The big picture

? Subtopic question(s)

During this subtopic, you will be working towards answering the following subtopic question:

- To what extent is memory a valid source of knowledge?

The guiding questions in each section help to guide you towards answering the subtopic question at the end of the subtopic. The subtopic questions require you to pull together your knowledge and skills from different sections, to see the bigger picture and to build your conceptual understanding.

Sam is at the store. However, they did not bring the list of things to buy because they were convinced that they could remember it all without the list. In between leaving home and getting to the store, many things happened to Sam. For example, they ran into an old friend and then they stopped to pet a puppy. When Sam gets to the store, they can only remember the first item on their list.

In this situation, Sam's memory is not so reliable. There are many reasons why Sam could not remember what they needed to buy. Maybe the items never moved from short-term to long-term memory because they didn't rehearse them. Or maybe the mental juggling of running into an old friend and navigating their way to the store overloaded their memory. Maybe, in the end, they got the wrong items, buying things they always get because they assumed the items were on the list, even if they were not!

This subtopic will explore these explanations for why Sam's memory wasn't so reliable, by investigating cognitive models of memory, the factors that affect our cognitive processing and the evidence that helps us understand memory.

Cognitive psychology is the study of mental processes and how they influence behaviours. In this subtopic, you will focus on the specific cognitive process of memory, which is the encoding, storage and retrieval of information. Memory plays a fundamental role in your day-to-day life, as it helps you retain knowledge, skills and experiences. As you can see in **Figure 1**, memory can be divided into several types, each having its own unique characteristics and purpose.

Overview (/study/ap new/sid-540-cid-763690/c

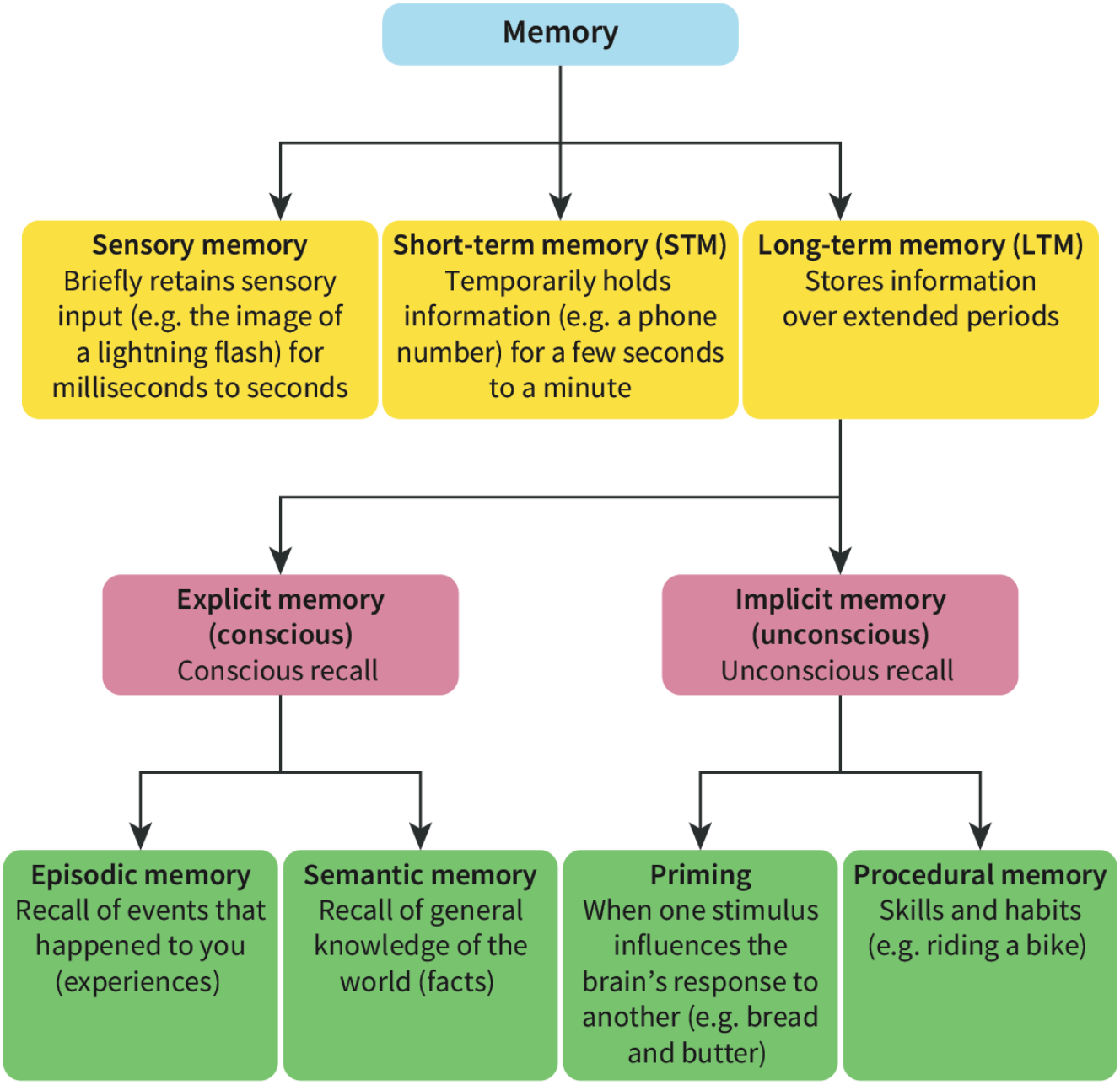

Figure 1. The different types of memory.

Source: Adapted from Queensland Brain Institute[1]

More information for figure 1

Tree diagram showing types of memory. Memory is divided into sensory memory, short-term memory and long-term memory. Sensory memory briefly retains sensory input, such as the image of a lightning flash, for milliseconds to seconds. Short-term memory or STM temporarily holds information, such as a phone number, for seconds to a minute. Long-term memory or LTM stores information over extended periods. LTM is divided into explicit memory and implicit memory. Explicit memory involves conscious recall and is split into episodic memory and semantic memory. Episodic memory recalls events that happened to you, that is to say, experiences, Semantic memory recalls general knowledge of the world, that is to say, facts. Implicit memory involves unconscious recall and is split into priming and procedural memory. Priming is when one stimulus influences the brain's response to another, for example, bread and butter. Procedural memory includes skills and habits, for example, riding a bike.

Making connections

Memory is closely linked to many human behaviours. In previous topics, you learned how memory and schemas can affect human relationships, and how schemas can increase an individual's vulnerability to depression.

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

- In **section 2.2.3** (/study/app/psychology-new/sid-540-cid-763690/book/what-is-the-relationship-between-etiology-and-treatment-id-49441/), for example, you looked at depressive etiologies and treatment. Negative schemas can contribute to an individual's vulnerability to depression, by causing individuals to focus on and recall negative experiences, reinforcing depressive thoughts and feelings.
- In **section 4.2.1** (/study/app/psychology-new/sid-540-cid-763690/book/how-can-understanding-human-cognition-decrease-conflict-id-49137/), you looked at cognition and decreasing conflict. Memory and schemas influence how individuals perceive and recall events, often leading to biased interpretations and misunderstandings that fuel interpersonal conflict.

[1] Adapted from Queensland Brain Institute (https://qbi.uq.edu.au/memory/types-memory). This work is licensed under a Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).

3 section questions

Question 1

SL HL Difficulty:

How might memory and schemas contribute to interpersonal conflict?

1 By influencing how individuals perceive and remember events, schemas can lead to biased interpretations and misunderstandings. ✓

2 By accurately recalling past events, individuals can prevent misunderstandings.

3 By creating shared positive memories, schemas always align between individuals.

4 By making individuals forget negative experiences, schemas prevent conflict.

Explanation

Memory and schemas influence how individuals perceive and recall events, often leading to biased interpretations and misunderstandings which fuel interpersonal conflict.

Question 2

SL HL Difficulty:

System 1 1 ✓ thinking often uses unconscious memories and heuristics, while system 2 2 ✓ thinking draws on conscious memories for more analytical processing.

Accepted answers and explanation

#1 1

#2 2

General explanation

Different types of memory support the two distinct modes of thinking. System 1 relies on unconscious, experience-based memories, while system 2 engages conscious, knowledge-based recall for deeper processing.

Question 3

SL HL Difficulty:

How do negative schemas contribute to an individual's vulnerability to depression?

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

1 They distort memory, causing individuals to focus on and recall negative experiences. ✓

2 They improve problem-solving abilities, leading to heightened self-esteem.

3 They enhance memory for positive experiences, creating unrealistic optimism.

4 They strengthen cognitive processing, reducing susceptibility to depressive thoughts.

Explanation

Negative schemas distort memory by causing individuals to focus on and recall negative experiences, reinforcing depressive thoughts and feelings.

Previous section(/study/app/psychology-new/sid-540-cid-763690/book/collected-research-studies-id-50537/review/) Next section (/study/app/p

Section Student... (0/0) Feedback Print (/study/app/psychology-new/sid-540-cid-763690/book/the-big-picture-id-49673/print/) Assign

Student view

What evidence exists in support of one or more models of memory?

A-4: Measurement B-4-2-2a: Evaluate the value of cognitive models to understand one or more cognitive processes.

B-4-2-2b: Compare two cognitive models used in understanding one cognitive process.

C-2-4: Describe the role of one or more cognitive models in understanding a cognitive process or behaviours.

C-2-6: Describe cognitive load theory and its relationship to the working memory model.

Teacher instructions

Learning outcomes

- Describe the role of one or more cognitive models in understanding a cognitive process or behaviours.
- Describe cognitive load theory and its relationship to the working memory model.
- Discuss the value of one or more cognitive models in understanding one or more cognitive processes.
- Discuss limitations of measurement in investigating theories of memory.

Facilitation guidance

In this section, students will learn about two main models of memory: the multi-store model and the working memory model. These concepts offer a different perspective on memory. It is important for students to understand that each model has its own strengths and limitations, and can be used to explain memory in different situations. Encourage students to apply these models to their own lives — particularly studying and learning!

? Guiding question(s)

In this subtopic, you will think about the question, '**To what extent is memory a valid source of knowledge?**' This section will help you make an informed response by working through the following guiding question:

- What evidence exists in support of one or more models of memory?

It may be surprising to learn that psychologists and neuroscientists do not have a lucid understanding of how memory works. This section will introduce you to two leading memory theories and ask you to consider, 'What evidence exists in support of one or more theories of memory?'

> Keep the guiding question in mind as you progress through this section. The guiding question builds into the subtopic question(s). You will return to the subtopic question(s) at the end of each subtopic. The subtopic questions require you to pull together your knowledge and skills from different sections, to see the bigger picture and to build your conceptual understanding.

Memory

Have you ever wondered why, for example, you can vividly recall the lyrics to your favourite childhood song but forget what your psychology teacher assigned for homework last lesson?

Your memory is a complex cognitive process, and memory differs from person to person. Why you remember some events, and not others, is something that psychologists have sought to explain since the birth of cognitive psychology.

Overview (/study/app/psychology-new/sid-540-cid-763690/c

In order to help explain complex processes like memory, researchers have developed cognitive models. These models are theoretical frameworks that describe how the mind processes, stores and retrieves information. These frameworks help simplify cognitive processes to make them understandable and measurable. Two prominent models of memory are the multi-store model of memory (MSM) and the working memory model (WMM).

Creativity, activity, service

Strand

Service

Learning outcome

- Demonstrate how to initiate and plan a CAS experience.

Create a ‘study strategies’ poster

Throughout this topic, you are learning about many applicable models of memory. Create a ‘study strategies’ poster that applies these memory models to your own learning. Place these posters around the school to help your peers study better.

Multi-store model of memory (MSM)

The multi-store model of memory, proposed by researchers Atkinson and Shiffrin in 1968 (https://doi.org/10.1016/S0079-7421(08)60422-3) , is a framework that shows how we encode, store and retrieve information. The MSM was a foundational theory for how memory operates, with many other models (including the working memory model) created based on the MSM.

According to this model, memory moves in a sequential and linear fashion between three distinct stores:

- Sensory memory
- Short-term memory (STM)
- Long-term memory (LTM)

The model operates similarly to a computer (**Figure 1**). Sensory inputs, like those from a keyboard, mouse or camera on a computer, are detected. If attention is given to these inputs, they are temporarily processed in short-term memory, which functions like a computer’s random access memory (RAM). From there, information can be stored more permanently in long-term memory, like a computer’s hard drive.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

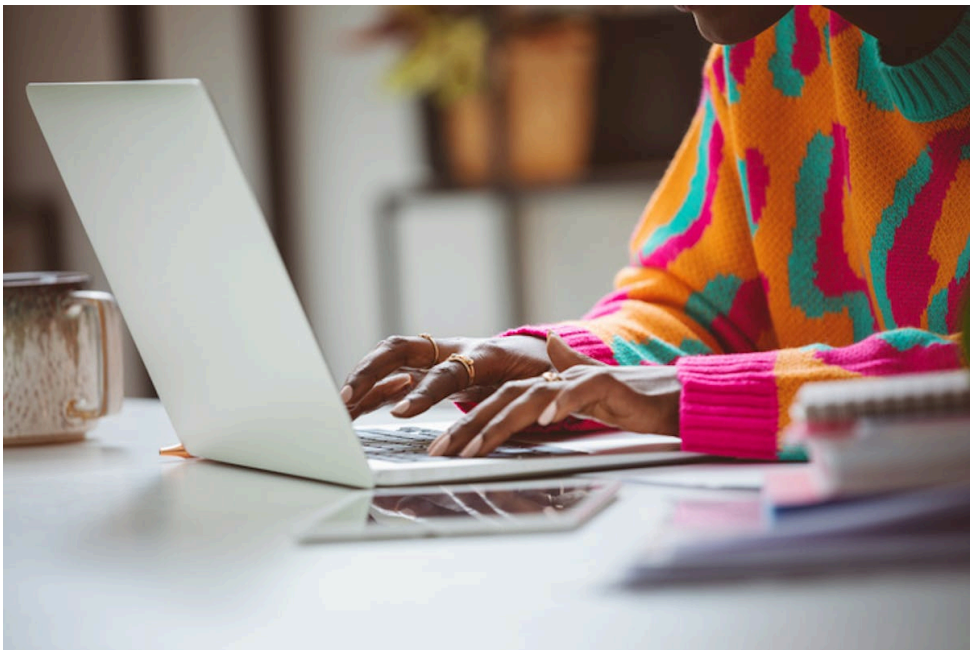

Figure 1. The multi-store model of memory operates similarly to a computer.

Credit: izusek, Getty Images

Sensory memory

Sensory memory holds information, in its original sensory form (for example, sound or taste), very briefly to allow the initial processing of information. The brain processes and filters through incoming sensory information, before ultimately deciding whether to transfer it to short-term memory or let it decay.

