

Cognitive psychology

Cognitive psychology is the study of the role of cognitive processes in human behaviour. Cognitivists study mental processes, such as perception, memory, attention, language and problem solving, in order to understand how we view, interpret and respond to our world. Cognitive psychologists investigate mental processes by examining people with cognitive impairments. By doing this, they are able to understand how damage affects processing ability. They also use experimentation and brain imaging to gather information about the nature and location of cognitive modules.

In this topic you will learn about:

- the nature of human memory systems
- individual differences in memory and how memory changes with age
- the way in which experiments and case studies of brain-damaged patients are used to understand cognition, and the analysis of data
- a classic and contemporary study of human memory
- key issues around the topic of cognitive psychology that are of relevance to society today
- how to carry out a practical research exercise relevant to topics covered in cognitive psychology
- wider issues and debates in cognitive psychology (A level).

2.1 Content

Learning outcomes

In this section you will learn about theories of memory including:

- the multi-store model of memory
- working memory as a theory of short-term memory
- the nature of semantic and episodic memory as different long-term memory stores
- reconstructive memory including schema theory.

Introduction to cognitive psychology

Cognitive psychology is concerned with internal mental processes, such as language, memory, problem solving and thinking. An important development in the cognitive approach was the advent of the computer age. The computer gave cognitivists the metaphor for understanding the human brain and the terminology to explain cognition more easily. The computer analogy likens the brain to a computer; a storage system that receives information from our environment, processes the information, and gives an output. The computer hardware resembles the structural features of our brain and the software resembles the experience that we write into the program or system. Experimental cognitive psychology is the study of human mental functioning in a controlled laboratory setting, using experimental tests to determine functioning. Cognitive science is a field that is concerned with mimicking human cognition in a computer program, modelling computer simulations and offering computational models for various aspects of cognition. Cognitive neuropsychology is the study of patients with brain damage to determine the impact of the damage on capacity and functioning. These studies have been particularly important in understanding the cognitive function that we refer to as memory.

The multi-store model of memory (Atkinson and Shiffrin, 1968)

Richard Shiffrin, and his academic supervisor, Richard Atkinson, proposed a general theoretical framework for understanding human memory, often referred to as the multi-store model of memory. Atkinson and Shiffrin distinguished between the permanent structural features of memory and its **control processes**. The structural features of memory can be seen as similar to the hardware and built-in programs of a computer which cannot be altered by the programmer, which amount to the basic memory stores of human memory. The control processes involved in memory are seen as similar to programs that the programmer can write into the computer and which determine the operations that the computer can perform. These control processes involve the way we encode, rehearse and retrieve memories.

WIDER ISSUES AND DEBATES

Reductionism

This model has been criticised for being overly simplistic: that it underplays the interconnections between the different memory systems by proposing that the memory has distinctly different stores. Artificially breaking up the memory stores makes it easier to study memory experimentally, but this model can be criticised for being reductionist.

The structure of human memory

The multi-store model describes memory as consisting of three basic stores: a sensory register, short-term store and long-term store. A sensory experience (something we have seen, heard, touched, etc.) first enters the sensory register/memory where it is held for a brief moment before it decays. **Attended information** from the sensory register is then transferred to the short-term store. Information is held for around 30 seconds before it decays, unless **rehearsal** is used to maintain this information for a longer period of time. From short-term memory, information can be transferred to long-term permanent storage in the long-term store.

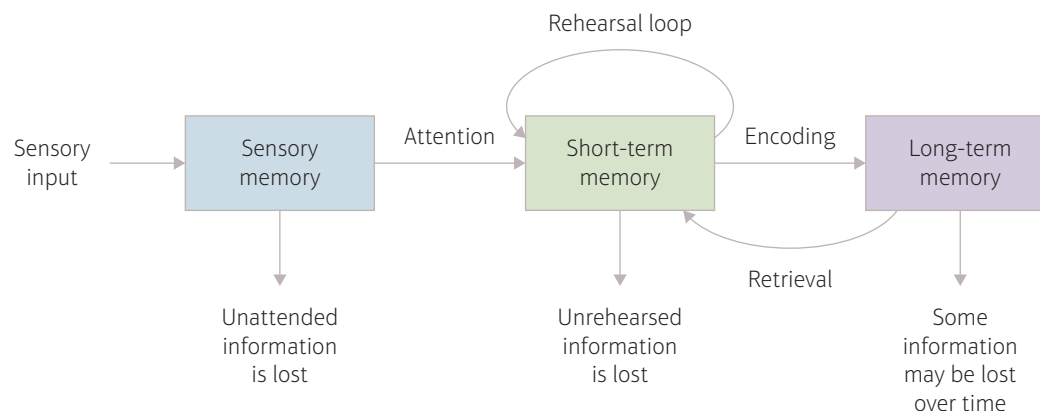


Figure 2.1 The multi-store model of memory, adapted from Atkinson and Shiffrin, 1968.

