PSYC100 GENERAL PSYCHOLOGY

MEMORY

Learning Outcomes

- What is memory?
- Encoding, Storage and Retrieval
- The Multi-Store Model (MSM)
- Episodic, Semantic and Procedural memory
- The Working Memory Model (WMM)
- The Levels of Processing Model (LOP)
- Theories of Forgetting

What is memory?

Memory, like learning, is a *hypothetical construct* denoting three distinguishable but interrelated processes:

- ***registration* (or *encoding*)** – the *transformation* of sensory input (such as a sound or visual image) into a form which allows it to be entered into (or registered in) memory.
- ***storage*** – the operation of *holding* or *retaining* information in memory.
- ***retrieval*** – the process by which stored information is *extracted* from memory.

These three processes work to manage how we encode, retain, and recall information in our memory.

- **Registration (Encoding)**: This is the initial step where sensory information is transformed into a format that can be stored in memory. It involves selective attention and relates to questions like "How is sensory information processed in a way that allows it to be stored?" or "How are things remembered?"
- **Storage**: This process involves retaining information in memory over time. It relates to questions such as "Where are our memories kept?" and "Is there more than one kind of memory?"
- **Retrieval**: This is the process of recovering stored information when needed. It connects to questions like "Are there different kinds of remembering?" "What do we remember?" and "Why do we forget?"