Sensory memory lasts for an extremely short amount of time, from roughly a fraction of a second to a few seconds, depending upon the type of sense. For example, iconic memory typically lasts for one-quarter of a second, whereas echoic memory lasts for 2 to 3 seconds. Imagine you are in a busy hallway, and someone calls out your name. The sound very briefly replays in your mind, lasting for only a few seconds – this is processed in your echoic memory. The capacity of sensory memory is large, as we are able to process a large amount of stimuli simultaneously, for example, all of the sights and sounds of a busy hallway. If information is paid attention to, it will move to short-term memory for further processing. However, if information is not paid attention to, it will decay rapidly.

Short-term memory

Short-term memory (STM) is the second store of memory in the MSM. It temporarily stores and processes the information we pay attention to in our sensory memory, or information retrieved from long-term memory. According to George Miller's famous experiments (1956) (https://doi.org/10.1037/h0043158) , STM has a capacity to hold seven items, plus or minus two. Most people can hold between five and nine items of information in their STM. In order to increase the capacity of STM, you can group items into meaningful units. This strategy is called chunking. For example, when remembering a random string of letters such as USAFBIUK, you can chunk it into USA – FBI – UK, which is easier than remembering a string of eight random letters that have no meaning. Information stays in STM for around 15–30 seconds without rehearsal. This time can be prolonged if it is actively maintained with rehearsal (**Figure 2**); for example, you repeat a phone number to yourself until you dial it. If we don't rehearse the information, it quickly decays or can be displaced by new information. STM primarily relies on acoustic encoding; we tend to store information by the way that it sounds.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

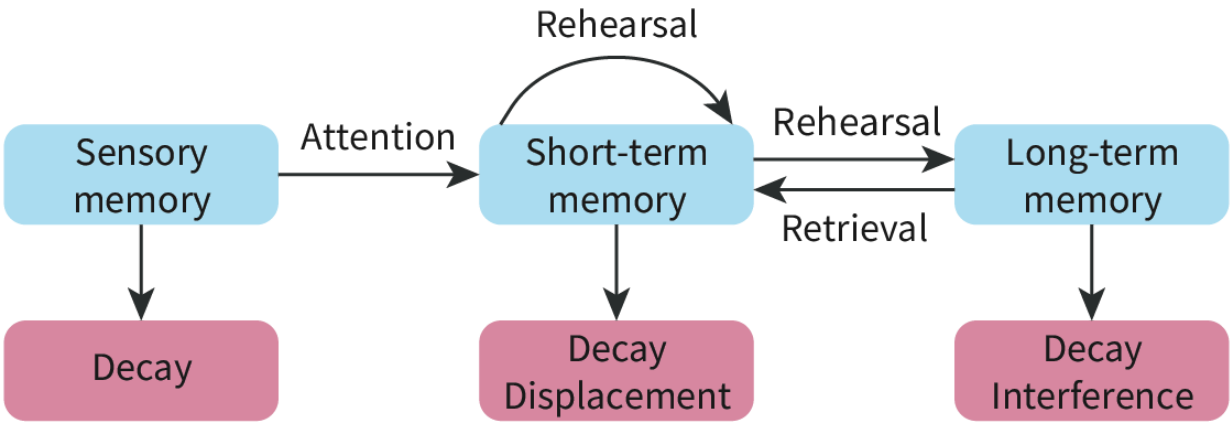

Figure 2. The multi-store model of memory.

More information for figure 2

Flowchart showing memory formation and retention. Information in sensory memory can move to short-term memory through attention. Lack of attention leads to decay of sensory memory. In short-term memory, rehearsal results in information being retained in short-term memory or transferred to long-term memory. Lack of rehearsal leads to decay or displacement of information in short-term memory. Through retrieval, information can move from long-term memory into short-term memory. Long-term memory is subject to decay and interference over time.

Long-term memory

When we engage in rehearsal, either elaborative (adding meaning to information, or connecting it to what we know, like relating a phone number to a birthday) or maintenance (simple repetition, like repeating a phone number to yourself), information moves to long-term memory (LTM). According to the MSM, LTM holds all of the information encoded from STM. It can hold information for extended periods of time, from minutes to a lifetime, and has an unlimited capacity. LTM is important as it helps us retain knowledge, experiences and skills, and this stored information can be accessed when we need it through retrieval. However, this stored information can be forgotten from LTM through decay (loss of the memory trace over time), interference (similar memories blocking retrieval) or retrieval failure (a lack of necessary cues to recall the information). Unlike STM, the primary type of encoding in LTM is **semantic**, meaning that we encode information based on its meaning.

HL Extension

Motivation

The role of motivation in memory

Motivation plays a significant role in memory in many ways:

- Motivation triggers the release of neurotransmitters like dopamine, which strengthens synaptic connections in brain areas involved in memory, such as the hippocampus.
- Motivated individuals are more likely to focus on relevant stimuli, reducing distractions and facilitating deeper processing. Murty and Dickerson (2016) (https://doi.org/10.1108/S0749-742320160000019019) found that intrinsic motivators (such as curiosity) enhance encoding by increasing attention and engagement during learning tasks.
- Motivation can lead to elaborative rehearsal, where individuals connect new information with existing knowledge, improving encoding quality.

Reflection questions

Student view

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1. Does the MSM of memory and/or the working memory model explain the role of motivation in memory? If so, how?
2. How can motivation influence learning and memory in an educational setting? Come up with at least one example of how you or your teachers could implement strategies to enhance motivation.

Some limitations of MSM

While the MSM has been foundational in cognitive psychology and provided the basis for many other theories of memory, it has been subject to criticism. Some of the limitations of the model are as follows:

- The model arguably oversimplifies the complex process of memory. Each store is treated as its own, single store and independent of the other stores, which may not be the case. We now know that LTM is not a single store, but can be divided into explicit memory, the conscious recollection of facts and events, and implicit memory, a type of unconscious memory involving skills, habits and conditioned responses.
- The model does not explain why some information goes straight to LTM with minimal rehearsal. For example, the theory of flashbulb memories suggests that some memories of highly emotional events are vividly remembered without active rehearsal. Implicit learning can also occur easily without conscious rehearsal.
- There are several factors that influence memory that the MSM does not account for. Stress, emotion and culture can influence our memories in several ways.
- The MSM does not address individual differences. For example, people with neurological conditions or who are neurodiverse may process and store memories differently.

International mindedness

Cultural identity

Memory and cultural identities are deeply interconnected. For example, collective memories are the shared pool of knowledge and information held by a group of people, often passed down through storytelling, education, rituals and cultural practices.

Reflection questions

1. Why is it important to understand the relationship between memory and cultural identity?
2. How can this foster intercultural understanding?

Working memory model (WMM)

One model that was created to account for the simplicity of the MSM, is the working memory model (WMM). Created by Hitch and Baddeley in 1976, this model provides a more detailed understanding of STM specifically. The model suggests that we actively process and manipulate information, rather than passively store it. Evidence from dual-task experiments (https://doi.org/10.1080/14640747608400587) suggests that we can process different types of information at the same time, which the MSM cannot explain. Additionally, the experiments by Shallice and Warrington (1970) (https://doi.org/10.1080/00335557043000203) on patients with brain damage revealed that STM is not unitary – for example, a patient had an impaired verbal STM, but an intact visual STM.

The WMM suggests that STM is made up of several components:

Student view

- Central executive (CE)
- Phonological loop (PL)

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- Visuospatial sketchpad (VS)
- Episodic buffer (EB)

The central executive (CE) is the control centre of working memory. It directs attention and allocates resources to tasks (**Figure 3**). The CE does not store information itself, but rather has cognitive control in working memory. The phonological loop (PL) processes and stores verbal and auditory information. It consists of the phonological store, an 'inner ear', holding auditory information for a few seconds, and an articulatory control process, an 'inner voice', which rehearses information to keep it active. For example, if you repeat a phone number in your head to remember it, you are using your PL. We can only hold approximately 2 seconds' worth of information, which is why shorter words are a lot easier to remember than longer words. This is known as the word-length effect.

The visuospatial sketchpad (VS) processes and stores visual and spatial information, such as shapes, colours and spatial layouts. For example, visualising how you are going to get home from a certain place. It comprises a visual cache, which stores information about shape and colour, and an inner scribe, which handles spatial and movement information. Luck and Vogel (1997) (https://doi.org/10.1038/36846) suggest that the VS stores whole objects rather than individual features. It is estimated that the VS can hold three to four objects, depending on the complexity of the task.

The final component of the WMM is the episodic buffer (EB). This integrates all information from the PL and VS with LTM to create a coherent 'episode'. It acts as a temporary store, bridging the gap between working memory and LTM. For example, when solving a complex math problem, the EB retrieves relevant arithmetic knowledge from LTM, such as multiplication tables or addition rules.

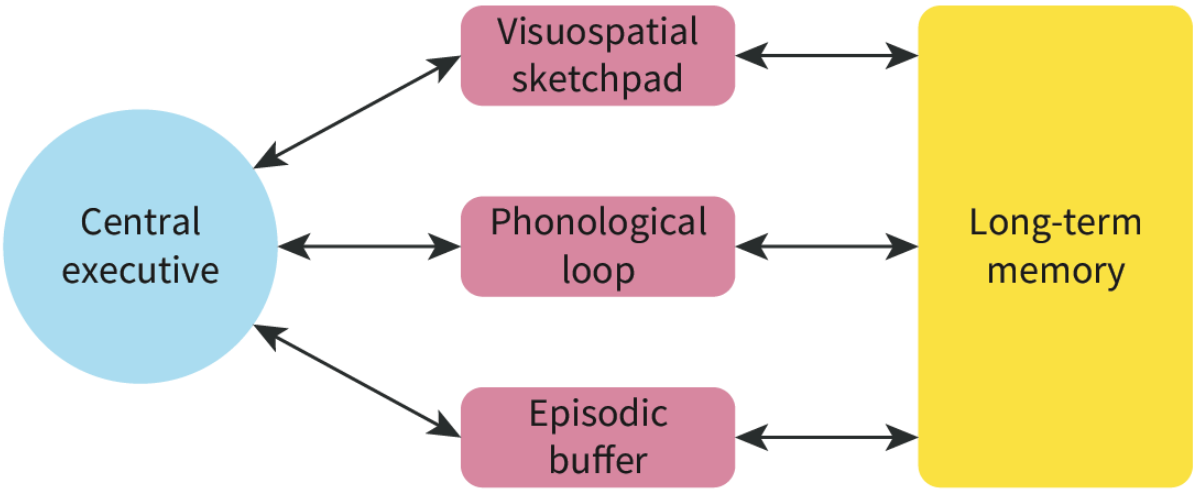

Figure 3. The working memory model.

More information for figure 3

Diagram of components of the working memory model. Two-way arrows connect the central executive to three subsystems, named the visuospatial sketchpad, the phonological loop and the episodic buffer. Two-way arrows also connect each subsystem to long-term memory.

The working memory model and cognitive load theory

While evidence from dual task experiments demonstrates that we can process different types of stimuli simultaneously, research into the WMM has demonstrated a limitation to our cognitive capacity. You have likely experienced this yourself. Have you ever been multitasking on your computer, had a thought that you needed to do something, and then when you

Student view

Overview (/study/ap new/sid-540-cid-763690/c

opened a new tab to address that task, you forgot what you intended to do? This is an example of cognitive overload and can explain your inability to remember what you intended to do.

Cognitive load theory has been investigated by many psychologists over the years but was made famous by John Sweller of the University of New South Wales. Sweller was especially interested in the impact of cognitive load on students and learning. Sweller believed that instruction should be as direct as possible and extraneous information eliminated in order to allow students to focus on the information that is truly necessary. He believed that complex information should be broken down into smaller, more manageable chunks.

Cognitive load theory emerged from the WMM, as it expanded on the findings that although we do have different components capable of juggling stimuli separate from one another, those components are themselves limited in scope and duration. Sweller identified three different types of cognitive load:

- **Intrinsic load**: related to the inherent complexity of the subject matter. For example, learning addition has low intrinsic load, but learning calculus has high intrinsic load.
- **Extraneous load**: caused by poorly designed instructional methods. For example, a slide presentation filled with excessive images or text can create extraneous load and decrease recall.
- **Germane load**: the desirable mental effort learners expend to form meaningful connections. This is focused cognition and is desirable and helpful. For example, you convert your teacher's IB DP Biology slides into your own words.

In order to be a more effective and efficient student, it is important that you understand there is no such thing as 'multitasking.' If you are not engaging with a singular stimulus (like your psych text!), then you are overloading your working memory and impeding your ability to recall information.

Evaluating the WMM

Because of the limited capacity of each component, you cannot efficiently engage in tasks that use the same component. Have you ever been told that listening to music with lyrics while studying is not effective? Both of these tasks rely on the PL for processing. Landry and Bartling (2011) (https://www.mcneese.edu/wp-content/uploads/2020/08/AJPR-11-07-Landry-5-09.pdf) demonstrated the limited capacity of the PL by investigating the effect of an articulatory suppression task (repeating the numbers '1, 2' aloud) on memory recall. Participants' ability to recall a list of letters was significantly reduced when completing the articulatory suppression task, compared to a control group. However, you can engage in two tasks simultaneously if they require different components, like navigating your way home (VS) and listening to a podcast (PL).

The WMM effectively explains how memory is an **active process**. It also explains multitasking – how we can perform two different tasks simultaneously if they use different components. For example, listening to music (PL) while navigating down a street (VS). While it provides an in-depth explanation of STM, it doesn't explain the interaction with LTM. This limits our understanding of the full process of memory and how the different types of memory interact. Testing the model as a whole is also challenging, and much of the research, such as Landry and Bartling (2011), only demonstrates individual components such as the PL. There is also little evidence about how the CE works. Isolating this component is challenging, as it has many functions and is involved in many cognitive tasks.

Concept

Measurement

Student view

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Memory is an abstract process that cannot directly be observed. Hence, researchers rely on indirect measures that may pose some challenges. For example, many studies that support the models discussed in this section use artificial tasks, challenging the ecological validity of the research.

Reflection question

1. Discuss the limitations of **measurement** in investigating models of memory.

Teacher instructions

Goals

- To explain the MSM and the WMM.
- To compare and contrast the WMM and MSM.
- To evaluate the WMM and MSM.

Facilitation guidance

The activity could be set up as a gallery walk or memory 'stations', where the students complete the experiments that their peers create. Encourage students to critically think about each model and compare the models with the ones they investigated.

Neuroscience for kids (https://faculty.washington.edu/chudler/chmemory.html#:~:text=Tell%20them%20that%20you%20will,you%20finish%20readir has lots of simple memory tasks that students can recreate and is linked in the activity, but you may wish to provide more examples.