Sensory register/memory

We experience our world through our five senses, and it is believed that we have a sensory register for each of these sensory modalities (seeing, hearing, touching, tasting and smelling). The visual sensory register has been widely researched using a **whole or partial report technique** (Sperling, 1960, 1963) in which a **visual array** of letters is presented via a **tachistoscope** for a brief moment and then a direction is given to recall the whole or a specific row of the array. Participants typically recalled on average 4.32 letters of the whole array. If a direction is given to recall a row of the array

Key terms

Control processes:

conscious decisions about what to attend to from the sensory information in our environment.

Attended information:

information that is given attention.

Rehearsal: consciously rehearsing and repeating items.

Whole or partial report technique: participants are asked to recall the whole array or part of the array, such as a line.

Visual array: an arrangement of digits or letters.

Tachistoscope: a device used to present visual information in a controlled way, typically to test sensory memory.

immediately after presentation, recall is reasonably precise, but this decays rapidly if there is a delay before the direction. Thus, the sensory register can hold only a limited amount of information for only a few hundred milliseconds before it is lost.

D	V	Y	Q
P	U	J	A
S	M	E	K

Figure 2.2 A visual array.

Short-term store

Duration of short-term memory

The second structural feature of Atkinson and Shiffrin's memory model is the short-term store or 'working memory'. Information that is attended to enters the short-term store and is held temporarily for 15–30 seconds and then is assumed to decay completely unless it can be maintained through rehearsal. Peterson and Peterson (1959) investigated the duration of short-term memory using an **interference task** to prevent rehearsal. Participants were required to remember a single **trigram** of three consonants for intervals of 3, 6, 9, 12, 15 and 18 seconds. The trigram was read out and participants were then given a number from which they had to count backwards in threes (e.g. 679, 676, 673, etc.). Correct recall of the trigram was likely after a short interval, but performance dropped rapidly after 15–18 seconds. Assuming that the interference task prevented rehearsal of the trigram, it can be concluded that decay occurs in the short-term store over a period of 15 seconds.

Capacity of the short-term store

Atkinson and Shiffrin assumed that the capacity of the short-term store was around five to eight items of information. However, Miller (1956) refined this figure to 'the magical number seven, plus or minus two'. We can therefore view the short-term store as a series of between five and nine slots in which information can be stored.

Encoding of short-term memory

The nature of information held in the short-term store does not depend on its input form, for example, we may register the image of a pineapple in its visual form, but it is held in verbal form as a short-term memory. Atkinson and Shiffrin believed that a memory trace in the short-term store was held in an auditory or verbal form because of the **phonological similarity effect**; letters and words of a similar sound presented to participants are more difficult to recall than dissimilar sounding letters and words. The similarity of sounds leads to confusion in the short-term store suggesting that the encoding in this store is primarily acoustic (auditory or verbal).

Retrieval from the short-term store

Retrieval of memory from the short-term store is largely based on a rapid sequential scan of the stored information. Rehearsal is important in maintaining information in the short-term store, increasing the strength of the memory trace and ultimately building up the memory trace in the long-term store. **Digit span** experiments suggest that we are able to maintain between five and nine items using rehearsal, and as more information is input into the store, older information or information with a weaker memory trace is knocked out (displaced) and quickly decays.

Key terms

Interference task: a task that prevents rehearsal, such as counting backwards.

Trigram: a set of three digits or letters.

Phonological similarity effect: similar sounding words and letters are acoustically confused in short-term memory, making them more difficult to recall.

Digit span: how many digits can be retained and recalled in sequential order without mistakes.

WIDER ISSUES AND DEBATES

The use of psychological knowledge in society

Rehearsal, or the refreshing of information, can reinforce learned information. Andrew Butler and Henry Roediger (2007) simulated a classroom environment where participants viewed three different lectures on consecutive days. Following each lecture, some participants were given a short recall test to refresh their memory and some did not receive these tests. One month later, the participants were tested for their memory of the lectures. They found significant evidence to suggest that the short recall tests reinforced knowledge for long-term memory of the lecture content. This evidence can be used in educational practice to help students learn more effectively.

Transfer of information between short-term and long-term store

Atkinson and Shiffrin described the relationship between the sensory register and long-term memory as being important for identification of sensory information. In order to transfer information received by our sensory register to the short-term store, we must use our long-term memory to make sense of the information and assign it a verbal label. For example, we may register the image of a horse, but this cannot be stored as an auditory-verbal short-term memory until we have identified it as such using our long-term memory of what the object represents. Transfer of information from the short-term to long-term store can be as a result of rehearsal, although this would leave a relatively weak memory trace. According to Atkinson and Shiffrin, a more durable memory trace can be achieved by using a mental operation, such as a **mnemonic**, to increase the strength of transfer.

