



Cognitive Processes

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The effect of brain damage on memory

- The brain is divided into two **hemispheres**, left and right and is covered by a thin layer known as the **cerebral cortex**
- The brain has four main **lobes**, each of which regulates and controls specific functions:
 - **The frontal lobe**
 - **The parietal lobe**
 - **The occipital lobe**
 - **The temporal lobe**
- Each lobe is **divided** between the two hemispheres
 - There is **symmetry** in the brain, with each lobe **mirroring** itself on the right/left hemisphere
- As each hemisphere is responsible for different functions then each lobe is also responsible for different functions too

Cognitive neuroscience

- **Cognitive neuroscience** is the **scientific** study of brain **structure** and **function** and how these relate to behaviour
 - E.g., movement, impulse control, memory, perception
- Cognitive neuroscience is relevant to the **localisation of brain function** as it seeks to '**map out**' the brain in terms of which structures and functions can be linked to specific behaviours
- If the brain is damaged then the functions which are associated with specific structures may subsequently become **impaired**
 - E.g., damage to the region in the left hemisphere known as **Broca's area** would result in someone having difficulty producing **fluent speech**
 - damage to the **pre-frontal cortex** would result in someone exhibiting a changed **personality**, possibly becoming more aggressive or impulsive

Research support for the effect of brain damage on memory

Milner (1958); Scoville (1997)

Aim:

- To investigate **memory loss** in a brain-damaged patient known as HM via examination of his brain **post-mortem** and via **MRI**.



Participant:

- The patient known as 'HM' (Henry Molaison) had been run over by a bicycle at the age of nine, which resulted in him experiencing **epileptic seizures**
- At the age of 27 he underwent a **bilateral medial temporal lobe resection**, which involved the removal of about two-thirds of his **hippocampus**
- HM's epilepsy improved but he began to suffer extreme **anterograde amnesia** and partial **retrograde amnesia**
 - He completely lost the ability to **form new memories** while **long-term** memories from the past remained reasonably **intact**

Procedure:

- HM was initially studied by Brenda Milner, who visited HM frequently, administering a range of **tests and measures**, including **psychiatric** tests such as **personality and mood** tests, depression **questionnaires**, and **interviews** with psychiatrists
- His scores did not indicate depression, anxiety or psychosis and he communicated a good awareness of his condition (i.e., he knew that he was suffering from anterograde amnesia)
- He completed a standard **IQ** test on which his score was normal; however, his scores on the **Wechsler Memory Scale** test demonstrated his **severe memory impairment**
- Milner noted that:
 - he frequently forgot what had happened that day
 - he thought he was younger than his actual age
 - he forgot the names of people he had just met
 - he commented that every day felt as if he was just waking up from a dream
- MRI scans on HM's brain conducted in 1992–1993 confirmed that HM's medial temporal lobe had been particularly affected by the surgery
- Milner and Corkin studied him for over 50 years until his death at the age of 82

Results:

- The key finding from the study of HM is that memory is not simply part and parcel of a collection of **cognitive** functions which reside in the **cortex**
 - It is a **distinct function** which is **localised** to the temporal lobe, specifically the hippocampus

Conclusion:

- Hippocampal damage may be linked to long-term anterograde amnesia
- The findings support localisation of brain function, as the formation of new memories is linked to the hippocampus

Evaluation of the effect of brain damage on memory



Strengths

- The **case study** of HM employed both **qualitative** and **quantitative methods**, generating both **reliable and explanatory data**
- The case of HM was groundbreaking in providing huge insight into localised regions of the brain

Limitations

- One possible **confounding variable** could be that HM's brain was already damaged due to his epilepsy, which would decrease the validity of the findings
- Not enough is known about the brain for researchers to form iron-clad conclusions as to exactly which functions are impacted by brain damage

Link to concepts

Bias

- Case studies usually involve one or more researchers working closely with a single participant, which runs the risk of researcher bias affecting the researcher's **objectivity and impartiality**
- Becoming too close to the participant means that the researcher may over-report some findings and under-report others (possibly because of a sense of duty towards the participant, i.e., not wanting to show them in a negative light)
- Researchers must practise reflexivity throughout the research process so as to ensure that the results are credible