Activity

IB learner profile attribute: Thinker/Knowledgeable/Communicator

Approaches to learning: Thinking/Researching/Social skills

Time required to complete activity: 60 minutes

Activity type: Group

Memory lab

Your teacher will assign each group with a different model:

- Multi-store model of memory (MSM)
- Working memory model (WMM)

For your model, create a one-page summary poster and two experiments for your peers to complete which demonstrate your model (for example, memorise and recall a list of seven letters to demonstrate the MSM). The Neuroscience for kids (https://faculty.washington.edu/chudler/chmemory.html#:~:text=Tell%20them%20that%20you%20will,you%20finish%20readir website is a good starting point for experiment ideas.

Share your summary and tasks with your peers.

Once you have shared your model and learned about your peers' models, come up with two questions that challenge another model (for example, 'How does your model explain forgetting?'). Answer the questions posed to your group.

As a class, discuss the following:

1. Which model best explains memory processes in the context of studying?
2. Which model best explains memory processes in the context of driving?

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3. How might these models complement each other?
4. How can you apply these models to your own learning and memory?
5. **(Concept application: measurement)** Discuss the limitations of measuring specific components of each model in relation to construct validity.

Learning outcomes

By the end of this section, you should be able to:

- Describe the role of one or more cognitive models in understanding a cognitive process or behaviours.
- Describe cognitive load theory and its relationship to the working memory model.
- Discuss the value of one or more cognitive models in understanding one or more cognitive processes.
- Discuss limitations of measurement in investigating theories of memory.

4 section questions

Question 1

SL HL Difficulty:

You are trying to visualise a map to plan your route to a friend's house. According to the working memory model, which component of working memory is involved?

Visuospatial sketchpad ✓

Accepted answers
Visuospatial sketchpad

Also accepted
Visuo-spatial sketchpad, The visuospatial sketchpad

Explanation
The visuospatial sketchpad is responsible for processing and storing visual and spatial information, such as mental images, maps and layouts. When you visualise the map, you are using the visuospatial sketchpad to create and manipulate a mental representation of the route.

Question 2

SL HL Difficulty:

One criticism of research on models of memory is that the experimental tasks do not reflect memory processes in real-life, meaning the research lacks 1 ecological ✓ validity.

Accepted answers and explanation

#1 ecological

General explanation

Many memory studies often use artificial tasks, such as recalling word lists under controlled laboratory conditions. These tasks are simplified and do not necessarily reflect how people use memory in real-world situations (for example, remembering a conversation, navigating a city or recalling a complex event). Hence, they lack ecological validity.

Question 3

SL HL Difficulty:

Which of the following is **not** a key difference between the multi-store model of memory (MSM) and the working memory model (WMM)?

Student view

Overview (/study/ap new/sid-540-cid-763690/c

1 The WMM focuses on long-term memory processes, while the MSM explains short-term memory only. ✓

2 The MSM suggests memory consists of separate stores, whereas the WMM focuses on a single store for all memory processes.

3 The WMM introduces multiple components within working memory, while the MSM focuses on three distinct memory stores.

4 The MSM emphasises the role of rehearsal in memory transfer, while the WMM does not include the concept of rehearsal.

Explanation

The WMM does not provide a detailed explanation of long-term memory as it is more concerned with how information is actively processed and temporarily stored in working memory. The multi-store model (MSM) explains memory as a sequence of stores: sensory memory, short-term memory and long-term memory.

Question 4

SL HL Difficulty:

A student is trying to memorise a list of 20 words. According to the multi-store model, why might they remember the first few words and the last few words better than the ones in the middle?

1 The first words are rehearsed and transferred to long-term memory, while the last words are still fresh in short-term memory. ✓

2 The words in the middle are forgotten due to interference from other tasks.

3 The first words are stored in short-term memory, and the last words are stored in long-term memory.

4 The middle words are transferred to long-term memory without rehearsal.

Explanation

The first few words in a list are more likely to be remembered because they are rehearsed and transferred into long-term memory. The last few words are still fresh in short-term memory and are more easily recalled.

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Student view

What factors affect the reliability and validity of memory?

B-4-1-2: Describe the role of schemas in thinking and/or learning by outlining their influence on cognitive processes and knowledge acquisition.

B-4-2-3: Identify the role of one or more cultural factors in one cognitive process.

B-4-2-4: Discuss the potential influence of one or more environmental factors on one cognitive process.

B-4-2-5: Describe one or more strategies to improve one or more cognitive processes. B-4-4-1a: (HL) Discuss the role of culture on learning and cognition.

B-4-4-1c: (HL) Discuss the extent to which learning and cognition across cultures is similar and different.

C-2-3: Describe the role of schema theory in understanding a cognitive process.

Teacher instructions

Learning outcomes

- Describe the role of schema theory in understanding a cognitive process.
- Describe the role of schemas in thinking and/or learning by outlining their influence on cognitive processes and knowledge acquisition.
- Identify the role of one or more cultural factors in one cognitive process (memory).
- Discuss the potential influence of one or more environmental factors on one cognitive process.
- Describe one or more strategies to improve one or more cognitive processes.

HL Extension

- Discuss the role of culture on learning and cognition.
- Discuss the extent to which learning and cognition across cultures is similar and different.

Facilitation guidance

In this section, students will learn about the reliability and validity of memory. The focus is on specific factors that influence the reliability and validity of memory, such as schemas, culture and emotion. Additionally, they will look at the misinformation effect and confabulation, using Loftus and Pickrell's 'Lost in the Mall' research, and how interference can impact memories. Encourage students to think critically about the research on the reliability and validity of memory, especially the challenges with studying factors affecting memory (for example, experimental research lacking ecological validity).

Note: Bartlett's research on schema theory (linked in the text) does use the term 'Indian', instead of the appropriate term 'Indigenous American'.

? Guiding question(s)

In this subtopic, you will think about the question, '**To what extent is memory a valid source of knowledge?**' This section will help you make an informed response by working through the following guiding question:

- What factors affect the reliability and validity of memory?

It is important to understand that memory is not infallible. In fact, research has demonstrated that memory can be augmented and influenced in a variety of ways. This section will ask you to consider the question, 'What factors affect the reliability and validity of memory?' Specific factors that will be addressed are schemas and emotion.

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Keep the guiding question in mind as you progress through this section. The guiding questions build into the subtopic question(s). You will return to the subtopic question(s) at the end of each subtopic. The subtopic questions require you to pull together your knowledge and skills from different sections, to see the bigger picture and to build your conceptual understanding.

Schema theory

Imagine you witness a crime occurring, such as someone stealing your friend's bike. Months later, the police call you in to recall the event. How confident would you be with your memory? How reliable do you think your memory would be? The Innocence Project (https://innocenceproject.org/), which focuses on the exoneration of people through use of DNA testing, estimates that more than 60% of wrongful convictions (as of 2020) have involved eyewitness misidentification. This means that erroneous memory is a leading cause of wrongful convictions. Eyewitness testimony is still heavily relied on in legal systems around the world, but it is important to understand that memory can be prone to error. Psychologists have been interested in explaining and understanding the factors that influence our memory. For example, details of the crime you witness may not fit with your expectations, so you may forget or distort this information.

Distortions or errors in our memory can be explained by schema theory. This is a cognitive framework, proposed by Frederick Bartlett in 1932 (https://doi.org/10.1080/0015587X.1920.9719123), that explains how our prior knowledge and experiences influence how we process, organise and store information. According to the theory, we use schemas to organise information and fill in gaps in our understanding. For example, you may have a schema for a phone: what a phone is, how it looks and how it functions. When you pick up a similar phone to the one you have a schema for, you know how to use it based on your schema for a phone. Schemas can develop and change over time. For example, as new technologies emerge such as foldable screens, we may update our schema to include these features.

Schemas affect our memory at all three stages:

- **Encoding:** We may pay attention to information that fits with our schemas, and encode this information more effectively than the information that does not align with our schemas. This schema-inconsistent information may be overlooked or ignored.
- **Storage:** When we store information, schemas help to integrate it with existing knowledge. This can lead to distortions if the information does not align with our schemas.
- **Retrieval:** Schemas can facilitate the recall of schema-related information, meaning that we have better recall for information that fits our schema compared to information that does not.

Memory retrieval involves reconstructive memory. This means that memory is not recorded like a video. Instead, it is an active process of reconstructing past events. We use schemas and external factors to 'fill in the gaps'. However, this can lead to errors or distortions, which affect the reliability and validity of memory. For example, in his famous 1932 'War of the Ghosts' study (https://doi.org/10.1080/0015587X.1920.9719123) , Bartlett found that when participants were asked to recall an unfamiliar folk tale, they reconstructed the story to align with their schemas. They did this by altering details to fit with their schema (a process known as **sharpening**), or leaving out specific details that did not fit (a process known as **levelling**). For example, participants frequently changed the term 'canoe' to 'boat' during recall. This reflected their familiarity with 'boats' rather than 'canoes', demonstrating how memory is influenced by personal and cultural schemas.

Student view

Theory of knowledge

Expectations and assumptions in knowledge creation

Overview (/study/ap new/sid-540-cid-763690/c

Just as memory can be affected by expectations, assumptions and existing cognitive schemas, so too can other types of knowledge creation.

Reflection question

1. Discuss how expectations and assumptions can impact knowledge creation in two different areas of knowledge. For example, in the human sciences, researchers' assumptions may influence how they interpret human behaviour.

Memories and external factors

Memories for events can also be influenced by external factors and cues, such as being exposed to incorrect or misleading information about the event. This information can come from various sources, such as media reports and discussions with other people. This leads to the misinformation effect, where individuals recall events or details that did not occur, or have inaccurate memories for the event based on exposure to this information. This concept gained traction through the work of Loftus and Palmer (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3), who investigated the impact of wording of participants' memories. Specifically, they were interested in the role of leading questions, where the wording of the question can alter participants' memories.

In one experiment, participants watched a video of a car accident and were asked to estimate how fast the cars were going when they hit each other. However, the verb 'hit' was changed for another condition to smashed, and a control group that did not make speed estimates. Participants estimated higher speeds when the verb 'smashed' was used, indicating that the leading question had influenced their memory of the accident. One week later, these same participants were more likely to say 'yes' to the question 'Did you see any broken glass?' even though there was no broken glass in the video, indicating that these questions had caused participants to 'reconstruct' their memory of that event (**Figure 1**).

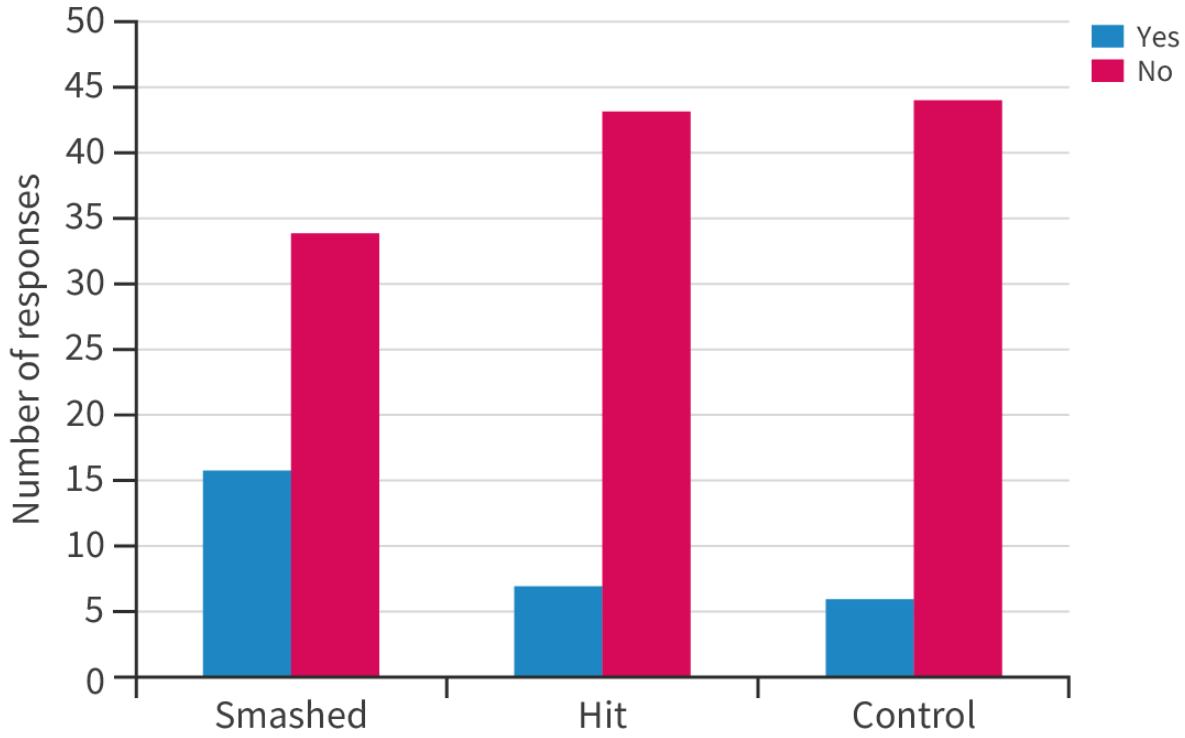

Figure 1. Distribution of yes/no responses to the question, 'Did you see any broken glass?' in Loftus and Palmer (1974).

More information for figure 1

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Dual bar chart with the y axis labelled as number of responses from 0 to 50. On the x axis, the number of yes responses and the number of no responses are given for three conditions, smashed, hit and control. For all three conditions, there are fewer yes responses than no responses, but for the smashed condition there is a smaller difference between yes and no than for the other conditions. For smashed, there are roughly 16 yes responses and 34 no responses. For hit, there are roughly 7 yes responses and 43 no responses. For control, there are roughly 6 yes responses and 44 no responses.

Concept

Bias

In eyewitness testimonies, cultural bias is another factor that can influence memory. One well-researched phenomenon is known as the 'other-race effect', which suggests that people tend to be better at recognising faces of their own race, compared to faces of other races.

A meta-analysis of 39 studies conducted by Meissner and Brigham (2001) (https://doi.org/10.1037/1076-8971.7.1.3) found that individuals were 1.4 times more likely to accurately identify same-race faces, and 1.56 times more likely to falsely identify other-race faces.

Reflection questions

1. What implications does this have for eyewitness testimonies that rely on memory?
2. In what other ways could cultural bias impact memory and eyewitness testimonies?

External factors can have significant implications in the real-world. For example, eyewitnesses may be less reliable if they have been exposed to post-event information. Paterson and Kemp (2006) (https://doi.org/10.1002/acp.1261) investigated the role of discussions between co-witnesses after watching a video of a crime. Participants were exposed to both accurate and inaccurate post-event information through a variety of methods, then tested one week later on their memory for the event. Participants in the control group received no post-event information. Participants were more likely to report the post-event information consistent with co-witnesses, including both misleading and accurate information. Additionally, the misled participants were often highly confident in their responses, indicating that even when memory is not accurate, we may be confident it is true. This has implications for the legal systems, as a confident eyewitness may not necessarily have the most reliable or valid memory for the event.