Long-term store

Retrieval from the long-term store

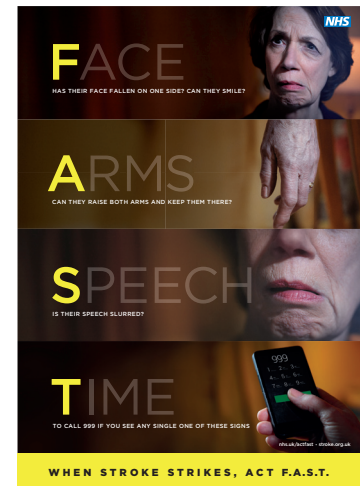
Atkinson and Shiffrin believed that long-term memories existed for all sensory modalities; we have memories for taste, sound, smells, etc. In the 1968 model, they proposed that multiple copies of a memory were retained in the long-term store. This proposition was largely based on the 'tip-of-the-tongue' phenomenon (Brown and McNeill, 1966), which demonstrated that people were able to accurately predict that they could recognise a correct answer even if they could not recall the answer at that moment in time. The individual may feel a correct answer is on the 'tip of their tongue' and may even be able to recall some features of the correct answer, such as the initial letter or its number of syllables. Atkinson and Shiffrin suggested that these results indicate that a long-term memory is not stored as one memory trace, but that multiple copies, in their various forms and fragments, are stored. When we experience 'tip of the tongue', we are retrieving a partial copy of the memory trace, and this partial copy retrieval can help us gain access to a more complete copy of the long-term memory through some associative process.

Taking it further

The next time you experience 'tip-of-the-tongue' consider what features of the to-be-remembered information you can recall; how many syllables it contains, what letter it begins with, what does it sound like, what is it similar to? Consider whether or not these fragments of a memory actually indicate that we have multiple copies of it, or something else.

Encoding in the long-term store

Encoding information into the long-term store can depend on the rehearsal process or some form of association between the new and pre-existing knowledge stored there. If information is linked to



This mnemonic was created by the Department of Health to help people identify the symptoms of a stroke.

Key term

Mnemonic: a system for remembering something such as an association or a pattern of letters.

Taking it further

The emphasis given to the role of rehearsal in memory has been criticised for ignoring other ways of transferring information to the long-term store. Fergus Craik and Robert Lockhart (1972) describe an alternative framework for memory called the Levels of Processing Approach. Investigate this alternative approach further and consider how this different theory of memory could be used to aid your own revision.

pre-existing knowledge it will make a search for the information far easier. This makes more sense as a random search of such a large store would be exhaustive. Atkinson and Shiffrin (1965) explain this based on their quizzing of a graduate student about the capital cities of US states. The student could not immediately recall the capital of Washington, but when he later recalled that the capital of Oregon was Salem, he immediately remembered that Olympia was the capital of Washington. When asked how the student remembered this, it was found that he had learned the capitals together. They were recalled as an associated pair that was semantically or temporally related.

Duration of long-term memory

The duration of long-term memory is potentially a lifetime. Bahrick et al. (1975) investigated what they referred to as Very Long-term Memory (VLTm) using a series of memory tests on the names and faces of students in their high school yearbooks. Four hundred participants between the ages of 17 and 74 years old were tested. They found that identification of names and faces was 90 per cent accurate within 15 years of leaving school and between 70 to 80 per cent accurate 48 years after leaving school. This shows that although memory deteriorates over time, long-term memory for faces and names is fairly resilient over the passage of time.

Capacity of the long-term store

The capacity of long-term memory is potentially infinite. Brady et al. (2008) showed participants 2 500 objects over the course of 5.5 hours. They were then shown pairs of objects and asked to identify which of the two objects they had seen. When participants saw the original object paired with a very different object, identification was 92 per cent. When the object paired with the original was similar, the identification rate was 88 per cent, and when the original object was depicted from a different angle, identification was 87 per cent. This demonstrates that thousands of images can be maintained successfully in the long-term store.

Table 2.1 Summary of the memory stores.

	Sensory register	Short-term store	Long-term store
Encoding	One register for each sensory modality: visual, auditory, haptic, olfactory, gustatory	Largely acoustic and verbal	Semantic and temporal
Storage duration	Limited – approximately 50 milliseconds to a few seconds	15–30 seconds	Potentially a lifetime
Storage capacity	3–4 items	5–9 items	Potentially limitless
Forgetting	Decay	Decay through displacement	Decay and interference
Retrieval	Scanning	Sequential search	Semantic or temporal search