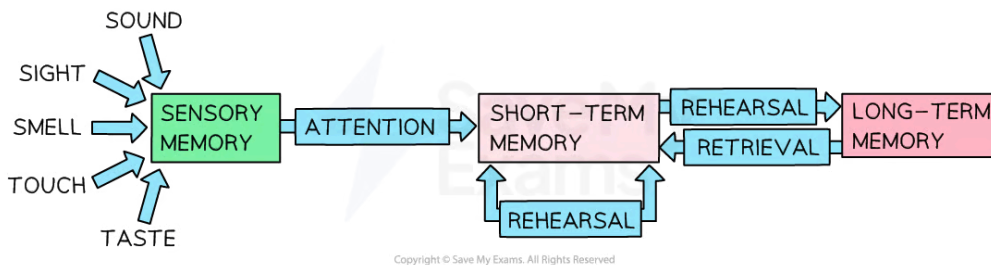
Responsibility

- When investigating topics such as the effect of brain damage on memory, it is vital that researchers are mindful of the **potential for harm** that they may (unwittingly) inflict on the participant
- With the case of HM the researchers were dealing with a **vulnerable person** who had no recollection of recent events (not even recognising the researchers themselves) and who had to live under supervision due to his catastrophic memory loss
- One **ethical consideration** that is problematic is that of **informed consent**
 - How could HM consent to something that he would instantly forget?
 - M's mother initially gave consent (known as **consent by proxy**) for the research to take place, followed by a court-appointed conservator, after his mother's death
 - HM's family, however, **contested** this and argued that he never willingly gave consent to be studied, which illustrates the **sensitive nature** of this type of research



The multi-store model of memory

- The **multi-store model of memory (MSM)** was devised by **Atkinson & Shiffrin (1968)** as a way of **conceptualising** the processes by which memories are **encoded**, stored and lost
- Information flows **linearly**: from the **sensory register (SR)** → **short-term memory (STM)** → **long-term memory (LTM)**
- Without rehearsal, information is quickly lost
- The model consists of three separate storage units:
 - the **sensory memory/register**;
 - **short-term memory (STM)** and
 - **long-term memory (LTM)**



The sensory register (SR)

- This is the point at which **environmental stimuli** are picked up by the five senses (sight, sound, smell, touch, taste)
- Sounds are encoded in the SR as **echoic memory** and images are encoded as **iconic memory**
- This environmental information is held onto for a fraction of a second, i.e., its **duration** is half a second at most
- Any information in the SR that is noticed or paid **attention** to is then passed onto STM

Short-term memory (STM)

- This is a **temporary** storage facility which has a limited **duration** and **capacity**
- The capacity of STM is **7 items, + or - 2**, according to **Miller's 'magic number 7' theory**
- The duration of STM is up to around **30 seconds**
- New information entering the STM from the SR pushes existing information out due to the limited duration and capacity of the STM



- E.g., you go into a room to find a book then you notice that your cat is on your bed; by the time you have moved the cat from your bed you have forgotten what it is you came into the room for
- In order to transfer information to LTM it is necessary to **rehearse** it
 - **Maintenance rehearsal** is a **shallow** form of rehearsal, as it simply requires you to repeat information verbally for long enough to be able to use it
 - E.g., on the way to the shop you keep telling yourself, 'Don't forget to buy milk'
 - **Elaborate rehearsal** is a **deep** form of rehearsal, as it requires you to learn information in several ways
 - E.g., repetition, **reframing** the information, writing the information down, **and reinterpreting** the information
- Information which is not rehearsed will be lost from STM via **displacement**
- Encoding in STM happens **acoustically** i.e., via **sound**
- STM can be improved by the process of '**chunking**' information
 - E.g., a phone number can be chunked into groups of three digits (e.g., 485 362 971 886) so that it is easier to 'digest' and thus to recall

Long-term memory (LTM)

- This is a **permanent** storage facility, holding a vast number of memories, some of which you may not even know are there
- Both the **capacity** and the **duration** of LTM is not really known but researchers agree that both may be limitless
- LTM is difficult to research (unlike STM which can be studied using **lab experiments**)
- Information may **decay** in LTM if it is not visited frequently or if the **cues** to **retrieve** it are missing
- Encoding in LTM happens **semantically** i.e., via **meaning**

Serial position effect & the MSM

- **Serial position** describes the placement of an item in a list
 - E.g., whether it's 1st, 2nd, 3rd, last, etc.
- Research suggests that the position of an item on a list affects how well it is remembered
- When people are presented with a list of items (e.g., words), they tend to remember the **first** few items on the list and the **last** few items on the list
 - items in the **middle** of the list are more likely to be **forgetten**
- This is known as the **serial position effect (SPE)**
 - The **primacy effect** is when items from the **beginning** of a list are recalled best compared to items in the middle



- The **recency effect** is when items from the **end** of a list are recalled best compared to items in the middle
- SPE has **relevance to the MSM** because:
 - it provides evidence for STM (linked to the recency effect: items most recently seen/heard and are still in STM)
 - it provides evidence for LTM (linked to the primacy effect: items seen/heard first have transferred to LTM)
 - items in the middle have not been rehearsed and have been displaced by the more recent items

Research which supports the MSM

Glanzer & Cunitz (1966)

Aim:

- To investigate SPE as evidence for there being two separate stores of memory (STM and LTM), which supports the MSM

Participants:

- 46 males who were all enlisted in the US army

Procedure:

- Each participant was individually shown 15 lists, each containing 15 words. There were three **conditions** of the **independent variable**:
 - **Immediate recall** after being shown the list
 - Recall after a **10-second interference task** (the **Brown-Peterson** technique of counting backwards aloud from a given number in 3s)
 - Recall after a **30-second interference task** (the **Brown-Peterson** technique of counting backwards aloud from a given number in 3s)

Results:

- Participants in the **immediate recall condition** showed the expected SPE – more items recalled from the beginning and the end of the list, showing **both** primacy and recency effect
- Participants in the **10-second delay condition** showed a similar primacy effect to the immediate recall group but much less of a recency effect
- In the **30-second delay condition** the primacy effect was high but the recency effect had **disappeared**, with fewest items recalled from the end of the list compared to the other two conditions

Conclusion:

- Prevention of rehearsal (eliminating the recency effect), means that items from the end of a list cannot be rehearsed in STM so they cannot be transferred to LTM
- There appear to be **two separate storage facilities** for STM and LTM

Evaluation of the MSM

Strengths

- This was the first model to attempt to conceptualise memory and it paved the way for further research in this field
- The existence of separate memory stores has been supported by lab experiments and by more than one case study (see also the [case of HM](#) for further details)

Limitations

- As the MSM is a linear model it lacks **flexibility** and **dynamism**
 - It presents STM and LTM as **static** stores without explaining how they **operate**
- Subsequent research has identified that there is more than one type of LTM:
 - **episodic memory** contains information from your own **personal** history, e.g., birthday parties
 - **procedural memory** contains information that helps you to **perform** actions such as riding a bike or playing the piano
 - **semantic memory** contains information as to **meaning**, e.g., knowledge about the world (e.g., Paris is the capital of France)

Link to concepts

Causality

- Research into the MSM has been largely lab-based with the implementation of a clear, operationalised independent variable and a dependent variable which is measured quantitatively and so can withstand statistical analysis
 - This means that the research tends to be **objective** and appropriate for **hypothesis-testing**, adhering to the **features of science**
 - Humans, though, are not easily quantified, so lab-based research can lose a lot in translation
 - It cannot fully convey real experience (in the case of memory, it cannot explain how some memories do not need to be rehearsed but instead go directly into LTM)

Causality

- The MSM is a conceptual cognitive model, an example of machine reductionism
- It could be argued that the MSM is an overly **contrived** attempt to make direct comparisons between a computer/machine and human memory
 - The comparison is **artificial and forced**
 - Human memory is often **unpredictable, multi-faceted** and affected by **emotion** (e.g., flashbulb memories)

- A computer is not designed to respond in the same way as a person might, which means that the MSM only has limited **application** to human memory

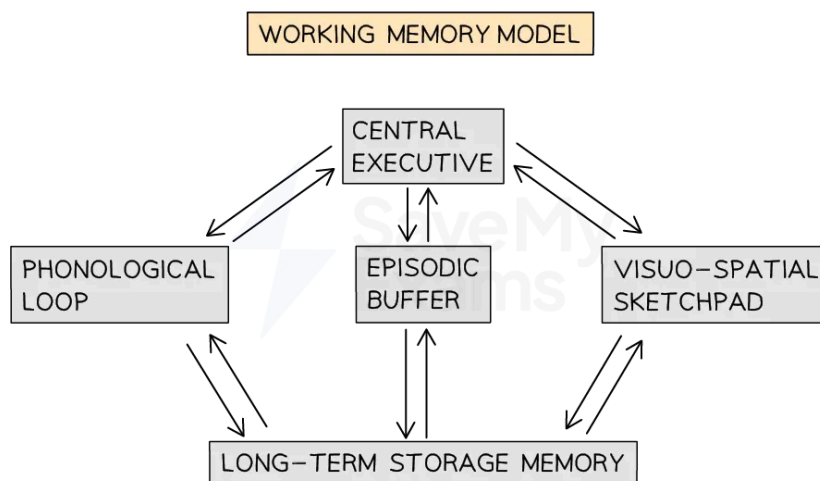


Your notes



The working memory model (WMM)

- The **Working Memory Model (WMM)** was devised by **Baddeley & Hitch (1974)** as a more **dynamic** and **flexible** model of memory
- The WMM focuses on **short-term memory (STM)** only; there is no provision made for the functions or types of **long-term memory** it only aims to explain the 'here and now' of memory
- The WMM sees STM as a **complex information processor** rather than as a static unitary store
- The WMM is composed of four units:
 - the **central executive (CE)**
 - the **phonological loop (PL)**
 - the **visuospatial sketchpad (VSS)** with the
 - **episodic buffer (EB)**, which was added much later on in 2000



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The Working Memory Model

The central executive (CE)