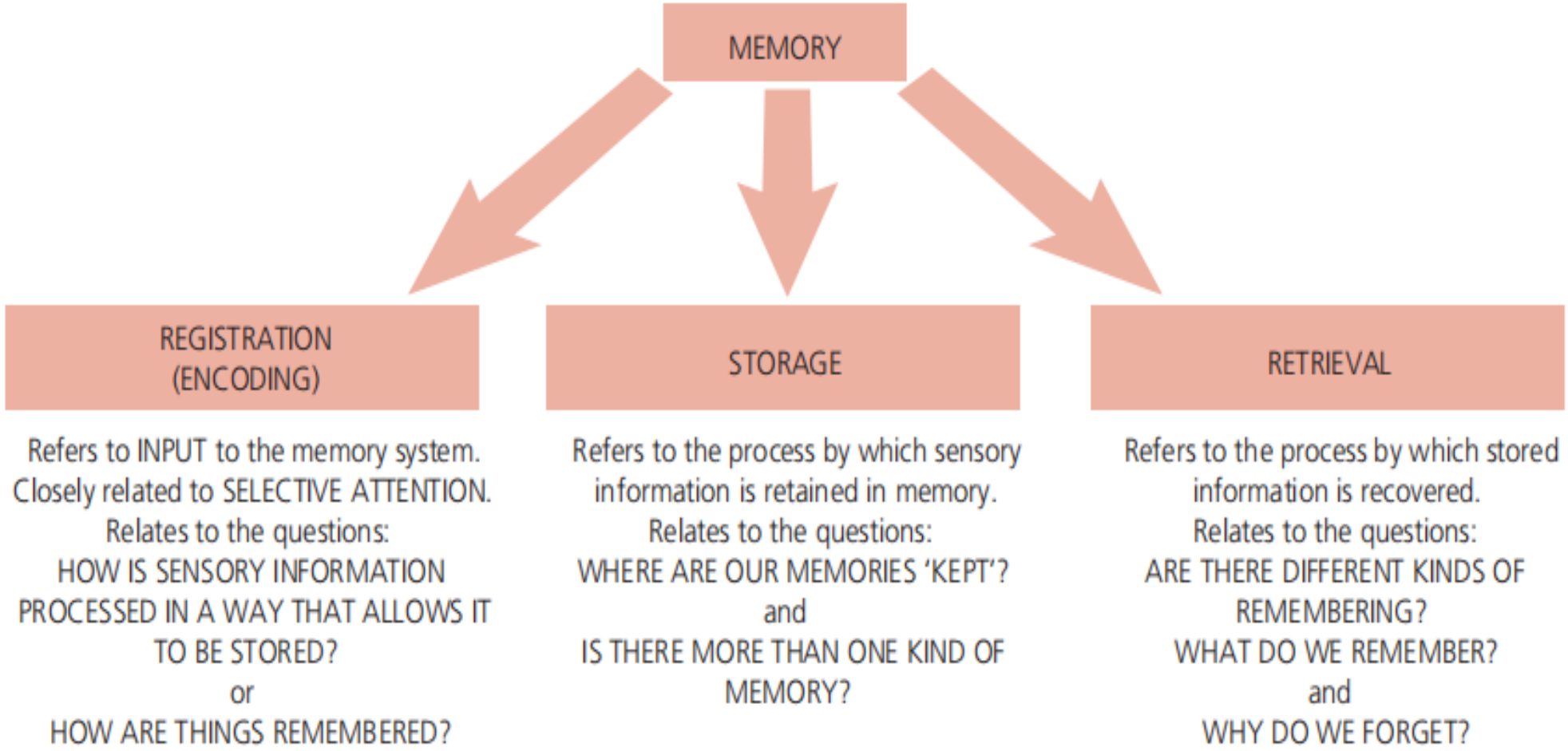


Figure 17.1 The three processes of memory

I - ENCODING (REGISTRATION)

Some information is encoded automatically without us being aware of it. Most people probably can recall what they had for breakfast yesterday, even though they haven't tried to remember it. Other information will only become encoded if you pay attention to it.

There are three ways of encoding information to be used by our memory system:

- **acoustic encoding** – encoding of sound
- **visual encoding** – encoding of picture images
- **semantic encoding** – encoding of meaning

Examples

Acoustic Encoding: If you are repeating someone’s phone number aloud.

Visual Encoding: Picturing the face of someone you met or imagining the layout of a room you visited.

Semantic Encoding: Understanding and recalling that "justice" means fairness or remembering the concept of "photosynthesis" as how plants make food.

II - STORAGE

- There are 3 forms of storage:

1. Sensory memory - This is the initial stage where sensory information (sight, sound, etc.) is briefly held for a very short period, typically less than a second to a few seconds. It acts as a buffer, allowing us to process and decide what to pay attention to.

2. Short-term memory - This holds information for a limited time, usually 20-30 seconds, and has a small capacity (about 5-9 items). It's where we actively think about or manipulate information, like remembering a phone number long enough to dial it.

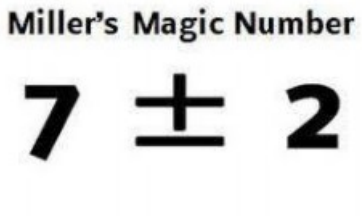
3. Long-term memory - This stores information for an extended period, potentially a lifetime, with a vast capacity. It includes knowledge, skills, and experiences, and is accessed when we recall past events or learned facts.

STM vs LTM

- **capacity** – how much information can be stored
- **duration** – how long the information can be held in storage
- **coding** – how sensory input is represented by the memory system.

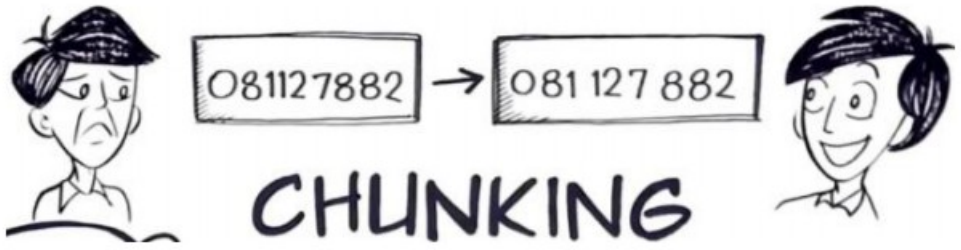
Short-term memory CAPACITY

- George Miller (1956) emphasized that the capacity of the STM is approximately “seven plus or minus two” pieces of information – digits, words etc. (the magic number 7+/-2).