Evaluation

Studies of patients with brain damage

Evidence to support the distinction, particularly between the short-term and long-term stores, comes from case studies of brain-damaged patients and experimental evidence from memory studies. Henry Molaison suffered amnesia following brain surgery for epilepsy, resulting in severe impairment to his long-term memory but his short-term memory was largely intact. This case study demonstrates that the short-term and long-term memory stores were differentially affected by the brain damage caused, perhaps because they are located in different regions of the brain. Similarly, Clive Wearing suffered long-term memory impairment following **encephalitis**, but his short-term store remained unaffected. In both cases the patient was unable to transfer information from the short-term store to the long-term store. Case studies such as these demonstrate the separation between short-term and long-term memory and support the distinction proposed by the multi-store

Key term

Encephalitis: inflammation of the brain causing damage to the structures of the brain.

model of memory. However, the subjects of case studies are unique and the nature of the brain injury sustained by each individual is equally unique, so we may not be able to generalise such a distinction based on individual cases alone. Despite this problem, amnesia research offers fairly convincing evidence for the distinction between short-term and long-term memory.

Case studies of brain-damaged patients that are used to support the multi-store model of memory can also be used to highlight the overly simplistic view of long-term memory. Clive Wearing, musician and chorus master, could not recall past events in his life, but he could remember how to play the piano and conduct an orchestra. Following a motorcycle accident that caused memory loss, Kent Cochrane (known widely as patient KC) could recall facts but showed severe memory impairment in remembering personal events in his life before the accident. These cases suggest that long-term memory is not one single unitary store, but that perhaps we have different long-term stores for procedural memory of practised skills and abilities, and other long-term stores for factual information and autobiographical events.



Memory for practised skills may be stored separately from stores for factual information.

WIDER ISSUES AND DEBATES

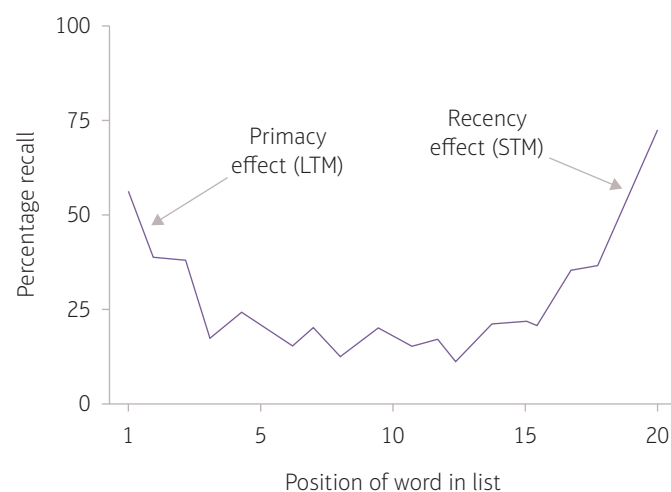
Ethical issues

Case studies of brain-damaged patients are often anonymised by using the initials of the patient rather than their full name, for example, until his death, Henry Molaison was only known as HM. This helps to protect patients' identities and maintains their right to privacy. In fact, the identity of Henry Molaison was fiercely defended by the researchers involved in his care. Despite being the most widely cited case study in the history of psychology, his identity was protected for over 55 years. However, in high-profile cases, such as Clive Wearing who was in the public eye, these individuals cannot be anonymised. This can lead to issues of privacy being violated as the research concerning the case is available within the scientific community and public arena.

Serial position effect

Compelling evidence for the existence of separate short-term and long-term memory stores comes from the **serial position effect** or primacy–recency effect. Murray Glanzer and Anita Cunitz (1966) conducted an experiment to investigate whether the position of a word in a list affected recall. They found that participants recalled more words from the beginning (primacy effect) and end (recency effect) of the word list, but recalled few from the middle of the list. It was thought that words recalled at the beginning of the list had the chance to be rehearsed, and memory for these words would have been strengthened and transferred to the long-term store. While the words at the beginning of the list are being processed, words in the middle of the list were filling up the slots in the short-term store. Words at the end of the list acted to displace the older memory trace for the middle words, leaving only words at the end of the list in the short-term slots.

Figure 2.3 The serial position curve demonstrates the difference between short-term and long-term stores.



Key term

Serial position effect: recall of information at the beginning and end of a list is higher than the middle of the list.

Key term

Dual task experiment: experiments that involve two tasks that either compete with each other for the same cognitive resource because they are similar tasks (two verbal or two visual tasks) or involve different cognitive resources because they are different tasks (one verbal and one visual).

WIDER ISSUES AND DEBATES

An understanding of how psychological knowledge has developed over time

Despite these criticisms, the multi-store model of memory proposed by Atkinson and Shiffrin has been a valuable framework in understanding human memory and heuristics that has stimulated a huge wealth of memory research. Because of the development of this model of memory, better and more precise theories of memory have been proposed.