Perspective lens

Sociocultural approach

The sociocultural perspective focuses on examining behaviour through the lens of social interactions (social) and environmental factors (culture). Given that humans are complex social animals, social and environmental factors can be difficult to control when studying cognitive processes, like memory. Paterson and Kemp (2006) (https://doi.org/10.1002/acp.1261) demonstrated the influence of discussions, a normal event to occur as we are social animals, on memory accuracy. This social interaction meant participants were exposed to misinformation, leading to memory errors.

Reflection questions

1. In what other ways do social factors influence memory? (For example, social interactions can produce misinformation.)
2. Do social factors positively or negatively affect memory, or both?
3. Why is it important to be aware of the interaction between social and cognitive psychology?

Student view

Overview (/study/ap new/sid-540-cid-763690/c

Interestingly, exposure to misinformation can lead to the creation of false memories. These are recollections of events that may feel real, but are either partially or entirely false. Post-event information, leading questions and social influences (such as shared discussions) can influence the creation of these false memories. This phenomenon was demonstrated in Loftus and Pickrell's (1995) (https://doi.org/10.3928/0048-5713-19951201-07) 'Lost in the Mall' study, where participants were given narratives of childhood events, three of which were true and one was false (about being lost in a mall, **Figure 2**). Participants were asked to recall and describe these events multiple times. Over 25% of participants reported partial or full memories of the false event, with some even recalling additional details. These participants also tended to express confidence in their memory for the event, even though it never occurred. This research demonstrates the reconstructive nature of memory and its vulnerability to suggestive information.

Figure 2. Loftus and Pickrell (1995) convinced participants that they had experienced being lost in a shopping mall as a child.

Credit: Peter Cade, Getty Images

Concept

Responsibility

In the context of research, responsibility is strongly tied to ethics. It is important to always consider the responsibility of researchers when ensuring ethical standards are followed and considered. Additionally, while some approaches to research and lines of investigation may be ethical, they may not be responsible, depending on your perspective.

Reflection question

1. Is it justified (responsible) for researchers to deceive participants with potential false memories to discover the extent to which our memory is valid?

Emotional states can also influence our memory, often strengthening memory consolidation for events that are highly emotional. This is supported by the theory of flashbulb memories, which suggests that emotionally charged events can create vivid, long-lasting memories. Flashbulb memories usually revolve around significant personal events that cause intense emotions, such as the death of a loved one. However, these emotional memories are not always accurate. Strong emotions can distort memories, leading individuals to 'reconstruct' their memory of the event. For example, this has been demonstrated in the weapon focus effect (Steblay, 2023 (http://doi.org/10.1093/obo/9780199828340-0313)), where attention may narrow to specific details such as a weapon, causing participants to miss other details (such as what the perpetrator looked like) in an emotionally charged event. Despite this low accuracy, individuals tend to be highly confident in their flashbulb memories.

Student view

HL Extension

Culture

Culture can influence memory in several ways, shaping how people encode, store and retrieve information based on shared values, experiences and cognitive frameworks. For example, in individualistic cultures (such as the UK and the USA), memories focus on personal achievements, unique experiences and individual emotions. In contrast, in collectivistic cultures (such as East Asia), memories may centre around family, community and social roles, or events that affect the wider community rather than oneself.

In their study, Wang (2004) (https://doi.org/10.1037/0012-1649.40.1.3) found that European American children had autobiographical narratives that were longer, more detailed and focused on personal experiences, individuality and emotional expression. However, Chinese children's narratives were shorter, less detailed and centred on social interactions, group activities and moral lessons.

Reflection questions

1. How can Wang's findings help you understand the role of culture on your learning?
2. In what real-life situations would these findings be useful?
3. Conduct research on a culture of your choice (different from your own culture). What does the evidence say about learning and/or cognition in this culture? Are education systems (schools or universities) different or similar in this culture compared to your own culture?

Strategies for enhancing memory

It is always important to consider ways in which psychological knowledge can be applied to your own life. For example, as a student who frequently has to remember a lot of new stuff, knowing how to make remembering easier can be a valuable thing (**Table 1**).

Table 1. Strategies for enhancing memory.

Strategy	What it is	Research supported
Chunking	Grouping disparate stimuli into small groups of stimuli with greater meaning. For example, when remembering a random string of letters such as USAFBIUK, you can chunk it into USA — FBI — UK, which is easier than remembering a string of random letters that have no meaning.	Through a series of experiments in 1956 (https://doi.org/10.1037/h0043158), George Miller found that chunking can be a useful memory tool.
Visual mnemonic	The strategy of linking stimuli to a visual anchor, and thus encode the information through visual encoding — a superior encoding technique given humans have highly developed neurobiology for vision. For example, let's say you want to remember that the chemical symbol for sodium is Na. You might create a visual mnemonic where you imagine an 'N' (for Na) shaped like a salt shaker, with an 'a' dancing around it.	Luan et al. (2022) (https://pmc.ncbi.nlm.nih.gov/articles/PMC8865088/) found that using visual mnemonic techniques increased long-term memory capabilities in students ages 10—16 years old.

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Strategy	What it is	Research supported
Active rehearsal (retrieval practice)	Quizzing yourself on content contained within a stimulus	Research conducted by Purdue University (https://www.science.org/doi/abs/10.1126/science.1199327) (2011) compared active rehearsal (retrieval practice) to elaborative rehearsal via concept mapping as well as standard 'cramming'. The researchers found that when university students were given a test on novel material immediately after reading it, they had greater long-term memory in regard to that material then students in the other rehearsal type conditions.

Teacher instructions

Goal

- To analyse the validity and reliability of eyewitness accounts from a given scenario.

Facilitation guidance

In the activity, students will apply their understanding of the factors influencing the validity and reliability of memory to different scenarios. Ask students to analyse one scenario each in pairs or small groups, share their analysis, and then come together as a whole group to discuss the most accurate testimonies. Direct students to justify their responses.

Individually, students will reflect on what they have learned from the activity.

Activity

From Syllabus:

IB learner profile attribute: Thinking/Communicating/Reflective

Approaches to learning: Thinker/Social skills/Researcher

Time required to complete activity: 30 minutes

Activity type: Group

Crime scene investigators

A valuable item has gone missing from a local museum during a crowded school trip. There are only the testimonies of four eyewitnesses to help solve the crime: a tour guide, a teacher, a student and a security guard.

- The tour guide recalls seeing a tall person in a red coat near the display. He was asked by a journalist, 'Did you see the thief grab the artefact?' However, during the time of the event, he was answering questions for a group of visitors.
- The teacher claims they saw a person in a blue hoodie acting suspiciously. However, the teacher was primarily focused on managing their students. They also felt quite stressed because one student went missing during the trip.
- The student states they saw someone running away but admits they were distracted by their phone. They later told their parents, who suggested the thief might have been a museum worker.
- The security guard saw someone leave the museum in a hurry. They did state that they were on their third cup of coffee as it was the middle of their shift. They also reviewed security footage but only after the artefact went missing, potentially influencing their account of the event.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

In your small group, analyse **one** testimony and identify factors that could influence the reliability and validity of your allocated witness's testimony. Share your findings with the class.

As a class, discuss which testimonies are more likely to be accurate and why.

Individually, answer the following questions:

1. How might leading questions or suggestions alter the eyewitness accounts?
2. What role did attention, emotion or distraction play in shaping memory validity?
3. **(Concept application: measurement)** As a researcher, how would you define 'reliable' information? How does the definition of this term impact the **measurement** of memory?

Learning outcomes

By the end of this section, you should be able to:

- Describe the role of schema theory in understanding a cognitive process.
- Describe the role of schemas in thinking and/or learning by outlining their influence on cognitive processes and knowledge acquisition.
- Identify the role of one or more cultural factors in one cognitive process.
- Discuss the potential influence of one or more environmental factors on one cognitive process.
- Describe one or more strategies to improve one or more cognitive processes.

HL Extension

- Discuss the role of culture on learning and cognition.
- Discuss the extent to which learning and cognition across cultures is similar and different.

3 section questions

Question 1

SL HL Difficulty:

1 Schemas ✓ help organise information but may lead to distorted memories by filling in gaps with 2 prior ✓ knowledge.

Accepted answers and explanation

#1 Schemas

#2 prior

General explanation

Schemas help organise and interpret information, but they can lead to distorted memories by filling in gaps with prior knowledge or expectations.

Question 2

SL HL Difficulty:

Which of the following is an example of how a leading question can influence memory?

1 Asking 'Did you see **the** broken glass?' increases the likelihood of remembering broken glass, even if none was present. ✓

2 Using open-ended questions ensures that participants recall all details accurately.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

3 Repeated questioning makes it less likely that participants will change their answers.

4 Leading questions only influence eyewitnesses if they are under high levels of stress.

Explanation

Leading questions suggest specific details, such as '**the** broken glass,' which can cause us to reconstruct our memory for events, using the information to 'fill in the gaps'.

Question 3

SL HL Difficulty:

Which combination of factors is most likely to reduce the validity of eyewitness memory during a crime?

1 A highly stressful situation with a visible weapon and suggestive questioning. ✓

2 A calm environment and questions about peripheral details.

3 A familiar environment and questions phrased in neutral language.

4 A witness recalling the event shortly after it occurred.

Explanation

A highly stressful situation with a visible weapon diverts attention from peripheral details, and suggestive questioning can further distort memory accuracy.

Previous section(/study/app/psychology-new/sid-540-cid-763690/book/what-evidence-exists-in-support-of-one-or-more-models-of-memory-id-50538/re

Student view

What role does biology play in memory?

A-5: Perspective B-4-2-1: Identify the role of one or more biological factors in one or more cognitive processes.

C-1-5a: Evaluate the role of localisation of function in explaining human behaviour and cognition. C-1-5b: Identify limitations of the argument that behaviour is localised.

C-1-8: Describe the value of animal research in the study of human behaviour and identify the ethical considerations in the use of animals in research.

C-1-9: Discuss the strengths and limitations of a reductionist approach to the study of behaviour.

Teacher instructions

Learning outcomes

- Discuss how research into the biological correlates of memory support a reductionist perspective to understanding human behaviour.
- Discuss the role of localisation of function in explaining human behaviour and cognition.
- Identify limitations of the argument that behaviour is localised.
- Discuss the strengths and limitations of a reductionist approach to the study of behaviour.
- Identify the role of one or more biological factors in one or more cognitive processes.
- Describe the value of animal research in the study of human behaviour and identify the ethical considerations in the use of animals in research.

Facilitation guidance

This section examines the relationship between our biology and cognition. Students will learn about the brain structures involved in memory formation, storage and retrieval. The aim of this section is to help students understand how biological factors contribute to memory processes and how they can be influenced by internal and external conditions. Encourage students to think about the use of a reductionist approach when researching the correlation between biology and cognition.

? Guiding question(s)

In this subtopic, you will think about the question, '**To what extent is memory a valid source of knowledge?**' This section will help you make an informed response by working through the following guiding question:

- What role does biology play in memory?

The focus of this section is on the biological correlates of memory and research into memory. The key brain regions discussed are the hippocampus and the amygdala. Work by Kandel (memory formation, long-term potentiation and sea slug work), Maguire (taxi-driver study), Scoville and Milner (H.M. case study), LeDoux (fear conditioning and short road/long road) are featured.

Given the heavy use of animals in research by some of the most well-known memory researchers, the application of animal models to humans is also discussed.

> Keep the guiding question in mind as you progress through this section. The guiding question builds into the subtopic question. You will return to the subtopic question(s) at the end of each subtopic. The subtopic questions require you to pull together your knowledge and skills from different sections, to see the bigger picture and to build your conceptual understanding.

Overview (/study/app/psychology-new/sid-540-cid-763690/c

The brain and memory

We know memories move into long-term memory through rehearsal, but what actually happens in the brain when we are encoding and retrieving this information? Where are memories made and stored?

Making connections

In **section 3.1.1** (/study/app/psychology-new/sid-540-cid-763690/book/what-is-the-role-of-biology-in-human-development-id-50514/), you learned about the critical role of neuroplasticity in brain development. When we learn new skills and form new memories, the neural pathways that are frequently used are strengthened in a process called long-term potentiation. This enables our brain to change in structure and function throughout life, and is crucial for learning and memory.

Memory involves the functional and structural change of neural networks. When we learn new information, connections between neurons are strengthened due to the repeated, frequent stimulation, and these synapses become more efficient at communicating with each other. This process is known as long-term potentiation. Memory is a complex process, but there are a few key brain structures that play an important role in this process (**Figure 1**).

Concept

Perspective

Understanding the reductionist perspective

- Kandel's research (2012) (https://doi.org/10.1186/1756-6606-5-14) on a type of sea slug, Aplysia, distinguished between short-term memory (STM) lasting minutes to hours and long-term memory (LTM) lasting days to years, revealing different molecular-level processes for each.
- Kandel's research revealed that learning and memory are based on changes in synaptic strength and structure. STM involves changes in neurotransmitter release, while LTM requires structural changes in synapses.
- Kandel's findings were key in understanding the role of synaptic plasticity in learning and memory — the brain's ability to modify and create new connections between synapses.
- These findings have been applied to humans. However, the Aplysia has a relatively simple nervous system with only about 20,000 neurons.

Reflection question

1. To what extent does research, such as that conducted by Kandel, into the biological correlates of memory illustrate and support a reductionist perspective to understanding human behaviour?

Student view

Overview (/study/ap new/sid-540-cid-763690/c

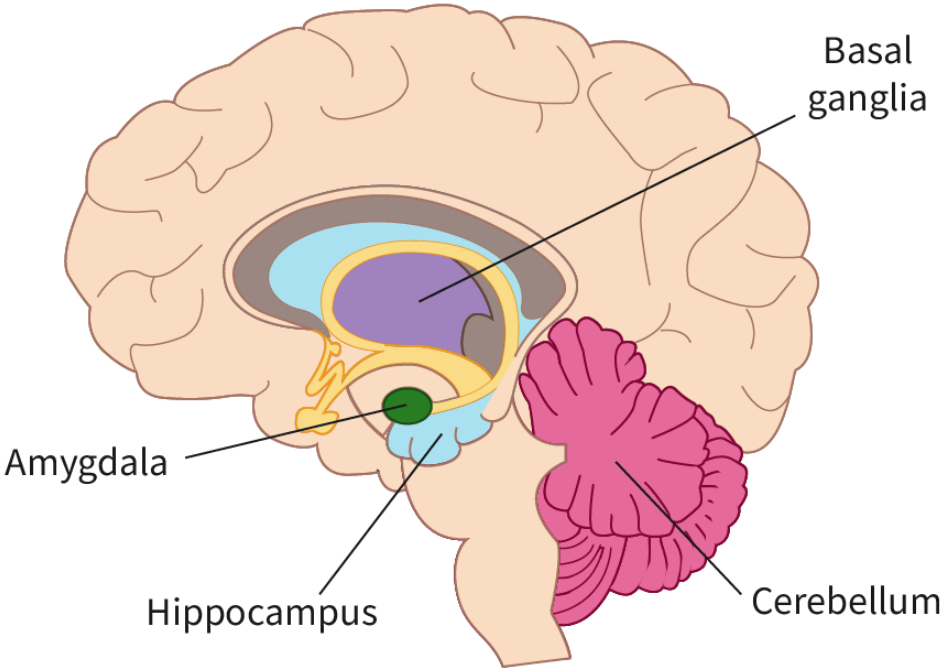

Figure 1. The key brain structures involved in memory.