Short-term memory CAPACITY

Chunking of information can lead to an increase in the STM capacity. This is the reason why a hyphenated phone number is EASIER to remember than a single long number.



Short-term memory DURATION

The duration of STM is thought to be **15-30 seconds**. If information is not rehearsed within 18 to 30 seconds whilst in STM, it is lost due to its limited duration. Short-term memory encodes information **acoustically** through repetition of information. If we rehearse (repeat) this information (say it over and over to ourselves), we can store it in our short-term memory for many minutes and it can then be transferred to the long-term memory store (almost indefinitely) (Peterson & Peterson, 1959).

Short-term memory CODING

- Mainly **acoustic** (e.g. When you try to remember a phone number by repeating it in your head); Some **semantic** (encoding by meaning); **Visual** is also possible (e.g. briefly remembering an image or shape.)

Long-term memory CAPACITY & DURATION

The capacity of LTM could be **unlimited** as it can hold a potentially unlimited amount of information.

Duration: Long-term memory can store memories for minutes or up to an **entire lifetime.**

Long-term memory CODING

Encoding in long-term memory is largely **semantic** (e.g. You remember that “a whale is a mammal” because of what it means, not how it sounds), but can be **visual** (e.g. remembering what your childhood home looks like) or **acoustic** (e.g. remembering the tune of a favorite song).

	Capacity	Duration	Coding
STM	Seven bits of (unrelated) information. Can be increased through *chunking*	15–30 seconds (unaided). Can be increased by (maintenance) rehearsal	Mainly acoustic. Some semantic. Visual is also possible
LTM	Unlimited	From a few seconds to several years (perhaps permanently)	Semantic, visual, acoustic, and also olfactory (smells) and gustatory (tastes). Very flexible

RETRIEVAL

Retrieval refers to getting information out of storage. If we cannot remember something, it may be because we are unable to retrieve it.

e.g. Ebbinghaus study (1885)

e.g. Standing study (1973)

Pure memory (Ebbinghaus, 1885)

- To study memory in its 'purest' form, Ebbinghaus invented three-letter nonsense syllables (a consonant followed by a vowel followed by another consonant, such as XUT and JEQ).
- Ebbinghaus spent several years using only himself as the subject of his research. He read lists of nonsense syllables out loud, and when he felt he'd recited a list sufficiently to retain it, he tested himself. If he could recite a list correctly *twice* in succession, he considered it to be learned. After recording the time taken to learn a list, he then began another one.
- After specific periods of time, he'd return to a particular list and try to memorise it again. He calculated the number of attempts (or trials) it took him to relearn the list, as a percentage of the number of trials it had originally taken to learn it (a *savings score*).
- He found that memory declines sharply at first, but then levels off. For example, in one set of experiments involving a series of eight different lists of 13 nonsense syllables, he found savings scores of:
  - 58 per cent, 20 minutes after training
  - 44 per cent, 60 minutes after training
  - 34 per cent, 24 hours after training
  - 21 per cent, 31 days after training.

... Thus, most of the memory loss occurred within the first minutes after training; once the memory had survived this hurdle it seemed much more stable ... (Rose, 2003)

This finding has subsequently been replicated many times.

Recognising how to ask people to remember (Standing, 1973)

- Participants were shown series of slides of either pictures or words (20 or so per series), each slide for five seconds, and each series at three-minute intervals. Two days later they were shown further series of slides using a double projector. Thus they saw two pictures side by side, one taken from the original series, the other being new. They had to indicate which looked more familiar.
- Amazingly, as the number of images went on increasing up to 10,000, the error rate didn't seem to increase at all with the number of items to be remembered. Standing concluded that, for all practical purposes, there's no upper limit to memory capacity.
- Contrary to the evidence that there are limits to what's transferred from STM to LTM (see text below), it seems that some accessible trace of each item must have been left – enough to enable a new item to be compared with the trace and classified as familiar or unfamiliar. According to Rose (2003):

... On this basis, it could be argued that nothing is forgotten, provided we know how to ask if it is remembered ...

