain why the above scenario would be used to criticise the model. **[4 marks]**
8. Outline and evaluate the multi-store model of memory. **[12 marks AS, 16 marks A-level]**