- This is the driving force of the WMM as it decides which tasks are to be assigned to which specific **slave systems**, rather like the managing director of a company
- The CE is not so much a memory store but a '**command centre**', as it plays a key role in **controlling** the processes of working memory
- Although the CE is probably the most important element of the WMM it is very difficult to **test** (unlike the VSS and the PL)



- The CE decides which information to pay **attention** to and which information to ignore and it then directs the slave systems accordingly

The phonological loop (PL)

- This slave system attends to and organises **acoustic** information in the form of spoken or written information
 - E.g., written words are **encoded** via vocalising them in the mind so that visual information becomes acoustic information
- The PL can be divided into two parts:
 - the **phonological store**
 - the **articulatory control system**
- The phonological store is the '**inner ear**' of the WMM as it processes and stores acoustic, speech-based information for a very short **duration** (a couple of seconds)
- The articulatory control system translates **written words** into **speech** so that they can then be kept in the phonological store in a kind of loop or 'holding pattern'
 - E.g., **repeating** a phone number over and over again until we can put it into our phone

The visuospatial sketchpad (VSS)

- This slave system attends to and organises **visual** and **spatial** information
 - E.g., the **colour** of a flower, the **arrangement** of windows and doors in a house
- The VSS is used when someone recognises a friend or when they give directions to a stranger
- The VSS can be divided into two parts:
 - the **visual cache**
 - the **inner scribe**
- The visual cache is the '**inner eye**' of the WMM as it stores information about form and colour
 - E.g., a purple triangle, a tall white vase
- The inner scribe contains spatial and **movement-related information**
 - E.g., how to get from one side of a crowded room to the other
- The inner scribe **rehearses** information which is then stored in the **visual cache**

The episodic buffer (EB)

- This slave system was added to the model in 2000 as a way of acknowledging that the CE and slave systems have to **communicate** with LTM in order to be able to function effectively



- WM must be able to respond to the **current** situation – not being able to remember which side of the road to drive on, for example, could cause all sorts of problems!
- The EB arranges information into 'packets'
 - When required it moves this information to the slave systems in a set sequence
 - Events occur **continuously** rather than seeming out of joint (e.g., if you are having a conversation, you see the other person speaking at the same time as their lips move)

Cognitive load & the WMM

- **Cognitive load theory (CLT)** proposes that working memory has a **limited capability** for processing new information
- CLT suggests that learning and task success are impaired when WM is overloaded, as it does not have the capacity to handle too much **competing** information at any given moment
 - In other words, the load is too heavy for WM to cope with
- A demonstration of CL can be seen in **dual-task** studies which test the assumptions of the WMM
- A dual-task procedure is where participants perform **two tasks simultaneously** to investigate how they **compete** for cognitive resources
 - E.g., drawing a picture whilst listening to music/drawing a picture whilst trying to mentally visualise different shapes
- This method is used to assess the effect of **divided attention** on performance and to understand cognitive load

Research which supports cognitive load theory & the WMM

Baddeley et al. (1973)

Aim:

- To investigate the existence of the **VSS** and the **PL** as separate components in the **Working Memory Model** by using a **dual-task activity** (dual-task study)

Procedure:

- A dual-task **lab experiment** in which participants were given a tracking task (following a spot of light with a pointer around a circular path) while imagining block capitals in their heads, such as H, T, F and E.
 - **Condition A:**
 - Participants were asked to start at the bottom left-hand corner of the path and to begin tracking the light
 - They were asked to give **verbal yes/no responses** about features of an imagined block capital (e.g., does it have a top/middle/bottom line?)



- So, if the participant was thinking of the letter 'F', then they would respond that yes, it had a top and a middle line but no bottom line
- They did this while tracking the spot of light
- **Condition B:**
 - The participants were asked to track a light and were then told to imagine one of the letters, 'F' for example
 - While they were tracking the pattern, they were asked, 'Does this letter have a top line/middle line/bottom line in it?'
 - They were asked to silently visualise letter features while tracking the light

Results:

- Participants in condition B experienced **great difficulty** in tracking the spot of light and, at the same time, accurately identifying in their head whether the letter had a top/middle/bottom line
- Tracking and letter imagery tasks were **competing** for the limited resources of the VSS, whereas the tracking and verbal tasks in condition 1 (responding verbally whilst visualising the letter) used separate components: the VSS and PL

Conclusion:

- There may be separate slave systems – the VSS and the PL – which operate in working memory
- Overloading one of the slave systems with two tasks means that it cannot **function** properly

Evaluation of cognitive load theory & the WMM

Strengths

- Dual-task research is **replicable** as most studies are **lab-based** and use **standardised procedures** which can be **replicated** to check for **consistency (reliability)**
- The study focuses on the dynamic nature of working memory, as it demonstrates how memory is used in the moment in order to complete a complex task