The Multi-Store Model (MSM)

Richard Atkinson and Richard Shiffrin developed the Multi-store Model of Memory (1968) by drawing conclusions from memory experiments conducted by other researchers. This model is a structural model and Atkinson and Shiffrin described memory as having separate stores.

By pulling together this research, they were able to identify **three distinctly different** stores in our memory system:

- the sensory register (or sensory memory)
- short-term memory
- long-term memory

The Multi-Store Model (MSM)

Atkinson and Shiffrin proposed that memory stores differ from each other in the way information is encoded, their capacity and duration, and how information is retrieved.

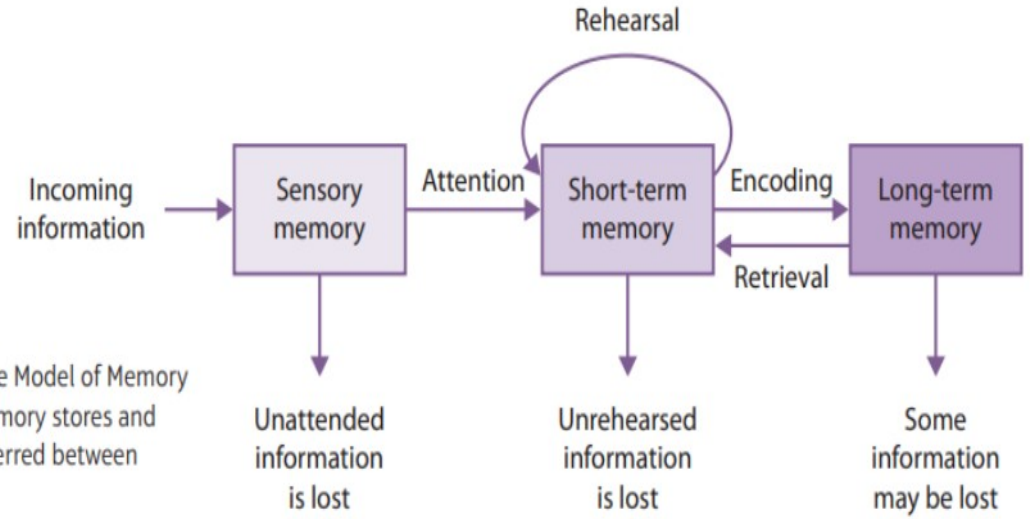


Figure 2.1 The Multi-store Model of Memory shows three separate memory stores and how memories are transferred between each store

Experimental studies of STM and LTM

1. Experimental studies of STM and LTM
2. Studies of coding
3. Studies of brain-damaged patients.

1. Experimental studies of STM and LTM

The Serial Position Effect (Murdock, 1962): Participants typically recalled those items from the end of the list first, and got more of these correct than earlier items (**the recency effect**). Items from the beginning of the list were recalled quite well relative to those in the middle (**the primacy effect**), but not as well as those at the end. Poorest recall is for items in the middle.

Primacy effect due to LTM, recency effect due to STM.

2. Studies of coding

Remember acoustic coding in STM, semantic coding in LTM!

However, Miller and Selfridge (1950) has demonstrated that knowledge of semantic and grammatical structure (presumably stored in LTM) is used to aid recall from STM. Therefore, an acoustic code isn't the only one used in STM.

3. Studies of brain-damaged patients.

If STM and LTM really are distinct, then there should be certain kinds of brain damage which impair one without affecting the other. One such form of brain damage is anterograde amnesia.

HM case where after the brain operation, he was unable to form new explicit long-term memories, however his immediate or working memory remained functional (STM intact, old LTM intact, new LTM severely impaired).