More information for figure 1

Cross-section of the brain. The hippocampus is positioned deep within the temporal lobes. The amygdala is adjacent to the hippocampus. The cerebellum is located at the bottom rear of the brain. The basal ganglia are located near the centre of the brain, surrounding the thalamus.

The hippocampus

The hippocampus (see **Figure 1**) is a key structure in the limbic system of the brain, and is involved in learning and memory. The hippocampus is essential for the formation of declarative memories, for example, remembering the capital city of your home country, or the date of your birthday. It transfers short-term memories into long-term storage. Additionally, the hippocampus helps you process spatial relationships, for example, navigating your way home.

Maguire et al. (2000) (https://doi.org/10.1073/pnas.070039597) provided evidence for this by using magnetic resonance imaging (MRI) to examine the brains of London taxi drivers. These taxi drivers undergo an intense training program, called 'The Knowledge', where they have to memorise over 25,000 street names in London and numerous points of interest. Taxi drivers had significantly larger posterior hippocampi compared to control participants, while their anterior hippocampi were smaller, indicating that the posterior hippocampus is associated with spatial memory. The longer the taxi drivers had spent driving, the higher the volume of their posterior hippocampus. This study also demonstrates the concept of neuroplasticity – the brain's ability to change and adapt in response to experiences, learning or environmental demands.

Evidence for the role of the hippocampus in memory also comes from case studies of **amnesia**, a memory disorder where individuals lose the ability to remember information. Retrograde amnesia is where individuals are unable to remember events before a certain time period, whereas anterograde amnesia is where individuals are unable to create new memories after a certain point. Due to the role of the hippocampus in the creation of new memories, damage often results in anterograde amnesia.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

One prominent case study is H.M., or Henry Molaison (Scoville and Milner, 1957 (https://doi.org/10.1136/jnnp.20.1.11)), who had his hippocampus removed to reduce severe seizures after a bike accident in childhood. Despite being able to remember most things that had occurred before the surgery, H.M. developed anterograde amnesia, and entirely lost the ability to form new long-term memories. For example, he would watch the same movies over and over again, with no memory of having watched them before. However, H.M. still retained the ability for other types of memory. When asked to trace a star shape repeatedly, he showed significant improvement in the task, despite having no memory of having performed the task (**Figure 2**). This demonstrated that his procedural memory was still intact, and the hippocampus is not responsible for this type of memory.

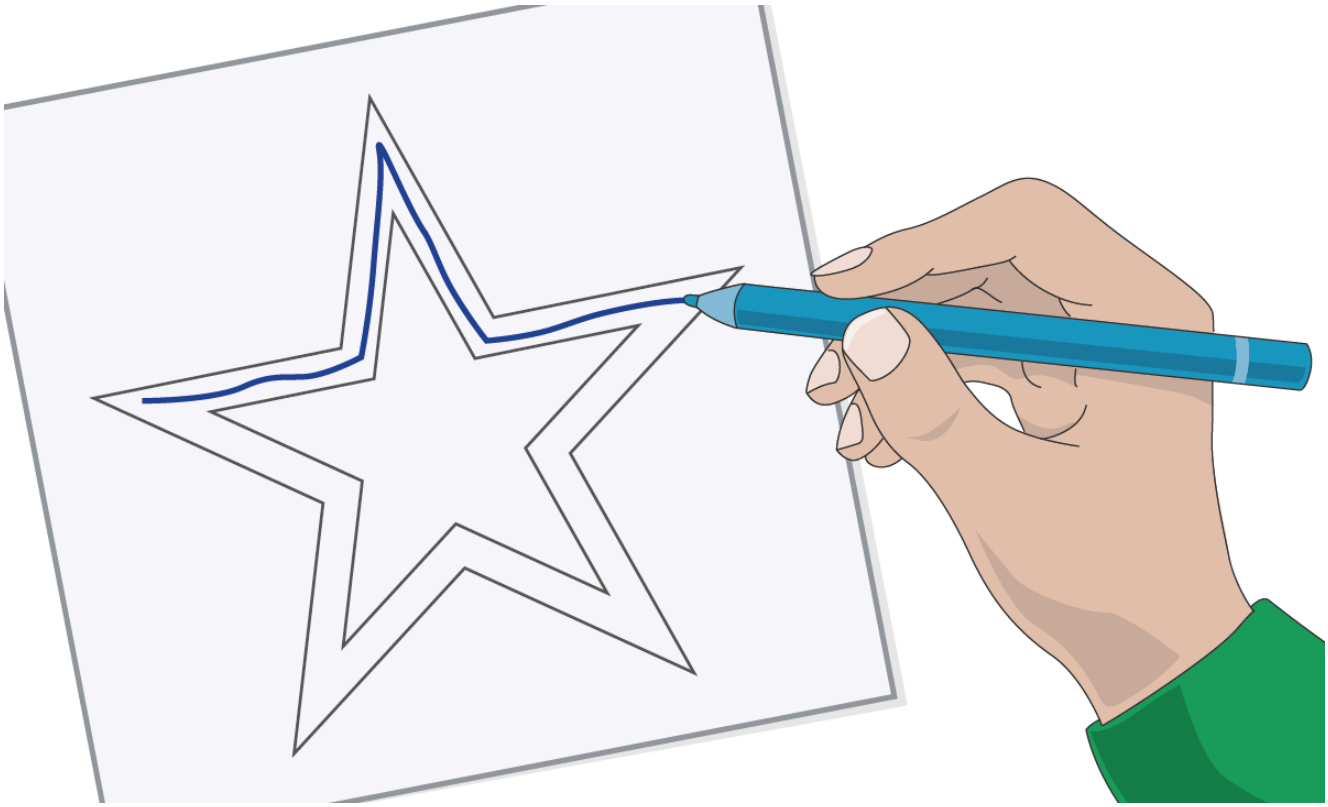

Figure 2. H.M. was able to improve on the star-tracing task, demonstrating his procedural memory was intact.

The cerebellum and the basal ganglia

Procedural memory is mainly supported by the cerebellum and the basal ganglia (see **Figure 1**). The cerebellum is important in learning motor skills and habits, as it is associated with motor control and coordination. For example, when you learn a new task, such as riding a bike or playing an instrument, the cerebellum helps to refine these skills over time. In contrast with declarative memory, which is explicit, this procedural memory is implicit, meaning it operates without our conscious awareness.

However, it is important to understand that procedural memory may not be localised to just the cerebellum. A network of brain structures are involved in procedural memory depending on the task, including the basal ganglia. Patients with diseases affecting the basal ganglia (https://doi.org/10.1093/oxfordhb/9780190917982.013.9) (for example, Parkinson's disease) are unable to perform tasks requiring procedural memory, despite their cerebellum being unaffected.

Making connections

Classical conditioning and the brain

Student view

- Kandel's work (https://www.funjournal.org/wp-content/uploads/2020/11/june-19-r19.pdf) (in 1997) on the sea slug, Aplysia californica, gave us insights into the neural mechanisms behind classical conditioning (**section 5.1.3**

Overview (/study/app/psychology-new/sid-540-cid-763690/c

(/study/app/psychology-new/sid-540-cid-763690/book/what-role-does-conditioning-play-in-behaviour-id-50531/)).

- His work demonstrated that conditioning led to changes in the strength of synaptic connections between sensory and motor neurons in the brain.
- This provided evidence for the concept of neuroplasticity, showing that the brain can rewire itself through experiences such as learning.
- LeDoux's work (https://doi.org/10.1523/jneurosci.08-07-02517.1988) (in 1988) demonstrated that the amygdala is the 'centre' for fear conditioning. It associates the neutral stimulus with the unconditioned undesirable stimulus.
- After conditioning, LeDoux found that the amygdala is responsible for triggering the conditioned response to the neutral stimulus.
- He found that damage to the amygdala prevented the expression of these fear responses.

The amygdala

Another important brain structure involved in memory is the amygdala (see **Figure 1**), specifically the formation, storage and retrieval of emotional memories. The amygdala enhances the consolidation of emotionally arousing events, and works with brain regions such as the hippocampus to ensure that these memories are remembered vividly for a long period of time.

The amygdala is activated during highly emotional events, by stress hormones that are released, including epinephrine and cortisol. The amygdala then has an influence on related brain regions, including the hippocampus and prefrontal cortex, facilitating long-term memory storage. This mechanism is useful for survival, as critical information about threats or rewards is remembered, in comparison to more neutral events. For example, if someone gets chased by a dog after taking a wrong turn on their walk to a friend's house, they remember not to go that way next time.

Perspective lens

Biological approach

The biological approach to understanding behaviour emphasises the role of biological processes in influencing behaviour. In this section, memory and learning can be explained by the brain's neural processes, such as synaptic plasticity and structural changes in the brain.

However, simplifying complex cognitive processes like memory to purely cognitive processes is said to be reductionist. Using a reductionist approach to understand memory overlooks the influence of factors such as the environment, cognitive strategies and social interactions. In order to understand cognitive processes, a holistic approach using several psychological perspectives should be used.

There are several limitations when using a reductionist approach to understand cognition:

- Oversimplification of cognition to basic biological processes.
- This approach often fails to address 'why' cognitive processes occur, instead of focusing on the 'how'.
- The interaction between variables contributing to cognition is often overlooked, as variables are isolated.
- This approach often leads to deterministic views, ignoring free will and agency over cognition. This can possibly change attitudes towards responsibility for behaviour.
- There are limited real-world applications.

Reflection questions

1. For each of the limitations above, identify an example from this subtopic — this can either be from a research study or a concept.
2. The reductionist approach has several criticisms, however, there are many strengths to using this approach to understand behaviour. Explain three strengths of using a reductionist approach to understanding memory.

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Evidence for this comes from LeDoux's research on rats (https://www.simonandschuster.com/books/The-Emotional-Brain/Joseph-Ledoux/9780684836591) , which demonstrated that when the amygdala is removed, or partially removed, immediate threat responses are lost. In addition, the consolidation of long-term emotional memories is also reduced, indicating that the amygdala plays a crucial role in the processing of emotional memories. The amygdala is not a storage site for long-term emotional memories, but it does impact the way that they are encoded or consolidated. So, if the amygdala is removed, long-term emotional memories are still retained, but may lack vividness or salience.

The case study of S.M. (https://doi.org/10.1038/30982) (in 1998), a woman with damage to both sides of her amygdala, further supports the role of the amygdala in processing and remembering emotional stimuli. Because of the damage to her amygdala, she had difficulty developing a fear response during tasks that involved conditioning fears, as well as recognising fear in facial expressions.

LeDoux theorised that the brain processes emotional stimuli, such as fear, in two ways. This is known as the two-route theory (**Figure 3**).

- The **low road** is a rapid, reflexive response to stimuli, with information going directly from the sensory thalamus (a structure that acts as a relay centre for sensory information) to the amygdala. For example, a person is going on a hike, sees a snake and freezes immediately.
- In contrast, the **high road** is a slower and deliberate response to emotional stimuli. This involves the sensory thalamus, the sensory cortex and the hippocampus, before eventually reaching the amygdala. The sensory cortex determines the precise nature of a stimulus and the hippocampus provides context and memory to the response. For example, the person may see a snake, then engage in a more conscious, detailed analysis of the stimulus to realise that it is actually just a stick. This road takes longer to process emotional stimuli, but is more precise.

Both roads are beneficial. The low road ensures survival by immediate reactions, and the high road allows you to make more informed, accurate decisions.

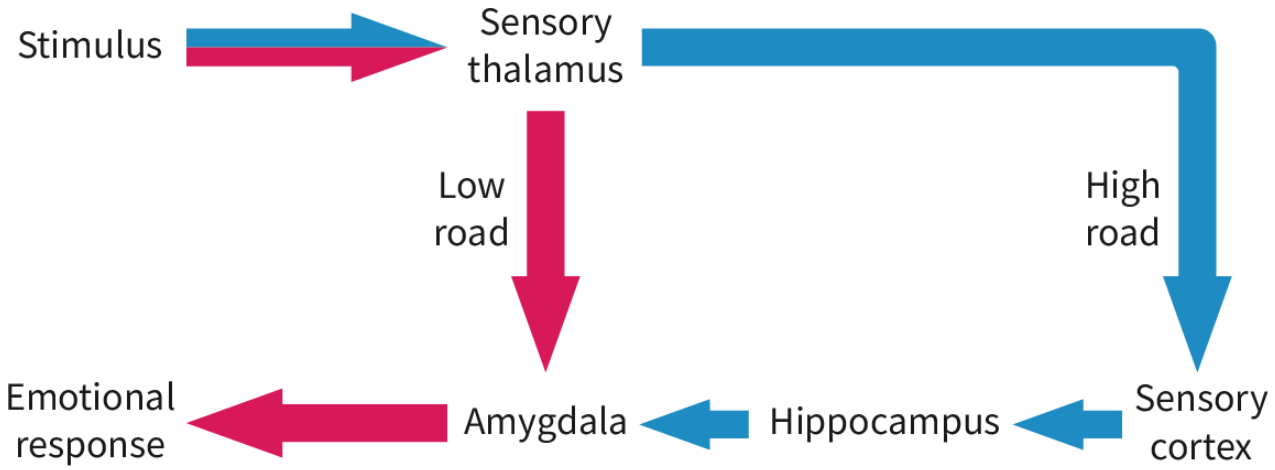

Figure 3. LeDoux's two-route theory of processing emotional stimuli.

More information for figure 3

Flowchart showing two emotional processing pathways in the brain, the low road and the high road. Both roads first lead from the stimulus to the sensory thalamus. The low road leads directly from the sensory thalamus to the amygdala and produces an emotional response. The high road goes from the sensory thalamus to the sensory cortex, then to the hippocampus, before reaching the amygdala and producing an emotional response.