Coding

The difference in the type of coding used by short-term and long-term memory also indicates that we have two separate memory stores. Alan Baddeley (1966) conducted a laboratory experiment on the sequential recall of ten words in a list that were either acoustically or semantically related. He found that semantically related words were more difficult to recall from long-term memory compared to acoustically related words; 9.6 per cent of similar sequences were recalled as opposed to 82.1 per cent of dissimilar words, suggesting that encoding in short-term and long-term stores was different. This leads to the assumption that different memory stores exist independently of one another. Additionally, similar sounding letters and words are less well recalled than dissimilar sounding letters and words. This suggests that there is acoustic coding in the short-term store, explaining why similar sounding phonemes are confused.

Alternative explanations

The multi-store model of memory has often been criticised for being an overly simplistic view of human memory. In particular, it fails to address the dynamic nature of short-term memory and our performance on **dual task experiments**. Dual task experiments show that we perform poorly when trying to deal with similar tasks, but perform well when trying to do two tasks of a different nature. For example, we tend to perform poorly when asked to do two verbal tasks or two visual tasks together, but perform well when given one verbal and one visual task together. Dual task performance cannot be explained by the short-term store, which assumes that capacity is unaffected by type of task. A different explanation of short-term memory, proposed by Alan Baddeley and Graham Hitch in 1974 (see page 12), can explain dual task performance and is seen as a more dynamic model of short-term memory.

The multi-store model has also been criticised for the emphasis given to rehearsal in the transfer of information from short-term to long-term storage. Although we do use rehearsal as a memory strategy, it is not essential for permanent learning to take place. In fact, we are often able to learn new skills and information without consciously trying to learn them. Using imagery is one such example of a memory strategy that leaves a strong long-term memory trace without the need for rehearsal. Craik and Lockhart (1972) offer an alternative explanation for the transfer of information from the short-term to long-term store. They describe different levels of processing; structural, phonemic and semantic, suggesting that the greater depth of processing we give information, the more durable the memory trace formed.

Exam tip

When evaluating the multi-store model of memory it is important to use research evidence that highlights the qualitative and quantitative differences between the short-term and long-term stores. It is not enough to state that Miller (1956) found that the short-term store could hold between five and nine bits of information, without contrasting this to the capacity of the long-term store.

It is also very important to explain **how** the research supports or goes against the model. Simply stating the research findings without linking back to the model is not effective evaluation.

For example:

Point: Clive Wearing suffered amnesia which meant that he could not remember events from his past or store new memories. However, he could hold information temporarily in his consciousness.

Link: This supports the multi-store model of memory as it shows that his long-term store was damaged but his short-term store was unimpaired. These stores must be independent of one another.

Working memory model (Baddeley and Hitch, 1974)

Alan Baddeley and Graham Hitch first proposed the theory of working memory as a three-component short-term memory system in 1974. The idea of a working memory was not a new one; in fact Atkinson and Shiffrin (1968) used the label 'working memory' for the short-term store within their multi-store model. Baddeley and Hitch noted significant problems with the multi-store explanation of working memory because it was overly simplistic and emphasised the role of rehearsal as being critical to learning. Baddeley and Hitch set about trying to understand short-term memory as a complex and active working memory.

The model

In their original model, Baddeley and Hitch proposed three components for working memory: a central executive that would deal with the running of the memory system, and two slave systems to deal with verbal and visual information. Overall, working memory was seen as a limited capacity system only able to deal with a restricted amount of information temporarily while it could be manipulated or worked with.

A useful exercise to demonstrate working memory is to perform a complex calculation, such as 15 multiplied by 32 in your head rather than on paper. Performing such a mathematical calculation requires the temporary storage of the two initial numbers while retrieving the knowledge needed to conduct a multiplication. It is likely that two calculations are needed (10 multiplied by 32 and 5 multiplied by 32 =) and the solutions to these calculations will also need to be stored temporarily before addition is used to generate a solution to the sum. All of these processes are performed by the working memory.

The role of working memory is therefore to temporarily store and manipulate information being used. We rely on working memory for many functions, such as remembering telephone numbers and lists, comprehending sequences of words in the form of sentences, mental calculation and reasoning. However, working memory is fragile and frequently susceptible to distraction (someone talking to you while you are trying to remember a number), overload (a long list of items) and overwork (complicated calculations).

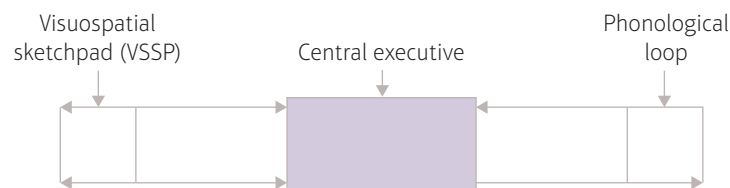


Figure 2.4 The working memory model.

The central executive

The central executive was originally described as a limited capacity component involved in general processing. It was essentially seen as a **homunculus**, a little man, with a supervisory role in deciding how the two slave systems should function. It was also regarded as having limited capacity but with the ability to deal with different types of sensory information (**modality free**). In the early stages of the theory of working memory the role of the central executive was unclear and it was not until later that it became more defined as an attentional controller with the capacity to focus, divide and switch attention.