HM's deficits strongly support the MSM by demonstrating a clear dissociation between STM and LTM, suggesting they are separate systems

Episodic, Semantic & Procedural Memory

- The multi-store model of memory, as supported by cases like HM, distinguishes between short-term and long-term memory, with long-term memory (LTM) further divided into subtypes based on the type of information stored and how it is retrieved. The three main types of long-term memory are episodic, semantic, and procedural.

Episodic Memory

- The storage and recall of personally experienced events tied to specific times and places. These are autobiographical memories that include contextual details (e.g., "what," "when," "where," and associated emotions). It is a type of explicit (declarative) memory, meaning it can be consciously recalled and described.
- **Autobiographical episodic memory -** Personal, specific events from one's life with rich contextual details (e.g., Recalling your first day of university, what your lecturer looked like, and how you felt.)
- **Flashbulb Memories**: Highly vivid, detailed memories of emotionally significant events (e.g., Recalling how you felt when you found out about the death of a celebrity or leader (e.g., Michael Jackson, Princess Diana).

Semantic Memory

- Involves the storage of general knowledge, facts, and concepts not tied to personal experiences or specific contexts. It is also an explicit (declarative) memory type, consciously recalled, but lacks the temporal and spatial specificity of episodic memory.
- e.g. knowing that 2+2=4 or that "cat" refers to a furry animal

Procedural Memory

- Involves the unconscious recall of skills, habits, and motor routines learned through practice. It is a type of implicit (non-declarative) memory, meaning it is expressed through performance rather than conscious recollection.
- e.g. riding a bicycle, chess player recognizing patterns, brushing teeth in the morning,