Student view

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Animal research

Animal research, like Ledoux's research on rats and Kandel's research on sea slugs, has played a crucial role in understanding cognitive processes, such as memory, by allowing researchers to study brain structures, neural mechanisms and learning processes in ways that would not be ethical with humans. However, whenever animals are used in research, they must be treated in a humane way, as they can still experience distress and pain, just like humans. Researchers also need to ensure they uphold scientific integrity, so that their findings are valid and reliable. Russell and Burch (1959) (https://caat.jhsph.edu/the-principles-of-humane-experimental-technique/) developed the 3R's principle to ensure ethical treatment of animals:

- **Replacement:** Use alternatives (for example, computer models, cell cultures) whenever possible.
- **Reduction:** Minimise the number of animals used while maintaining scientific validity.
- **Refinement:** Improve procedures to minimise pain and distress.

The American Psychological Association has developed their own guidelines (https://www.apa.org/science/leadership/care/animal-guide.pdf) for the ethical use of animals in research. These guidelines reflect the 3R's principle and, in addition, emphasise that the potential benefits of the study must outweigh any potential harm to the animals. They also stress the importance of researchers being adequately trained and competent in the procedures they perform in animal research.

Teacher instructions

Goals

- Research one brain region related to memory.
- Describe how memory is an interaction of many brain parts.
- Discuss the limitations of the reductionist approach to understanding memory.

Facilitation guidance

This activity has three parts to it:

- In the first part, small groups research one specific brain region related to memory from the main regions covered in this section.
- They then collaborate with the other groups to process scenarios, enabling them to see that memory isn't just 'localised' to one brain region, but is an interaction between many parts.
- Finally, the group engages in a discussion using the questions, emphasising limitations of a reductionist perspective to understanding memory.

Activity

IB learner profile attribute: Communicator/Inquirer/Knowledgeable

Approaches to learning: Thinking/Researching

Time required to complete activity: 45 minutes

Activity type: Group

Student view

Brain gallery

Your teacher will allocate a specific brain region related to memory (hippocampus, amygdala, cerebellum) to each group.

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In your group, create a visual 'exhibit' (such as a poster or a 2-minute video).

Include:

- the role your assigned brain region plays in relation to memory.
- what might happen if there is damage to this part of the brain.
- one research study that demonstrates the role of this brain region in memory.

Share this information in your class exhibition.

Scenarios

Collaborate with the other groups to 'process' the following scenarios, describing how your assigned brain region contributes in each situation.

1. You are giving a presentation in class when you suddenly feel nervous and your palms sweat. Later, whenever you think about public speaking, you feel the same nervousness.
2. You are at a family dinner and someone mentions your first day of school. You suddenly recall the details: the colour of your backpack, your nervous excitement and meeting your teacher.
3. You are walking down the street and see someone who looks familiar. After a moment, you realise it's an old friend you haven't seen in years.
4. You visit a new city and navigate your way back to your hotel without a map, relying on landmarks you noticed earlier.
5. You have decided to learn how to play the guitar. On your first day, you practise basic chords. Over time, you find that your fingers naturally move to the right positions without conscious thought.

Discussion questions

In your groups, discuss the following questions:

1. What other factors may be influencing memory in the above scenarios?
2. If memory functions are localised to specific brain areas, why might damage to one region not completely erase memory? What does this suggest about how memory is stored and retrieved?
3. **(Concept application: perspective)** Discuss how research into neurologically localised components of memory supports a reductionist perspective to understanding human behaviour.

Learning outcomes

By the end of this section, you should be able to:

- Discuss how research into the biological correlates of memory support a reductionist perspective to understanding human behaviour.
- Discuss the role of localisation of function in explaining human behaviour and cognition.
- Identify the limitations of the argument that behaviour is localised.
- Discuss the strengths and limitations of a reductionist approach to the study of behaviour.
- Identify the role of one or more biological factors in one or more cognitive processes.
- Describe the value of animal research in the study of human behaviour and identify the ethical considerations in the use of animals in research.

4 section questions

Question 1

SL HL Difficulty:

Student view

If a person's ability to recall emotional memories is impaired, which brain structure is most likely affected?

Amygdala ✓

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Accepted answers

Amygdala

Explanation

If a person's ability to recall emotional memories is impaired, the amygdala is most likely affected, as it plays a key role in processing emotional memories.

Question 2

SL HL Difficulty:

Damage to the hippocampus often results in difficulties forming new 1 long-term ✓ memories. This was demonstrated through the case study of the patient known as 2 H.M. ✓ .

Accepted answers and explanation

#1 long-term

#2 H.M.

General explanation

While his short-term memory and procedural memory remained intact, he was unable to form new explicit (declarative) memories, highlighting the hippocampus's critical role in memory consolidation.

Question 3

SL HL Difficulty:

Which of the following is a potential limitation of taking a reductionist perspective in biological research on memory?

1 A reductionist approach may overlook the influence of environmental, social and cultural factors on memory formation and retrieval. ✓

2 A reductionist approach provides a detailed understanding of the molecular and neural mechanisms of memory.

3 A reductionist approach ensures that psychological and sociological factors are integrated into memory research.

4 A reductionist approach emphasises the role of neurotransmitters but does not focus on how they influence individual neurons.

Explanation

A reductionist approach in psychology involves breaking down complex phenomena into simple components. While this method can be useful for understanding specific aspects of a process, such as the biological mechanisms of memory, it may have limitations.

Question 4

SL HL Difficulty:

According to LeDoux's two-route theory, the 1 low ✓ road quickly processes sensory information for immediate action, while the 2 high ✓ road processes information more slowly for conscious evaluation.

Accepted answers and explanation

#1 low

#2 high

Student view

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General explanation

According to the theory, the low road ensures survival by enabling rapid responses to immediate threats, while the high road allows for more deliberate decision-making. Together, they strike a balance between speed and accuracy, ensuring both survival and effective long-term planning.

Previous section(/study/app/psychology-new/sid-540-cid-763690/book/what-factors-affect-the-reliability-and-validity-of-memory-id-50539/review/)

Student view

(HL) How can digital environments affect memory and cognition?

A-3: Change B-4-4-3a: (HL) Discuss the role of technology in learning. B-4-4-3b: (HL) Describe the effect of technology on cognition.

HL Extension

Teacher instructions

Learning outcomes

- Explain how environments might create change in human cognition over time.
- Discuss the role of technology in learning.
- Describe the effect of technology on cognition.

Facilitation guidance

In this section, students will learn about the influence of digital environments on cognition. Digital environments can include, and are not limited to, websites and online platforms, social media, virtual reality, video games, digital communities and forums. Cognitive processes include attention, memory, decision-making and problem-solving. This section also addresses potential benefits and drawbacks of these influences, helping students critically evaluate their own interactions with digital technology. Encourage students to critically think about the current research on the interaction between digital technology and cognition.

? Guiding question(s)

In this subtopic, you will think about the question, '**To what extent is memory a valid source of knowledge?**' This section will help you make an informed response by working through the following guiding question:

- How can digital environments affect memory and cognition?

This section is mostly designed as an HL extension section. However, SL students will also find the learning and knowledge contained within it applicable to their studies.

The focus here is on the impact of our increased digital life on cognition. Memory is still emphasised here, specifically the work by Elizabeth Sparrow on the impact of digital technology on memory.

> Keep the guiding question in mind as you progress through this section. The guiding question builds into the subtopic question. You will return to the subtopic question(s) at the end of each subtopic. The subtopic questions require you to pull together your knowledge and skills from different sections, to see the bigger picture and to build your conceptual understanding.

Digital technology

Imagine a world without digital technology. How would you communicate with people worldwide? How would you complete your homework? What hobbies would you engage in? It is hard to imagine that many of the digital tools we rely on daily (such as the Internet and a smartphone) are relatively recent inventions, and evolving rapidly.

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In October 2024, over 5.4 billion people worldwide (https://www.statista.com/statistics/273018/number-of-internet-users-worldwide/) were using the Internet, and the average time spent online per day by each user was 6.5 hours. The top three reasons for Internet usage are to find information, communicate with others and for online content consumption (watching videos, TV shows and movies). The Internet is just one type of technology; online gaming, artificial intelligence and smartphone-use are some other prominent types of technology-use. Digital technology has undoubtedly had a positive impact on our lives by increasing methods of communication, improving efficiency and speed of completing tasks, and generally making access to information a lot more convenient. We can open up an app and accomplish various tasks by simply one tap of the screen, or call family members on the other side of the world in seconds.

Concept

Change

Digital environments have become an integral part of daily life, influencing the way humans think, learn and interact. These environments often demand rapid information processing, multitasking and engagement with vast amounts of information. This may enhance certain cognitive abilities, such as visual-spatial skills and information retrieval. Alternatively, they may have a negative impact on cognitive abilities.

Reflection question

1. As you work through this section, reflect on how digital environments might create **change** in human cognition over time, and to what extent they already have created change.

Digital technology and memory

Technology has a significant influence on our cognition – how we think, process and interact with the world around us. The increasing use of technology has prompted extensive research into its impact on our cognition (**Figure 1**).

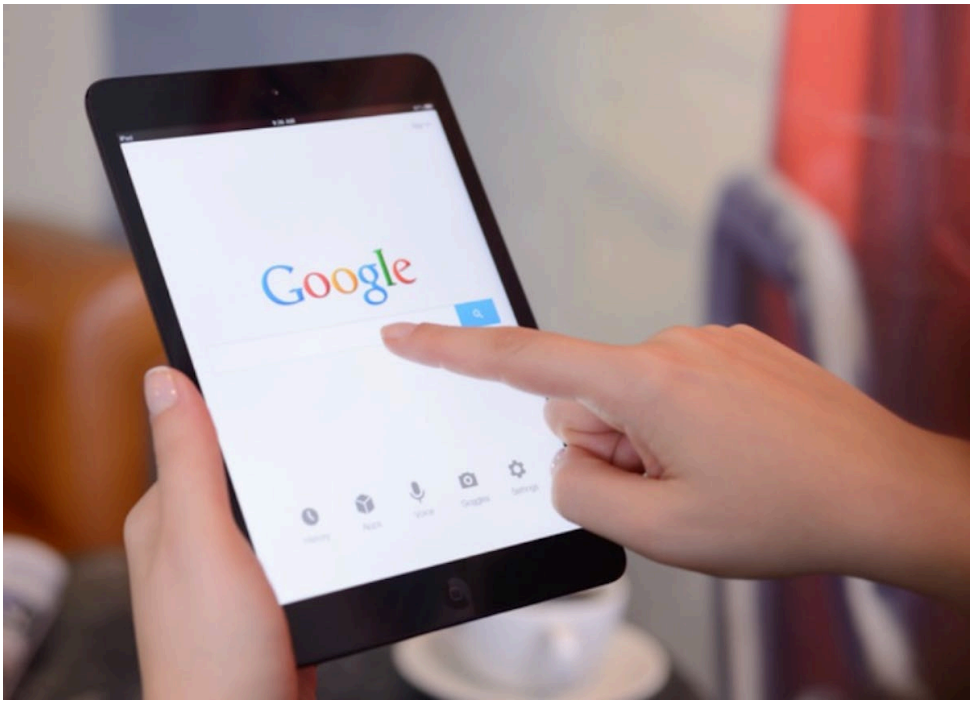

Figure 1. The 'Google effect', also known as 'digital amnesia', refers to the phenomenon where people are less likely to remember information because they know it can easily be retrieved online using search engines.

Credit: hocus-focus, Getty Images

Student view

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Google™, the most visited website on the Internet (https://www.statista.com/statistics/1201880/most-visited-websites-worldwide/), is an excellent source of information – with just a few taps on a keyboard, you can find out information about almost anything. However, is this always a good thing? The 'Google effect', also known as digital amnesia, is when we remember where or how to find information rather than the information itself. That is, people prioritise remembering the location of the information rather than the details of the information. This occurs when the information can be found easily through search engines like Google™. For example, you know that you can find trivial facts about a certain topic on Google™, rather than the facts themselves, or where to find phone numbers on your phone, rather than remembering the phone number itself.

Sparrow et al. (2011) (https://www.science.org/doi/10.1126/science.1207745) investigated how search engines like Google™ can influence our memory. The study included a series of experiments. In one experiment, participants typed trivial statements (for example, 'an ostrich's eye is bigger than its brain'[1]) into a computer. Half the participants were told the computer would save the information, and half were told the computer would erase the information. In addition, half the participants in each condition were explicitly asked to try to remember the information. Those that believed the computer erased what they had written had the best recall, regardless of being told whether or not to remember the information (**Figure 2**).

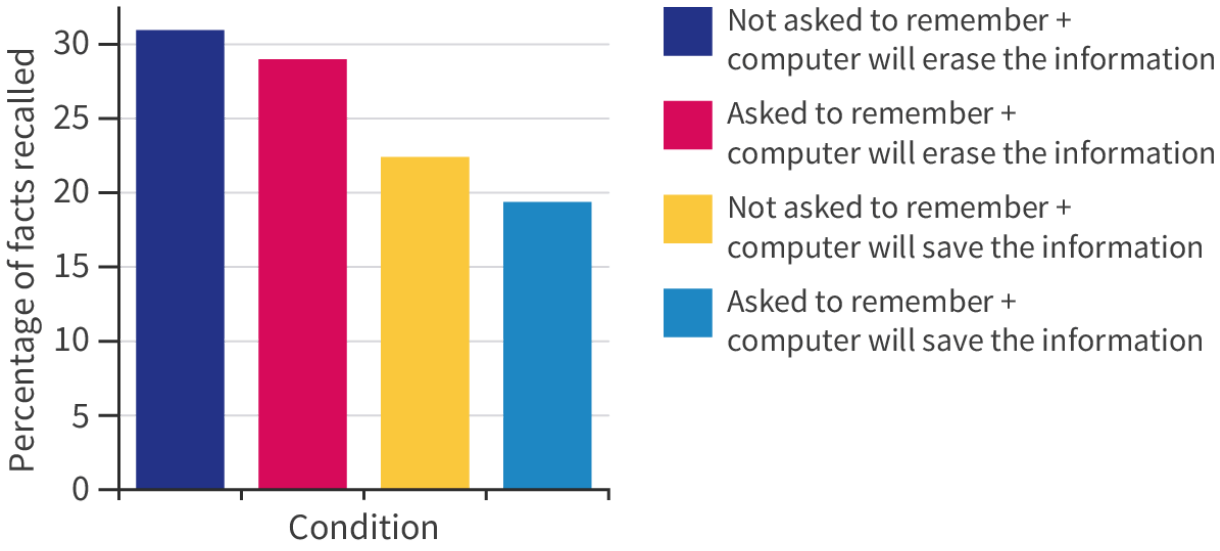

Figure 2. The results of Sparrow et al. (2011) showing memory recall based on conditions.

Source: Sparrow et al. (2011) (https://doi.org/10.1126/science.1207745)[1]

More information for figure 2

Bar graph illustrating the percentage of facts recalled under four different conditions. Condition 1 is labelled Not asked to remember and computer will erase the information. The percentage for this condition is roughly 31%. Condition 2 is labelled Asked to remember and computer will erase the information, with a percentage of roughly 29%. Condition 3 is labelled Not asked to remember and computer will save the information, with a percentage of roughly 22%. Finally, condition 4 is labelled Asked to remember and computer will save the information, with a percentage of roughly 19%.