WIDER ISSUES AND DEBATES

The use of psychological knowledge within society

Research into working memory and its assessment have helped identify children who have working memory impairments which mean that they struggle with scholastic activities in the classroom and often fail in education. Children with working memory problems may have difficulty concentrating, remembering lengthy instructions or with complex vocabulary. Working memory research has led to a variety of classroom interventions designed to help improve the learning and educational success of children with poor working memory skills (Gathercole and Alloway, 2008), although other researchers argue that these improvements in achievement may be specific and short lived (Melby-Lervåg and Hulme, 2012).

Key terms

Homunculus: a very small human.

Modality free: able to process different forms of information (acoustic, visual, haptic, etc.).

WIDER ISSUES AND DEBATES

Psychology as a science

The central executive in memory is a largely theoretical concept with limited experimental support. Because it is abstract it is not directly testable and does not meet the criterion of being scientific as empirical data cannot be gathered.

The phonological loop

The phonological loop is a slave system that deals with the temporary storage of verbal information. The phonological loop was initially believed to have two components: the articulatory rehearsal system and the phonological store. The phonological store was only able to hold a limited amount of verbal information for a few seconds, but this could be extended if the information was subvocalised or refreshed using the articulatory rehearsal system.

The phonological store can explain the phonological similarity effect, where it is more difficult to remember similar sounding words and letters (man, cad, mat, cap, can) compared to words and letters that sound different from one another (pen, sup, cow, day, hot). However, this effect was not true of remembering words that had semantic (meaning) similarity (huge, long, wide, tall, large) or words that were semantically unrelated (thin, wet, old, late, strong). This demonstrates that the phonological store relies on acoustic encoding for storage (Baddeley, 1966a).

INDIVIDUAL DIFFERENCES

It can be claimed that the working memory model ignores individual differences in capacity and functioning of each subsystem, or at least fails to explore these individual differences. Yet we know that some people have a better short-term memory than others and, in many cases, poor working memory has been associated with dyslexia and Specific Language Impairment.

WIDER ISSUES AND DEBATES

Psychology as a science

Much of the research into working memory is experimental and laboratory based, involving the testing of specific hypotheses concerning the nature of short-term memory that have testable outcomes (e.g. word recall/accuracy). This research meets many of the criteria of being scientific because there is an emphasis on control, objectivity and replicability.

The articulatory rehearsal system was used to explain the word length effect, where short monosyllabic words (cat, rug, hat) were recalled more successfully than longer polysyllabic words (intelligence, alligator, hippopotamus). Essentially, longer words filled up the limited capacity of the articulatory rehearsal system resulting in the decay of words positioned earlier in the list. The longer the word the more capacity was used up and forgetting was more likely. It could also explain why there was deterioration in recall when rehearsal was prevented through articulatory suppression (repeating the word 'the' while learning a word list).

Subsequent research into the phonological loop has provided an understanding of why it may have evolved. Researching an Italian woman (VP) with an acquired phonological impairment, Baddeley found that she was unable to retain any vocabulary learned from a different language, suggesting that the phonological loop may have evolved for language acquisition (Baddeley, et al., 1988). Further research using children with **Specific Language Impairment** (SLI) demonstrated that they found it incredibly difficult to recall non-words (slimp, poot, dar, gep), and this correlated to the size of their vocabulary. This finding suggested that the phonological loop was necessary for language acquisition and that deficits in this component of working memory resulted in difficulty learning and comprehending novel language (Gathercole and Baddeley, 1996). Non-word repetition tasks are now a standard and widely used test for and indicator of Specific Language Impairment.

Key term

Specific Language

Impairment: Individuals whose language skills are much lower than other cognitive skills such as IQ and non-verbal abilities.

Visuospatial sketchpad (VSSP)

This slave system of working memory was described to temporarily hold and manipulate verbal and spatial (position/location) information. The VSSP can deal with visuospatial information either directly through observing images or by retrieving visuospatial information from long-term memory. The role of the VSSP is to maintain and integrate visual and spatial information from these different channels using a visual code.

Recent research has attempted to distinguish between the visual and spatial components of the VSSP using tasks that test memory span. Spatial span has been tested using the Corsi block tapping task, where participants are presented with a series of blocks on a screen that light up in a sequence that they have to repeat. Error frequency increases with the number in the sequence, suggesting a limited capacity to spatial memory.



We rely on visuospatial information in our long-term memory to remember our route home.

Exam tip

Describing the working memory model requires a straightforward recount of the facts about the explanation. The command word 'describe' means that you will need to write about the original model and each of the subcomponents in terms of their features (capacity, function, coding). The amount of detail will need to be guided by the mark allocation and available writing space. You are not required to evaluate the theory but you can use examples to help elaborate your description points.