Limitations

- As the participants had to visualise each letter in their heads, there is the possibility that they became distracted and thought of other things, which would mean that the study lacks **validity**
- **Extraneous variables** might **confound** the findings of dual-task research
 - E.g., some people have naturally better memories or concentration spans than others; some people are more visual or more auditory learners; some people are **dyslexic/dyspraxic**
 - This means that the findings may not be due to cognitive load; thus, the research may not account for **individual differences**

Link to concepts

Perspective

- The WMM provides a much more detailed and dynamic model of STM than the MSM
- It explains how different processes in memory
 - E.g., response to acoustic and visual information occur at the same time rather than conceptualising memory in a **linear, static** fashion
- Most researchers will only refer to 'working memory' rather than 'short-term memory', as the term evokes the 'here-and-now' nature of WM
 - It is working hard to process a lot of information using restricted duration and capacity

Causality

- There is very little **insight** or evidence as to how the CE functions in terms of directing attention towards the slave systems
- The CE is **almost impossible** to test, so the concept of the CE remains **hypothetical** whereas the VSS and PL are easier to measure and test
- Additionally, by not properly explaining the role of LTM in WM means that the WMM is limited and ignores **key factors** as to how LTM and the EB combine to facilitate the operations of WM



Your notes

Comparison of the Multi-store Model & the Working Memory Model



Your notes

Comparison of the MSM & the WMM

Similarities	Differences
Both models conceptualise memory, i.e., they are both cognitive models.	The MSM sees memory as unitary stores , whereas the WMM conceptualises memory as a dynamic, flexible process.
Both models include detail as to the capacity and duration of each store/component.	The MSM includes a rehearsal loop for transferring information from STM to LTM whereas the WMM is vague about LTM.
Both models are supported by lab experiments (e.g., Glanzer & Cunitz; Baddeley) and case studies of brain-damaged patients (e.g., HM, KF)	The MSM is supported by serial position effect lab studies, whereas the WMM however, is supported by dual-task studies .
Lab-based research to support both models lacks mundane realism (artificial tasks) and case studies lack generalisability (one participant).	The WMM can explain parallel processing of information via the VSS and the PL, which the MSM fails to do.
The capacity and function of the CE and EB have never been measured nor has the exact duration and capacity of LTM.	The WMM only involves STM, so it is not a full model of memory like the MSM. It does not explain changes in processing ability that occur as the result of practice or time .

Link to concepts

Perspective

- The concept of WM is very **useful** in terms of understanding how people attend to the 'here and now', which can be applied to **educational and clinical settings**
 - E.g., testing **cognitive ability** or possible **deficits** in attention or information processing
 - The MSM does not have such a direct application to other settings

Bias

- It is possible that both models lack cultural relativism
 - They are **biased** to Westernised, rather than **collectivist**, concepts of memory

- Eastern collectivist cultures tend to focus on contextual information and **group/social relationships** in memory which may not fit neatly into a model or diagram
- The cognitive approach uses machine reductionism to depict human cognition
 - E.g., models of memory, which may not align with cultures where the 'human' element of memory is more important than the processes involved in its formation



Your notes



The effect of culture on memory

- **Culture** refers to the shared products of **socialisation** within a group, society or nation and involves a set of **rules, norms and customs** that members agree upon and follow
- Culture is **active**, not passive; individuals contribute to and are shaped by the cultures they experience
- Culture is a **bi-directional** process: people create culture and culture influence their development
- Culture is not **static**; it changes over time by advancing technologies, by social change, and geographical movement

Flashbulb memories & culture

- A **flashbulb memory (FBM)** is a vivid, long-lasting, **emotionally significant memory** triggered by a surprising or meaningful event
 - **Autobiographical** memories can be a type of FBM as many of these memories have great meaning attached to them due to their emotional nature
- FBMs are thought to be more **vivid, detailed, long-lasting** and **enduring** than everyday memories
- FBMs may be formed from **episodic events** in a person's life
 - E.g., winning a race, a birthday party, falling from a tree
- FBMs are described as being '**captured like a photograph**', stored in long-term memory for years or even a lifetime.

Research support for the effect of culture on memory

Wang et al. (2008)

Aim:

- To investigate autobiographical memory for childhood events in three culture groups

Participants:

- The participants were all college students
 - 101 participants from the USA
 - 104 participants from England
 - 97 participants from China (210 female; 92 male)

Procedure:

- The participants were **allocated** to small groups and were asked by a researcher to recall as many **childhood events** as possible from when they were five years old



- Each participant was then asked to recall:
 - the date when each event occurred
 - how old they were at the time of each event (to the nearest month)
- They were then asked to use a **five-point scale** to **rate** each memory in terms of its:
 - frequency as a **talking point** in their family
 - how **important** it was to them
 - how **clear**, detailed, emotional and positive/negative it was
 - **where** it came from (from themselves or from someone else)

Results:

- Participants from the USA recalled the **highest number** of memories from childhood
- Participants from England had the second highest recall rate
- Participants from China recalled the fewest childhood memories
- The Chinese participants recalled memories from a **later age** than did the American and English participants
- The best-remembered memories were those that had been **rehearsed** to some extent
- Most of the memories came from the individual rather than from others

Conclusion:

- Chinese people may be less prone to recalling **vivid** events from childhood than American or English people due to cultural influences
- American people are more likely to view their childhood from an **individualistic** perspective, i.e., what is relevant to the individual
- Chinese people are more likely to view their childhood from a **collectivist** perspective, i.e., what is relevant to the groups to which they belong

Evaluation of the effect of culture on memory

Strengths

- Culture permeates every aspect of a person's life (even if they are unaware of its reach), which means that research such as Wang's has good **external validity**
- Participants recalled childhood events within the same five-year time frame, which means that the researchers compared the frequency, number and quality of the memories across the 3 cultural groups
 - This means that **emerging patterns** could be clearly identified, which increases the **reliability** of the findings

Limitations

- **Individual differences** may have confounded the results:



- some of the participants may have had more eventful childhood experiences than others, making the memories more vivid and therefore easier to recall
- Some people have better memories than others, which is another individual difference not accounted for in Wang's study

Link to concepts

Causality

- In Wang's study participants were given only five minutes to collect their thoughts and retrieve childhood memories
 - This means that the findings could be the result of the **pressure** of trying to recall such events within a short period of time, which could have resulted in some **false** memories or in a temporary **loss** of a specific memory
 - Perhaps given more time the results would have been more similar across the groups

Bias

- Only one collectivist culture (China) was **represented** in the sample, whereas two individualist cultures were represented
 - This means that the findings are **biased** towards the individualistic cultures and may even suffer from an imposed etic, that is, a culturally-specific idea is wrongly imposed on another culture
 - E.g., the assumption is that autobiographical memory is experienced in ways which are only meaningful when given an individualistic perspective



The effect of learning on spatial memory

- The human brain is **hardwired to learn**:
 - It is naturally **curious**, seeking meaning and problem-solving opportunities
 - It is **primed to improve with practice**, strengthening skills over time
 - It learns by forming **neural connections**, creating pathways that support new learning
 - It is highly **adaptive**, constantly reshaping in response to environmental factors.
- This adaptability is known as **neuroplasticity**.

Neuroplasticity

- **Neuroplasticity** refers to the brain's ability to **adapt to change** from **injury, illness, learning, or experience**
- **Structural plasticity** refers to physical changes within the brain, such as increases in **grey matter** in regions engaged by repeated practice or experience
 - these changes are **gradual**, developing in proportion to the **extent of learning** or the **degree of damage**.

The build-up of grey matter reflects increased **synaptic connections** in active brain regions
- Plasticity means that the brain is not a **static, concrete mass**
 - It is a **flexible** organ that continually reorganises itself in response to environmental demands

Research which supports the effect of learning on spatial memory

Maguire et al. (2000)

Aim:

- To investigate neuroplasticity in **London black cab taxi drivers** as a result of experience in **spatial navigation** (a specific type of **memory**).

Participants:

- 16 healthy, right-handed male London black cab taxi drivers who had passed 'The Knowledge', a test of spatial navigation
- The sample was aged 32–62 years with a mean age of 44 years
- All participants been taxi drivers for at least 18 months, with the highest number of years as a taxi driver at 42 years



Procedure:

- The participants were placed in an **MRI** scanner and their brains were scanned
- The MRI measured the volume of **grey matter** in the **hippocampus** of each participant
- These scans were then compared to preexisting scans of 50 healthy, right-handed males who were not taxi drivers (the **control group**)
- Grey matter was measured using **voxel-based morphometry** (VBM), which focuses on the density of grey matter and **pixel counting**

Results:

- The **posterior hippocampi** of the taxi drivers showed a greater volume of grey matter than that of the controls
- The control group had increased grey matter in their **anterior hippocampi** compared to the taxi drivers
- Maguire also carried out a **correlational analysis** which showed a **positive correlation** between volume of posterior hippocampal grey matter and length of time spent as a taxi driver

Conclusion:

- The effect of learning (years spent as a taxi driver) may increase grey matter in the posterior hippocampus and this region of the brain may in turn be **localised** to spatial navigation/memory skills

Evaluation of the effect of learning on spatial memory

Strengths

- The study used a highly **controlled clinical** method (MRI) of obtaining **objective** data which could then be easily compared and analysed
 - This means that the study's findings should be **reliable**
- Understanding neuroplasticity can help aid the recovery of people who have suffered **brain damage**

Limitations

- A correlation cannot show cause-and-effect so it is impossible to know whether the taxi drivers already had naturally high levels of hippocampal grey matter
- The results are only **generalisable** to male, right-handed London taxi drivers so the nature of neuroplasticity in women is not known

Link to concepts

Causality

- MRI techniques have a high degree of **precision** in measuring specific brain structures but sophisticated technology alone cannot provide a full and rounded explanation of the effect of learning on specific behaviours



Your notes

- MRIs and similar technology can only identify correlations between brain and behaviour, and often these correlations are **mediated** by the environment and/or cognition
- Maguire's research may suffer from bidirectional ambiguity: was increased grey matter already present in the taxi drivers' brains or did it increase only due to time spent navigating the streets of London?