Overall, Sparrow's research demonstrated that when we know information is easily accessible (either online or externally stored), we are less likely to remember the information itself.

The 'Google effect' can be seen as positive, as it may be an efficient use of cognitive resources, as we can use our memory for other, more important tasks. With an overwhelming amount of information available in the digital age, this could be an adaptive response. However, over-reliance on tools like Google™ may impair long-term memory and critical thinking skills.

Student view

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While smartphones have increased connectivity and put the world at our fingertips, simply their presence may be at a cost to cognition. The 'brain drain' hypothesis ((https://doi.org/10.1086/691462)Ward et al., 2017 (https://doi.org/10.1086/691462)) (https://doi.org/10.1086/691462)suggests that our brain has a limited amount of attention it can use at one time. If you are using some of that attention to stop yourself from checking your phone, there's less attention left for other things you are trying to do. This means you might not do as well on those tasks. Thus, simply the presence of a smartphone reduces the availability of our cognition.

Much of the focus of research has been on the negative impacts of technology on cognition. However, research has demonstrated that there can be several positive effects (https://doi.org/10.3390/ijerph192114009). (https://doi.org/10.3390/ijerph192114009) There is a growing body of research, in particular into adolescents, otherwise known as digital natives. 'Digital natives' are those who are born into the world with access to digital technology, whereas older adults, born into a world without technology, are known as digital immigrants.

Video games, a common activity for many adolescents worldwide, have been shown to demonstrate positive effects on cognition. Moisala et al. (2017) (https://doi.org/10.1016/j.brainres.2016.10.027) investigated the effects of gaming on working memory in 167 teens and young adults, with a range of gaming experience. Participants completed a working memory task, while researchers measured task performance and brain activity in a functional magnetic resonance imaging (fMRI) machine. There was a correlation between gaming experience and accuracy on the working memory task, as well as an increase in brain activity in areas like the prefrontal cortex (responsible for memory and attention). When the task decreased in difficulty, gamers had lower brain activity in the same areas. Gaming boosted memory skills and efficiency, even in non-expert gamers. This study demonstrates that technology, particularly gaming, can enhance cognitive abilities that are essential for learning, such as attentional control and working memory.

Additionally, Kühn et al. (2014) (https://doi.org/10.1371/journal.pone.0091506) found that teens who played more video games had thicker grey matter in specific brain areas – the left dorsolateral prefrontal cortex, which helps with planning and self-control, and the left frontal eye fields, which aid in visual attention and eye movements. Since the prefrontal cortex is involved in processes such as decision-making, cognitive control, working memory and problem-solving, this study provides evidence that gaming may positively influence cognitive abilities that are crucial for learning.

The research on technology can be problematic for several reasons:

- Often the studies are only correlational. For example, we cannot be sure whether or not gaming causes these changes or if people with better memory are more drawn to gaming.
- There are also many different types of technology, so comparing findings across studies can be challenging.
- While video games have been demonstrated to have positive effects, results vary depending on the type of video game, and the duration and frequency of use.
- Factors such as age, personality and socio-economic status can also influence how people interact with technology, and hence how it may impact their cognition.
- Technology is rapidly changing, so studying its long-term effects can be challenging. Many studies have low temporal validity, as they can be quickly outdated as soon as new technologies emerge.

Teacher instructions

Goal

- Debate the impact of digital technology on cognition in young people.

Facilitation guidance

Student view

For the activity, allocate students to a side of the debate. If suitable, you could begin by asking students to agree or disagree with the debate question, and then allocate them to the opposite of what they think to challenge their thinking. Define key terms with students before beginning — such as cognition and digital technologies. Students

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can focus on any cognitive process and any digital technology in their debates, as this will help with the post-debate discussion.

Allow students 30 minutes to research their position, using research studies and real-world examples to support their arguments. Provide example points if needed, such as the use of digital tools for learning. Remind students that there is no 'winner' of the debate — the purpose is to engage in discussion and critical thinking on a relevant topic. You can have students decide which argument was stronger, and why.

This activity can be adapted based on class size; if the class size is large, you can have two teams of each. They then debate against each other. The two teams not debating then decide which team was most persuasive and the best speaker, and vice versa. If the class size is small, then two teams will work well.

Activity

IB learner profile attribute: Communicator/Inquirer/Open-minded

Approaches to learning: Thinking/Researching/Social skills

Time required to complete activity: 60 minutes

Activity type: Group activity

Class debate

Debate question: To what extent does digital technology have a negative impact on the cognition of young people?

Your teacher will allocate you to a side to debate, either for or against the question.

- **For:** You will be arguing that digital technologies negatively impact cognition.
- **Against:** You will be arguing that digital technologies have a positive impact on cognition.

Using the debate prep sheet, research your group's position and prepare a counter argument. You must have at least two key points and at least two research studies to support your argument.

Debate structure

- **Opening statements:** 3 minutes per team. Each team presents their main argument, outlining their stance.
- **Rebuttal round:** 5 minutes per team. Each team responds to the arguments made by the other side.
- **Closing statements:** 2 minutes. Teams summarise their strongest arguments and why they believe their side is correct.
- **Class discussion:** 10—20 minutes. Teams have the opportunity to ask questions and discuss the following:

1. Do you agree with any of the arguments made by the opposing side? What is your own view?
2. Discuss any limitations in the research presented by either team.
3. **(Concept application: change)** To what extent do you agree that digital environments (for example, the Internet, social media, websites, virtual reality) create change in cognition over time?

Learning outcomes

By the end of this section, you should be able to:

- Explain how environments might create change in human cognition over time.
- Discuss the role of technology in learning.
- Describe the effect of technology on cognition.

Student view

[1] Sparrow et al. (2011) (https://doi.org/10.1126/science.1207745) 'Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips', Science, Volume 333, Pages 776—778. Copyright © 2011, American Association for the Advancement of Science

3 section questions

Question 1

SL HL Difficulty:

Which of the following best describes a way technology influences human cognition?

1. Technology shifts cognitive focus from memorising information to locating information. ✓
2. Technology eliminates the need for critical thinking and problem-solving.
3. Technology reduces the brain's ability to form new neural connections.
4. Technology prevents individuals from developing visual-spatial skills.

Explanation

With the widespread availability of information through search engines, online databases and digital tools, people are less likely to memorise facts or details because they know they can easily access them when needed.

Question 2

SL HL Difficulty:

The 1 Google ✓ effect is the phenomenon where people are 2 less ✓ likely to remember information because they know it can easily be retrieved online.

Accepted answers and explanation

#1 Google

#2 less

General explanation

The Google effect, also known as digital amnesia, refers to the phenomenon where people are less likely to remember information because they know it can easily be retrieved online using search engines like Google™. Instead of committing the details to memory, individuals focus on remembering how or where to find the information.

Question 3

SL HL Difficulty:

Which of the following is a common issue when studying the effects of digital technology on human cognition?

1. Difficulty in isolating the effects of digital technology from other influencing factors ✓
2. The lack of available digital devices for research purposes
3. Ethical concerns about exposing participants to digital environments

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4 The inability to study short-term impacts due to rapidly evolving technology

Explanation

Human cognition is shaped by a wide range of variables, including education, culture, socio-economic status and individual differences in experience and habits. Digital technology use often overlaps with these factors.

Previous section(/study/app/psychology-new/sid-540-cid-763690/book/what-role-does-biology-play-in-memory-id-50540/review/) Next section

Student view

Activity sheet: To what extent is memory a valid source of knowledge?

Teacher instructions

Learning outcomes

- Discuss limitations of measurement in investigating theories of memory.
- Describe the role of schemas in thinking and/or learning by outlining their influence on cognitive processes and knowledge acquisition.
- Identify the role of one or more cultural factors in one cognitive process.
- Discuss the potential influence of one or more environmental factors on one cognitive process.
- Describe one or more strategies to improve one or more cognitive processes.

Facilitation guidance

These activities aim to help students understand the validity of memory as a source of knowledge. Students will analyse two prominent studies on the reliability of memory, then evaluate these studies. This can be done individually, or students can complete this in pairs, where each student researches one study.

Figure 1. Is memory a valid source of knowledge?

Credit: XiXinXing, Getty Images

In this activity, you will be applying your knowledge of the validity and reliability of memory. You will investigate two prominent research studies in the field of eyewitness testimony, and use these studies to critically think about this research and what it suggests about memory.

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? Subtopic question(s)

During this activity sheet, you will be working towards answering the following subtopic question:

- To what extent is memory a valid source of knowledge?

Before you start

Make sure you have completed **section 5.2.0** (/study/app/psychology-new/sid-540-cid-763690/book/the-big-picture-id-49673/) to **section 5.2.4** (/study/app/psychology-new/sid-540-cid-763690/book/how-can-digital-environments-affect-memory-and-cognition-id-50541/) and the related activities!

Part A

Knowledge and understanding

Which of the following is **not** a limitation of using the experimental method to investigate memory processes?

1 Experimental controls can help isolate specific variables. ✓

2 Experiments may lack ecological validity due to artificial settings.

3 Participants might behave unnaturally under observation.

4 The results may not generalise to real-world memory use.

The influence of 1 leading ✓ questions on eyewitness testimony directly challenges the reliability of memory.

According to schema theory, prior knowledge influences memory reconstruction. How might this process affect the validity of memory as a source of knowledge?

1 It introduces distortions based on expectations or stereotypes. ✓

2 It makes memory entirely objective and reliable.

3 It prevents any errors in memory recall.

4 It ensures memories are encoded in perfect detail.

Part B

Application and analysis

Two prominent research studies that investigate the reliability and validity of memory are Loftus and Palmer (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3) and Yuille and Cutshall (1986) (https://doi.org/10.1037/0021-9010.71.2.291) . Loftus and Palmer investigated the effect of leading questions on memory distortion using controlled experiments and videos of car crashes. Yuille and Cutshall examined eyewitness memory in a real-life crime, emphasising the accuracy and stability of memory over time.

Student view

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Research these two studies and create a comparison chart, including the following categories:

- Setting (real-life vs. experimental)
- Participants used (for example, university students)
- Type of event studied (real crime vs. simulated event)
- Factors affecting memory (for example, leading questions, emotional involvement)
- Key findings on reliability (for example, distortion vs. accuracy)
- Strengths and limitations of the methods used.

Share your chart with a peer and compare your findings.

Key

Category	Yuille and Cutshall (1986)	Loftus and Palmer (1974)
Setting	Real-life field study (shooting incident in Vancouver)	Laboratory experiment (participants watched car accident videos)
Participants	13 real witnesses of a real-life armed robbery and shooting in Canada	45 (Experiment 1) and 130 (Experiment 2) university students
Type of event studied	Real crime (high emotional arousal due to life-threatening event)	Simulated event (video clips of car accidents, low emotional impact)
Factors affecting memory	• Emotional involvement and high stress. • Potential post-event information from media. • Motivation to recall accurately due to real-life stakes.	• Leading questions (e.g. 'smashed' vs. 'hit') influencing memory. • Lack of emotional involvement. • Demand characteristics in a lab setting.
Key findings on validity	• Memory was highly accurate even after several months. • Leading questions had little effect on recall. • High ecological validity due to real-life setting.	• Memory was distorted by leading questions. • Participants' estimates of speed changed based on the verb used. • Lower ecological validity due to artificial setting.
Strengths of methods	• High ecological validity. • Real-life relevance. • Demonstrates that memory can be accurate despite time and leading questions.	• High control over variables. • Demonstrates how easily memory can be distorted. • Useful in understanding the reconstructive nature of memory.

Student view

Category	Yuille and Cutshall (1986)	Loftus and Palmer (1974)
Limitations of methods	• Small sample size. • Lack of control over external variables (e.g. media influence). • Ethical concerns (reliving trauma). • Hard to replicate the study again.	• Low ecological validity (lab setting). • Demand characteristics may have influenced responses. • Participant variability may have played a role in the difference between conditions.

Part C

Synthesis and evaluation

Using your comparison chart from **Part B**, answer the following questions.

Why might memory be more valid in Yuille and Cutshall's study compared to Loftus and Palmer's?

Key

- Yuille and Cutshall's study was conducted using a real-life crime. This means the study has high ecological validity, and you could argue that it reflects memory more in a real-life situation. The personal involvement could have enhanced memory retention.
- On the other hand, Loftus and Palmer's study was conducted in a controlled setting with a task that was not typical of an everyday task. So, you could argue that the activity was far less engaging and reduced memory recall.

How does emotional arousal impact memory reliability in these studies? What other factors might impact the reliability and validity of memory in these studies?

Key

- In the Yuille and Cutshall study, witnesses experienced high levels of emotional arousal, potentially creating flashbulb memories (vivid, detailed memories of significant events).
- In the Loftus and Palmer study, the participants' emotional arousal was minimal because they were simply watching recorded footage, making their memories more prone to distortion from external influences, such as leading questions.
- Other factors that could have influenced the research of Yuille and Cutshall are: rehearsal, time delay, post-event information, motivation.
- Other factors that could have influenced the research of Loftus and Palmer are: artificial setting, demand characteristics, lack of emotional involvement, leading questions, short timeframe.

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How might the findings from these studies influence real-life applications (e.g. eyewitness testimony)?

Key

- Yuille and Cutshall suggested that in high-stress situations (e.g. crimes), eyewitnesses might provide reliable accounts, especially when their memories are tied to strong emotional experiences.
- Loftus and Palmer's study raises concerns about how police, lawyers or investigators phrase questions when interviewing witnesses, as subtle changes in wording can alter memory recall.

Concept: What limitations are there with the measurement of memory in both studies?

Key

- In the Loftus and Palmer study, memory was tested through recall of specific details (e.g. car speed) rather than a holistic account of the event. This focus may miss how memory works in more complex or emotional real-life scenarios.
- Yuille and Cutshall's study was conducted in a real-world setting, making it harder to control external variables, such as media influence, witness discussions or individual differences. These uncontrolled factors may have influenced witnesses' memory, making it difficult to isolate the exact cause of accurate recall.
- Memory was measured through self-reports, which rely on participants accurately recalling and communicating their memories. Self-reports are often subjective and prone to errors.

Motivation may be one factor that influences the reliability and validity of memory. In what ways could motivation lead to both enhanced reliability and potential distortion of memory?
(For example, motivation can direct attention.)

Key

- In Yuille and Cutshall's study, witnesses to the real-life shooting were highly motivated to recall details accurately because the event had real-world significance.
- Their memories could have legal implications, making them more motivated to provide precise and truthful accounts. This could lead to the high accuracy and reliability of memory.

Student view

- In Loftus and Palmer's study, participants were university students watching video clips of car accidents in a lab setting, with no real-life consequences attached to their recall.
- Their motivation to provide accurate memory recall may have been lower, since the task was artificial, with no personal relevance or stakes. This likely made participants more susceptible to memory distortion from leading questions.