You will be required to demonstrate your knowledge and understanding of this theory by being able to explain different situations; for example, how you may find it difficult to process two sets of visual or verbal information simultaneously. Try to use your knowledge of working memory to explain the following situation. Remember that the command word 'explain' means that you need to make a point (why it is difficult) and then justify your point (expansion or explanation).

Why it is difficult to process two conversations simultaneously, such as when you are talking on the phone and a friend is trying to tell you something at the same time.

Point: It is difficult to process both conversations because they are verbal and both utilise the phonological store.

Expansion: The phonological store has a limited capacity so is unable to cope with the demands of two tasks at once and results in poor performance in processing.

Evaluation

Evidence for separate visuospatial and phonological subsystems comes from both experimental research and neurophysiological evidence.

Neurophysiological evidence

Williams syndrome is a rare condition where individuals show normal language ability but impaired visual and spatial ability. Individuals with this condition are affected by the same phonological factors, such as word length and word similarity, as the general population, but perform poorly on Corsi block tapping tests. This offers clinical evidence for separate visuospatial and phonological subsystems. Interestingly, children with Williams syndrome were also found to have significant problems comprehending sentences with spatial prepositions (words that describe the position of an object in relation to another object, such as behind, underneath, against), suggesting an association between visuospatial memory and language acquisition (Phillips et al., 2004).

Further neurological evidence comes from the single case study of KF (Shallice and Warrington, 1974) who suffered short-term memory impairment following a motorbike accident that damaged the parietal lobe of his brain. KF had a digit span of one, suggesting a gross impairment in his phonological store, but his visual memory was intact. In contrast, Henry Molaison suffered from a gross impairment in his spatial memory with a relatively unaffected short-term memory for verbal information. This supports the proposal that working memory has two subsystems to deal with verbal and visuospatial information relatively independently. Neuropsychological case studies offer an insight into memory function but are limited to unique individuals with specific impairments so care should be taken when generalising these findings.

Key terms

Neuroimaging: images showing the structure or function of the brain using scanners such as an MRI or CAT.

Broca's area: an area of the left (typically) frontal lobe associated with the production of language.

Supramarginal gyrus: an area of the parietal lobe of the brain associated with the perception of language.

Evidence from neuroimaging

Neuroimaging has also offered some evidence for the localisation of the different subcomponents of working memory in the brain. Paulesu et al. (1993) demonstrated that different regions of the brain were activated when undertaking tasks that employed the phonological store and the articulatory rehearsal system. Using a PET scan, they found that the **Broca's area** was activated during a subvocal rehearsal task (remembering words) and the **supramarginal gyrus** was activated when the phonological store was being used. This research provides evidence for the phonological loop and its separate subcomponents. However, the exact location of the central executive has been difficult to find as it is largely diffuse across the cortex.

Experimental evidence

Classic experimental evidence for working memory comes in the form of dual task experiments. Dual task experiments require participants to perform two tasks simultaneously that involve one or more slave systems of working memory. Baddeley and Hitch (1976) conducted an experiment where participants had to simultaneously use a pointer to track the location of a moving light on a screen while imagining the capital letter 'F' and mentally tracking the edges of the letter and verbally saying whether the angles they imagined were at the top or bottom of the image. Participants could easily complete each task separately, but had difficulty performing the tasks simultaneously. This shows how two visual tasks both compete for the limited resources of the visuospatial sketchpad resulting in impairment in performance. However, when participants were asked to perform the visual tasks while undertaking a verbal task at the same time, performance was not affected because one task used the visuospatial sketchpad and the other task used the phonological loop. Dual task experiments offer support for separate visual and verbal slave systems because performance is affected by whether the tasks compete for the limited resources of the same or different slave systems.

Research into separate visual and spatial memory systems

Recent research into the visuospatial sketchpad has been concerned with distinguishing between the visual and spatial components. Klauer and Zhao (2004) found that visual memory tasks were more disrupted by visual interference and spatial tasks more disrupted by spatial interference, offering evidence for separate components to the visuospatial sketchpad.

This separation of components was further supported by Darling et al. (2007), where 72 non-student participants were all presented with a series of 30 white squares positioned randomly on a black screen. In one of the squares was the letter 'p'.

Participants had to recall either the appearance (font) of the letter 'p' or its location within a square on the screen. Participants then experienced either spatial interference by having to tap a sequence of keyboard keys in a figure of eight, or experience a visual disruption task in the form of a visual array of black and white flickering dots on the screen, before they saw the screen again.

The researchers found that the spatial interference task disrupted spatial memory but not memory for appearance, and that the visual disruption task affected, to a lesser extent, memory for appearance but not for location. This provides evidence for separate visual and spatial memory systems; however, visual memory often has to contend with an array of visual stimuli rather than just one category of visual information (the letter 'p'), so this experiment does not reflect everyday visual processing of images.