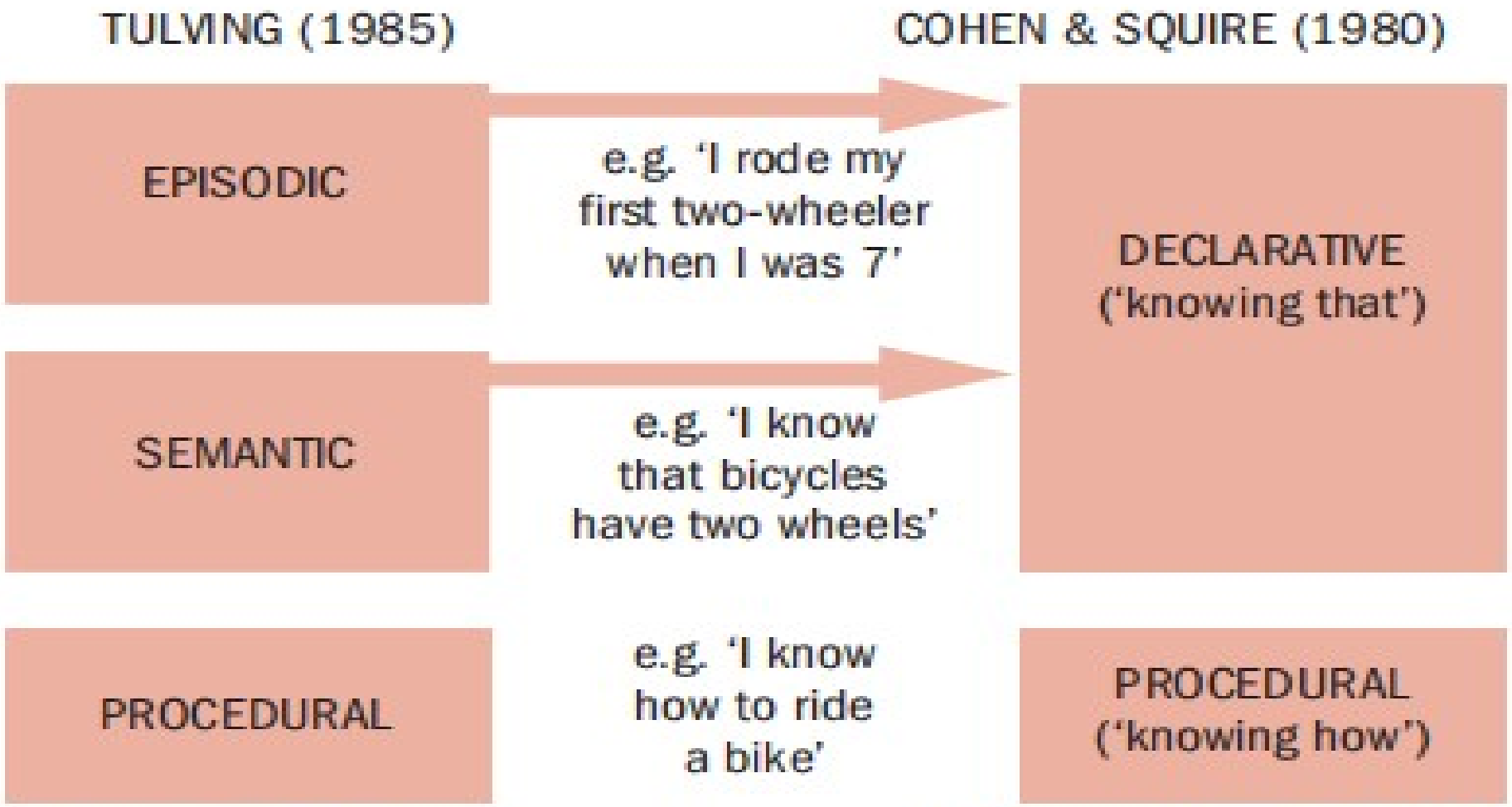
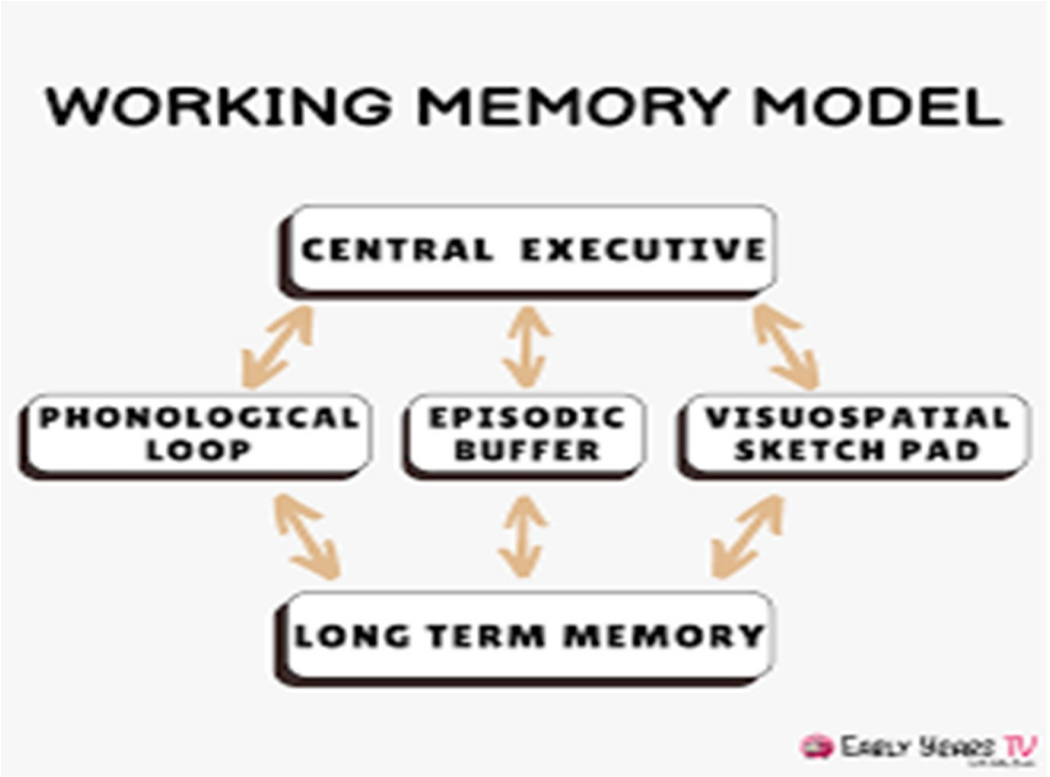