Measurement

- MRI scanning *should* be 100% accurate, precise and thus, reliable
- Research has shown, however, that some machines appear to be more precise than others
 - There may be a variety of potential **errors** in calibration or in response to external factors, such as the light level in the room, which may affect the measurement
- There is also the issue of **operator** error (humans can and do make mistakes)
 - The reliability of MRI scanning may depend on how well the researchers/operators handle the equipment and how knowledgeable they are in their understanding of the findings



The effect of cultural schemas on memory

- A **schema** is a **mental representation** of something
 - E.g., a schema for **concrete**, tangible things such as 'cat', 'house', 'mother' or for **abstract** ideas/concepts such as 'freedom', 'jealousy', 'love'
- A schema holds all of the information that an individual has **assimilated** over the course of their life so far, obtained via direct personal experience
 - E.g., watching a TV series about school life or via contact with others
 - parents telling you about their experience of school
- Schemas may give rise to **distorted memory**
- When you experience an event either directly or indirectly it is usual for **schematic activation** to guide your understanding/expectation of that event
- The problem with having set and pre-determined schemas is that they can **interfere** with accurate **recall**
 - This happens when someone recalls an event not as it truly happened but as a result of **schematic interference**
 - Their schemas 'got in the way' of 100% accurate recall of the event (generally people are unaware of this happening)
- Schemas may lead to **biased** recall
 - E.g., you are in a pub and there is a fight. the police ask you what you witnessed and you say that one man was bleeding but in fact this is not true
 - Your schema for 'fight' added blood at the scene because it fits your schema for 'fight'
- A **cultural schema** is assimilated via **enculturation**:
 - the products, influences, rituals, attitudes, habits and beliefs that someone builds up depending on the culture in which they were raised
- Cultural schemas may lead to incorrect and faulty recall of material which does not align with or fit into a person's schema based on their own culture, as the following study demonstrates:

Research support for schema theory

Bartlett (1932)

Aim:



- To investigate the effect of cultural schemas on recall of a **culturally unfamiliar** story

Participants:

- 20 male students from the University of Cambridge in the UK

Procedure:

- Bartlett instigated a procedure known as **serial reproduction**
 - One participant read a **Native American** folk story called 'The War of the Ghosts'
 - This participant then reproduced the story in writing
 - This version of the story was then read to a second person
 - The second person then wrote his own version of the story
 - This version was then read to a third person
 - This third person then produced his own version of the story and so on

Results:

- Bartlett found that the resulting stories bore **little similarity** to the original Native American folk tale. The changes made by the participants included:
 - **Omission**
 - Key details were ignored or dropped, especially **unfamiliar or unpleasant** ones, e.g.,
 - "Contorted face" or "black coming out of a mouth" were omitted
 - the central theme of **ghosts fighting** was often dropped, even though it was the story's title
 - Omission reflected how some details **did not fit with participants' schemas** (e.g., adult male views of war)
 - **Assimilation and sharpening**
 - Story details were changed to suit the participants' own cultural schemas e.g.,
 - 'canoes' became 'boats'
 - 'paddling' became 'rowing'
 - a spirit wound was **re-interpreted** as a flesh wound
 - Participants added words such as 'therefore' and 'because' to make sense of events
 - **Levelling**
 - The story became **shorter** and simpler
 - The original text was approximately 350 words but the participants' version was around 180 words



Conclusion:

- Cultural schemas contribute to the **reconstructive** nature of memory
- Memory is an active process in which pre-existing information and expectations may interfere with the accuracy and **reliability** of the memory

Evaluation of schema theory

Strengths

- Bartlett's study was one of the first pieces of research to **highlight** the role of schema in reconstructive memory
 - E.g., two people who witness the same event may give very different accounts of what they have seen
- Bartlett's procedure (serial reproduction) is **replicable**, which means that it could be repeated to check for **reliability**

Limitations

- Bartlett's sample was small and limited to an elite **demographic** of university students who were all male, which makes the findings difficult to **generalise**
- Schemas are not easy to **measure**, as they are subjective and unique to the individual

Link to concepts

Bias

- Bartlett's study is, ironically, an example of culture bias with its sample of British undergraduate students based at Cambridge university
- The demographic of Cambridge students in the 1930s was overwhelmingly white, male, and from privileged, upper-middle to upper-class backgrounds
- Today the student body is more **diverse and representative** of different cultural groups, which means that Bartlett's findings lack temporal validity