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Summary

In this activity, you learned about the various factors that influence our memory through the exploration of prominent research studies. Schemas, our environment (such as misinformation) and culture are some factors that can influence the validity of our memories, in both positive and negative ways.

Reflection

Referring back to the subtopic question:

- To what extent is memory a valid source of knowledge?

How would you answer this question after completing this activity?

Previous section(/study/app/psychology-new/sid-540-cid-763690/book/how-can-digital-environments-affect-memory-and-cognition-id-50541/review/)

Student view

Checklist

Learning outcomes

By the end of **subtopic 5.2**, you should be able to:

- Describe the role of one or more cognitive models in understanding a cognitive process or behaviours.
- Describe cognitive load theory and its relationship to the working memory model.
- Discuss the value of one or more cognitive models in understanding one or more cognitive processes.
- Discuss limitations of measurement in investigating theories of memory.
- Describe the role of schema theory in understanding a cognitive process.
- Describe the role of schemas in thinking and/or learning by outlining their influence on cognitive processes and knowledge acquisition.
- Identify the role of one or more cultural factors in one cognitive process.
- Discuss the potential influence of one or more environmental factors on one cognitive process.
- Describe one or more strategies to improve one or more cognitive processes.
- Discuss how research into the biological correlates of memory support a reductionist perspective to understanding human behaviour.
- Evaluate the role of localisation of function in explaining human behaviour and cognition.
- Identify the limitations of the argument that behaviour is localised.
- Discuss the strengths and limitations of a reductionist approach to the study of behaviour.
- Identify the role of one or more biological factors in one or more cognitive processes.
- Describe the value of animal research in the study of human behaviour and identify the ethical considerations in the use of animals in research.
- Explain how environments might create change in human cognition over time.

HL Extension

- Discuss the role of culture on learning and cognition.
- Discuss the extent to which learning and cognition across cultures is similar and different.
- Discuss the role of technology in learning.
- Describe the effect of technology on cognition.

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view

Collected research studies

Teacher instructions

These are the main research studies mentioned throughout this subtopic. However, this is not an exhaustive list and you are encouraged to use other research studies that are relevant.

Students are not required to memorise all details of the studies, but may wish to include them to support their explanations.

Summary	Evaluation
Loftus and Palmer (1974) (https://doi.org/10.1016/S0022-5371(74)80011-3) **Location of study** USA **Aim** To investigate whether the wording of questions about an event could create false memories, specifically of non-existent broken glass **Method** • Participants watched a video of a car accident. • They were asked about the speed of the cars using verbs such as 'smashed' or 'hit.' • A week later, they were asked if they had seen broken glass in the accident (there was none). **Results** Participants who heard 'smashed' were more likely to report seeing broken glass than those who heard 'hit' or those who were not asked about speed. **Conclusion** The phrasing of questions can distort memory, leading to the formation of false memories.	**Strengths** • Controlled experimental design allowed for clear cause-and-effect conclusions. • Practical implications for eyewitness testimony reliability. **Limitations** • Artificial laboratory setting may reduce ecological validity. • Participants may have been influenced by demand characteristics. **Ethical considerations** • Minimal risk involved, but participants may have experienced slight distress from watching accident footage • Full debriefing was necessary to clarify the purpose of the study and eliminate any misconceptions.

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Summary

Paterson and Kemp (2006) (https://doi.org/10.1002/acp.1261)

Location of study

Australia

Aim

To investigate the influence of co-witness discussions on the accuracy of eyewitness memory

Method

- Participants viewed a simulated crime event individually.
- They were then exposed to misleading information through one of three methods:
  - Co-witness discussion (interactive conversation with another 'witness').
  - Written narratives (misleading information presented as a written account).
  - Media exposure (misleading details presented via media).
- A control group received no misleading information.
- Participants were later asked to recall the event and answer specific questions about it.

Results

- Participants exposed to misleading information through co-witness discussions were more likely to incorporate false details into their recall compared to the other methods. These participants were highly confident in their responses.
- Written narratives and media exposure also led to memory distortions but to a lesser extent.
- The control group, which did not encounter misleading information, had the most accurate recall.

Conclusion

Co-witness discussion is a particularly powerful source of post-event information and can significantly distort eyewitness memory.

Evaluation

Strengths

- The study provides insight into how post-event information affects eyewitness memory, which has significant implications for legal procedures.
- By testing multiple methods of exposure to misleading information, the study isolates the influence of co-witness discussion relative to other sources.
- The simulated crime scenario mirrors real-life situations, making the findings applicable to forensic settings.

Limitations

- Watching a simulated crime may not evoke the same emotional and cognitive processes as witnessing a real-life crime, which might influence memory.
- Participants might have guessed the study's aim and altered their responses accordingly, particularly in the co-witness discussion condition.

Ethical considerations

- Misleading information was intentionally introduced, but participants were debriefed afterwards to clarify the study's purpose and address any misconceptions.
- Care was taken to ensure that the simulated crime was not overly distressing.

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Summary	Evaluation
Loftus and Pickrell (1995) (https://doi.org/10.3928/0048-5713-19951201-07) **Location of study** USA **Aim** To investigate the reliability of memory by determining if false memories of being lost in a shopping mall could be implanted **Method** • Participants were presented with four childhood stories, one of which was false. • The false memory involved being lost in a mall and rescued by an elderly stranger. • Participants were asked to recall details about each story over several interviews. **Results** About 25% of participants 'remembered' the false memory, often adding detailed but fabricated elements **Conclusion** False memories can be implanted through suggestion, demonstrating the malleability of human memory.	**Strengths** • Practical application in understanding memory reliability, particularly in legal contexts • Novel insight into how suggestion affects memory formation **Limitations** • Small sample size limits generalisability • False memory creation may not generalise to more significant or traumatic memories **Ethical considerations** • Potential distress from realising a memory was fabricated • Full debriefing ensured participants understood the nature of the experiment

Student view

Overview (/study/app/psychology-new/sid-540-cid-763690/c

Summary	Evaluation
Luan et al. (2022) (https://doi.org/10.3389/fpsyg.2021.740829) **Location of study** China **Aim** To investigate the effect of mental imagery-based mnemonic training on improving working memory and long-term memory **Method** The experimental group of students aged 10—16 received 8 days of training in the use of cognitive-based visual mnemonics. **Results** • The training significantly increased long-term memory-related task performance. However, no statistically significant increase in working memory capacity was observed. • Researchers also found that, post-experiment, participants most frequently used their newly learned memory techniques for learning music, Chinese and English. **Conclusion** Mental imagery-based mnemonics are an effective strategy for increasing long-term memory of stimuli.	**Strengths** • Researchers conducted pre-, post- and follow-up tests (three months after experiment), which increased the validity of measuring long-term memory retention. • Equal distribution of genders • Used school-aged population, which was relevant to the aim • Conducted three different experiments to triangulate results **Limitations** • Relatively small sample sizes of less than 60 participants in each of the three experiments **Ethical considerations** • There were no serious ethical considerations involved in this study. It could be argued that students who were in the control condition and did not receive training on visual mnemonics 'suffered' via not acquiring this useful memory skill. • While not giving the treatment to participants in the control condition can be considered unethical in cases of medical necessity, being able to remember things extra well is not considered a fundamental need or right. Research considerations • Despite relatively small sample sizes in each of the four experiments, the triangulation of the results helps validity. • The population was Chinese youth, thus limited generalisation

Student view

Overview (/study/ap new/sid-540-cid-763690/c

Summary	Evaluation
Landry and Bartling (2011) (https://www.mcneese.edu/wp-content/uploads/2020/08/AJPR-11-07-Landry-5-09.pdf) **Location of study** USA **Aim** To investigate how articulatory suppression affects recall of phonologically similar letters **Method** Participants were shown lists of dissimilar letters and asked to recall them. The experimental group performed articulatory suppression (repeating '1,2') until recall, while the control group did not. **Results** The experimental group showed reduced recall accuracy, indicating that articulatory suppression interfered with verbal memory processing. **Conclusion** The study concluded that articulatory suppression disrupts the phonological loop.	**Strengths** • The controlled environment allows for high internal validity, as variables like articulatory suppression were carefully manipulated. • The use of an independent group design minimises the risk of order effects and ensures that the results reflect the impact of articulatory suppression on memory. **Limitations** • The artificial nature of the task (recalling lists of letters) does not reflect real-world memory processes, lowering ecological validity. • Using university students limits the generalisability of the findings, as the sample may not represent the broader population. **Ethical considerations** • All researchers conducting studies within psychological research are expected to consider ethical guidelines. The experiment tested memory recall and all ethical requirements were adhered to. Research considerations • The use of the between group (independent measures) design was a limitation, as it introduced the confound of memory differences between the two groups. Participants were randomly assigned to the groups in an attempt to minimise this confound, However, a repeated measures design would strengthen validity.

Student view

Overview (/study/ap new/sid-540- cid-763690/c

Summary	Evaluation
Maguire et al. (2000) (https://doi.org/10.1073/pnas.070039597) **Location of study** UK **Aim** To investigate whether structural differences in the brains of taxi drivers were associated with their extensive spatial navigation experience **Method** • Structural magnetic resonance imaging (MRI) scans were conducted on London taxi drivers and control participants. • The volume of the hippocampus was measured and compared between the two groups. **Results** • Taxi drivers had significantly larger posterior hippocampus and smaller anterior hippocampus compared to controls. • A positive correlation was found between years of taxi-driving experience and hippocampal volume. **Conclusion** The hippocampus is involved in spatial memory and navigation, and its structure can change in response to environmental demands and experience.	**Strengths** • Non-invasive imaging technique provided precise structural data • Strong ecological validity due to the real-world expertise of taxi drivers **Limitations** • Correlational design cannot establish causation (for example, whether driving causes hippocampal changes or whether people with a larger hippocampus are more likely to become taxi drivers) • Small sample size limits generalisability **Ethical considerations** • Participants provided informed consent and were not subjected to harm. • Confidentiality of brain imaging data was maintained

Student view

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Summary	Evaluation
Scoville and Milner (1957) (https://doi.org/10.1136/jnnp.20.1.11) **Location of study** USA **Aim** To investigate the effects of hippocampal damage on memory and to understand the role of the hippocampus in memory formation **Method** • Case study of patient H.M., who underwent bilateral medial temporal lobe resection to treat epilepsy • Data collected through interviews, cognitive tests, direct observations and later neuroimaging techniques **Results** • H.M. experienced profound anterograde amnesia (inability to form new memories) but retained procedural memory and memories from before the surgery. • His short-term memory was intact, but he could not transfer information into long-term declarative memory. **Conclusion** The hippocampus is crucial for the transfer of short-term memories to long-term declarative memory storage but is not necessary for procedural memory.	**Strengths** • Provided groundbreaking insight into the localisation of brain function and memory systems • Use of triangulation (multiple methods of data collection) enhanced validity **Limitations** • Single case study limits generalisability • Lack of pre-surgery baseline data makes it difficult to fully attribute memory deficits to the surgery alone **Ethical considerations** • H.M. could not provide informed consent due to his memory impairment; ongoing consent procedures were critical. • Researchers needed to protect H.M.'s privacy and ensure no harm resulted from the study.

Student view

Overview (/study/ap new/sid-540-cid-763690/c

Summary	Evaluation
Sparrow et al. (2011) (https://doi.org/10.1126/science.1207745) **Location of study** USA **Aim** To investigate whether people are more likely to remember information if they expect it to be erased, or forget it if they believe it will be saved **Method** • Participants were presented with 40 trivia statements (e.g. '*An ostrich's eye is bigger than its brain*[1]). • After reading each statement, participants were told to type it into a computer. • Half of the participants were informed the information would be saved, while the other half were told it would be erased. • Moreover, half of the participants in each condition were told to remember the information. • They were then tested on their memory of the trivia facts. **Results** Participants who believed the information would be erased remembered significantly more statements than those who believed the information would be saved. **Conclusion** The results suggest that people tend to offload memory tasks to external storage (e.g. computers) when they believe the information will be accessible later.	**Strengths** • The study addresses a modern phenomenon — the reliance on digital tools for memory storage — making its findings highly applicable to real-world contexts. • The study establishes a clear cause-and-effect relationship between expectations about information storage and memory retention. • The study introduces the concept of 'cognitive offloading,' which expands our understanding of how memory operates in the digital age. • The clear and straightforward procedure allows for replication and validation of findings by other researchers. **Limitations** • The experimental tasks (e.g. typing trivia statements) may not fully reflect how people interact with information in everyday digital contexts. • Participants might have been influenced by demand characteristics, attempting to remember information because they knew they were part of a memory study. • The study assesses memory in the short-term, leaving questions about the long-term effects of cognitive offloading unanswered. **Ethical considerations** • Participants should have been fully informed about the nature of the study and their role in it. • If participants were not made aware of the true aim of the study, to avoid bias, this needs to have been justified, and a thorough debriefing should have occurred afterwards.

Student view

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Summary	Evaluation
Moisala et al. (2017) (https://doi.org/10.1016/j.brainres.2016.10.027) **Location of study** Finland **Aim** To investigate the relationship between gaming activity and working memory performance, as well as brain activity **Method** A total of 167 participants aged 13—24 years, with varying amounts of gaming experience, were recruited and performed an *n*-back working memory task, switching randomly between auditory and visual inputs. Functional magnetic resonance imaging (fMRI) was used to measure brain activity during the task. **Results** • Daily gaming activity was positively correlated with both accuracy and speed during the harder 2-back level of the working memory task. • Increased activation of the prefrontal cortex was also observed. • During the less demanding 1-back level, higher gaming activity was associated with decreased activity in the same cortical regions. **Conclusion** Greater daily gaming experience is linked to enhanced working memory performance and adaptive changes in the prefrontal cortex brain activity, based on task difficulty.	**Strengths** • Large sample size of 167 participants • Using an fMRI ensures objective measurement of brain activity. • Gaming is a common activity among adolescents and young adults, increasing the real-world applicability of the findings. **Limitations** • The study is only correlational — a cause-and-effect relationship between gaming and working memory cannot be established. • Gaming habits were self-reported, meaning there may be inaccuracies or bias. • The *n*-back working memory task is a specific task that may not reflect the full benefits of gaming. **Ethical considerations** • Informed consent — participants would need to consent to the study, and parental consent may need to be obtained. • Confidentiality — personal data and brain imaging would need to be securely stored. • Potential for the misinterpretation of the findings — the study suggests the positive effects of gaming but should avoid promoting excessive gaming without acknowledging potential limitations.

[1] Sparrow et al. (2011) (https://doi.org/10.1126/science.1207745) 'Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips,' *Science*, Volume 333, Pages 776–778. Copyright © 2011, American Association for the Advancement of Science.

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