Figure 17.6 Distinctions between different kinds of LTM

The Working Memory Model (WMM)

- Baddeley & Hitch (1974; 2000) - this model focuses on how short-term memory (STM) actually works in practice. Instead of being just a “storage box,” it’s seen as an active system that manipulates and processes information.
- **Central executive**: Acts like a manager; Directs attention and coordinates the other subsystems; Has limited capacity.
- **Phonological Loop**: stores spoken words for a short time; allows rehearsal
- **Visuo-Spatial Sketchpad**: Holds and manipulates images
- **Episodic Buffer**: Integrates information from different sources (sound, vision, long-term memory) into a single “episode.”



MSM vs WMM

- **Multi-Store Model** - STM is a single, passive store; focus on the structure of memory (where info goes); Simple, linear, “box-like” model.
  - e.g. remembering a shopping list - You hear the list of items → it enters sensory memory → you rehearse it in STM (silently repeat “milk, eggs, bread”) → with enough rehearsal, it transfers to LTM.

- **Working-Memory Model** - STM is an active system with multiple components; focus on the process of memory (how info is handled); More detailed and dynamic model.
  - e.g. remembering a shopping list - Phonological Loop: you repeat “milk, eggs, bread” in your head; Central Executive: focuses your attention and tells you not to get distracted; Episodic Buffer: links “milk” with the image of the fridge at home being empty.

The Levels of Processing Model (LOP)

- Remember MSM argues we need to reherse the information in order to transfer it from STM to LTM. However, Jenkins (1974) **Incidental learning** - remembering without rehersing. Craik and Lockhart (1972) argues what matters is the kind of rehearsal or processing.
- **So, rather than rehearsal in STM, you can achieve LTM via deep, semantic processing.**
- e.g. If you're trying to remember the word "elephant":

MSM → You repeat "elephant" in STM until it transfers to LTM.

LOP → You think about what an elephant looks like, how big it is, or connect it with the zoo (semantic processing), which makes it memorable.

Key evidence LOP

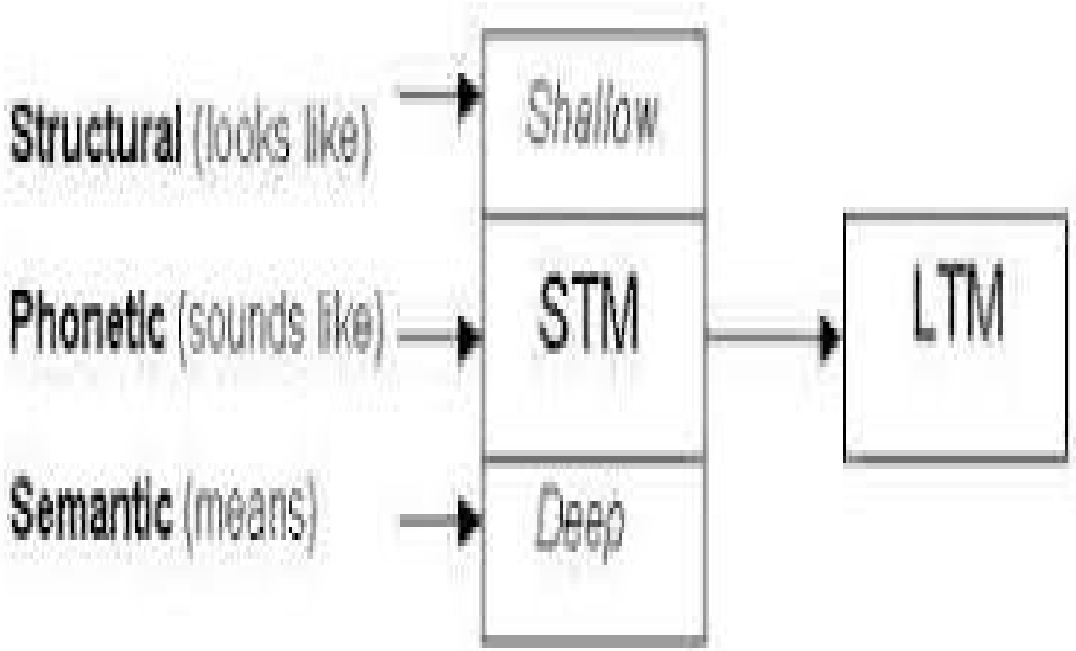
Craik & Tulving (1975): Participants were given a list of words, but instead of being asked to memorize them, they answered different kinds of questions about each word. The questions encouraged different levels of processing:

Shallow (structural) → e.g., "Is the word in capital letters?"

Intermediate (phonemic) → e.g., "Does the word rhyme with 'cat'?"

Deep (semantic) → e.g., "Does the word fit in this sentence: 'The _____ walked into the room'?"

- After answering these questions, participants were given a surprise recognition test (asked which words they had seen before).
- Words processed at a deep, semantic level were remembered much better than words processed at shallow or phonemic levels. **Depth of processing, not just rehearsal, determines how well information is remembered** (STRONG EVIDENCE AGAINST MSM!).


Structural (looks like)
Phonetic (sounds like)
Semantic (means)
Shallow
STM
Deep
LTM

Theories of Forgetting

- Forgetting can occur at the encoding, storage or retrieval stages.
- What prevents information staying in STM long enough to be transferred to LTM?
  - **Decay theory**: Suggests that memories fade over time if they are not accessed or rehearsed **(STM + LTM)**
  - **Displacement theory**: new incoming information pushes out older information as we exceed the limited capacity of **STM**
  - **Interference theory:** forgetting occurs when new or old information disrupts the recall of other memories **(LTM)**. There are two types:
    - **Proactive Interference**: When old information interferes with learning or remembering new information. *For example, if you used to have an old phone number and it keeps popping into your mind when you try to recall your new one AND Learning a new password is harder because your old password keeps coming to mind..*
    - ***Retroactive Interference****: When new information interferes with the ability to recall older information. For instance, learning a new language might make it harder to remember vocabulary from a previously learned language AND You learn new dance steps, then forget some of the old ones..*

	Capacity	Duration	Encoding	Forgetting
Short-term memory	Around seven bits of information	Around 18 seconds without rehearsal	Acoustic	Displacement Decay
Long-term memory	Potentially limitless	A few minutes to a lifetime	Mainly semantic	Decay Interference Retrieval failure

Efficient forgetting?

- According to Schacter (2002), efficient forgetting is a crucial part of having a fully functioning memory; this is lacking in people with hyperthymestic syndrome (or highly superior autobiographical memory/HSAM).

The Case of A.J. (Parker *et al.*, 2006)

- A 42-year-old woman from California, A.J. (real name, Jill Price) remembers every day of her life since her teens in extraordinary detail. Mention any date since 1980, and she's immediately transported back in time, picturing where she was, what she was doing, and what made the news that day. She can also identify the day of the week for any date since 1980 and give the correct date for apparently insignificant events.
- She's locked in a cycle of remembering that she describes as 'running a movie that never stops'. She describes her constant recall as 'non-stop, uncontrollable and totally exhausting' and as a 'burden' of which she's both warden and victim.

Lecture Summary

- What is memory? Encoding, storage, retrieval
- The Multi-Store Model (MSM) – Atkinson & Shiffrin
- Episodic, Semantic and Procedural memory
- The Working Memory Model (WMM) - Baddeley & Hitch
- The Levels of Processing Model (LOP) - Craik and Lockhart
- Theories of Forgetting – Decay, displacement, interference