Measurement

- It is possible that Bartlett's participants did not try very hard to recall exactly the War of the Ghosts story as it had been told to them
- They may have considered the research to be of **low status** (as it was not, on the surface, 'scientific')
- Bartlett himself was also rather careless when it came to controlling the conditions in which he conducted the study, leaving large gaps between some of the periods of serial reproduction and not implementing strict **controls** over the procedure



The effect of computer games on memory

- We live in an increasingly complex, technology-driven world with access to information that would have been unimaginable only a few decades ago
- **Cognitive load theory** suggests that excessive exposure to technology can **overwhelm cognitive resources**, leading to impaired memory and thinking
- There are generational differences:
 - **Digital immigrants** are those born before widespread internet and personal computer use
 - **Digital natives** are those born after these technologies became established.
- One perspective argues that digital natives depend too heavily on continuous access to technology, impairing their cognitive processes
- Another view is that modern technologies can actually **enhance cognition** in both digital natives and digital immigrants

Positive influence of digital technologies

- **Hyperconnectedness**: constant access to multiple streams of information and communication (e.g., internet use, computer action games)
- **Computer games**:
 - Involve **multitasking** (switching between scenarios, reacting quickly to threats and rewards)
 - This may sharpen cognitive functions such as **attention, processing speed, and working memory**
- **Metacognition**:
 - Task switching in games can encourage metacognitive awareness (thinking about how we think)
 - Practising metacognition may improve **memory, problem-solving, and flexible thinking**
- One argument for the positive influence of digital technologies is the idea of 'hyperconnectedness'
 - This means that an individual can be connected to multiple forms of information and communication, such as surfing the internet or playing computer **action games**

Research which supports the effect of computer games on memory

Blacker et al. (2014)

Aim:

- To investigate the extent to which **action computer games** may improve **visual working memory (VWM)**

Participants:

- A **self-selecting sample** of 34 male university students (**mean age = 20 years**)

Procedure:

- The participants were **randomly allocated** to one of two **conditions** of the **independent variable**:
 - **Condition 1**: participants were asked to play active games, e.g., Black Ops games, Call of Duty, Modern Warfare using **single-player mode**
 - **Condition 2**: participants were asked to play a non-active game (The Sims strategy game); this was the **control condition**
- Participants in each group were asked to **train** (i.e., play the game and practise the skills involved) for over 30 hours across a continuous stretch of 30 days
- Prior to the training period the participants were assessed using a **self-report** (0–9 **rating scale**) which asked them how motivated they were to complete a visual working memory (VWM) task
- After the training period was over, the participants were asked to complete another self-report which asked them about how **engaged** they had been in the VWM task (e.g., their level of enjoyment and absorption in the game)

Results:

- The researchers found no **significant differences** in levels of **self-reported** motivation and engagement between the two groups on either the tasks or the VWM assessments
- The participants who trained using the action game demonstrated significant improvement on one measure of VWM **capacity** (a **change control** task which involves switching **attention** quickly), a small improvement on a colour wheel test and no improvement on a complex **span task** compared with those who trained on the Sims game

Conclusion:

- Action computer games may directly improve VWM, or improve it through the enhancement of **selective attention**

Evaluation of the effect of computer games on memory

Strengths

- The study has good **application** as it highlights the responsiveness of the VWM to training, which could be used in **educational settings** where improving cognitive skills is a key



objective

- The procedure took place over 30 hours, which means that the participants were able to immerse themselves in whichever game they were playing across time
 - This makes the findings more **valid** than they would be if a **snapshot** design had been used

Limitations

- There is no way of knowing if the participants stuck strictly to the 30-day practice period
 - Some of them may have practised the game more and some less, which would decrease the **reliability** of the findings due to a lack of **consistency** across conditions
- The study shows what happened – the improvement in VWM on one measure – but it cannot explain *why* it happened; thus, it lacks **explanatory power**

Link to concepts

Perspective

- There is some concern that technology-based laziness, (which could come from playing too many computer games or over-use of technology generally) may result in less **neuroplasticity**
 - This would mean that neuroplasticity is put on 'pause' and, instead, neural pruning would proliferate in the parts of the brain that gaming uses the most
 - E.g., the hippocampus for both memory and spatial navigation
- An **over-reliance** on gaming may also negatively impact social interactions
 - Research has shown that people who spend more time gaming lose some ability to **recognise faces**, as screens **interfere** with the ability to interpret **emotion** in face-to-face encounters

Responsibility

- When researching the impact of gaming, it is essential that researchers screen their participants prior to the process to ensure that none of the sample have a **gaming addiction** (or be vulnerable to developing one)
- There is a fine line between enjoying gaming and **depending** on it and the researchers have a duty of care to establish this line rather than exacerbating an existing problem