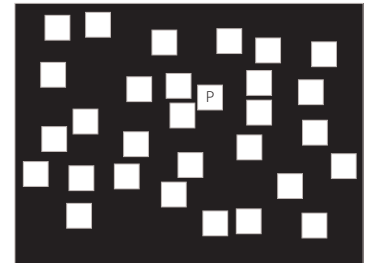


Figure 2.5 Darling et al. (2007) apparatus.

Alzheimer's disease and the role of the central executive

Evidence for the coordination role of the central executive is far less extensive than research into the subsystems; nevertheless research with clinical patients suffering from **Alzheimer's disease** has shown decreased central executive function as the disease has progressed. Baddeley et al. (1991) conducted a series of dual task experiments on young, elderly and Alzheimer's patients using verbal and visual tasks together or separately. The performance of the Alzheimer group did not differ significantly from the other groups when performing a visual or verbal task but showed significant impairment when trying to do them together. According to Baddeley et al., the central executive is responsible for the coordination of the subsystems, so this impairment in performance demonstrates significant problems with executive functioning.

The episodic buffer

A significant limitation with the working memory model was its inability to explain why we could store only a limited number of word sequences in the phonological loop but could store far longer sentence sequences (up to 15 to 20 sentence units). It seemed that word sequences in the form of sentences could be bound together by meaning and grammar that could not be explained by the limited capacity of the phonological loop alone and this somehow related to information held in the long-term memory. A further problem with the original model was that it did not explain evidence from verbal span experiments that verbal and visual encoding could be combined. The model could not explain how the subcomponents could interface with each other or with long-term memory. Baddeley addressed this in 2000 with the addition of a fourth component called the **episodic buffer**. The episodic buffer was proposed as a limited capacity storage system that could integrate information between the subcomponents and feed into and retrieve information from long-term memory.

Taking it further

There is a huge wealth of experimental research into working memory, much of which involves laboratory research using specifically designed verbal and visual learning tasks. Consider how well this research represents everyday use of working memory and the implications of this for understanding everyday memory.

Key terms

Alzheimer's disease: a neurological degenerative disease that impairs cognitive functioning causing memory loss and impairments in thinking and language.

Episodic buffer: a subcomponent of the working memory associated with interfacing with long-term memory and integrating information from other subcomponents.

Exam tip

You may be asked to compare explanations of memory by exploring the similarities and differences between them. It is useful to compare the multi-store model of memory and working memory because they represent rather different explanations of memory. Remember that comparison does not involve simple description of each theory, it requires a discussion of similarities and differences between the models and even the evidence used to support or oppose the explanations. Each comparison point should explain how each theory relates to the point being made, and comparative words should be used to make your comments clear.

Key terms

Episodic memory: memory for events.

Semantic memory: memory for facts.

Temporal: relates to when something occurred.

Spatial: relates to where something occurred

Explanation of long-term memory – episodic and semantic memory (Tulving, 1972)

Endel Tulving first made the distinction between **episodic** and **semantic** memory in a book where he aimed to reduce the ambiguity around the nature of long-term memory. He proposed that long-term memory could be divided into two memory stores: episodic memory (remembered experiences) and semantic memory (remembered facts). Tulving proposed that the dissociation between semantic and episodic memory was based on evidence that each store was qualitatively different in terms of the nature of stored memories, time referencing, the nature of associations between memories held in each store, the nature of retrieving or recalling memories held in each store and the independence of each store.

The nature of semantic and episodic memory

Tulving suggested that semantic memory represented a mental encyclopaedia, storing words, facts, rules, meanings and concepts as an organised body of knowledge. These memories are associated with other facts that link the concepts together (e.g. 'school and learning', or 'bird and nest') without autobiographical association. For example, the statements 'I know that June follows May in the calendar' or 'South Africa is a hot country' are memories of facts that have been learned at some earlier time.

Tulving described episodic memory as a kind of mental diary. Episodic memory receives and stores information about experiences or events that occur at a time in our life. These memories are linked to time and context.

Time referencing

Tulving believed that episodic memory was dependent on time-referencing: memories about events that happened to you are linked to the time in which they occurred. For example, recalling your first day at school is linked to the date this event occurred. However, semantic memory was detached from any temporal link, as factual information could be recalled without reference to when it was learned. For example, you can recall that Paris is the capital city of France without remembering when and where you learned that fact.

Spatial referencing

Input into episodic memory is continuous, as we experience a whole episode in some **temporal** frame of reference, such as experiencing a birthday party, whereas semantic memories can be input in a fragmentary way. We can piece factual information together that has been learned at different points in time; for example, you may learn that Emmeline Pankhurst formed the Women's Social and Political Union in 1903, and later learn that Emily Davison is thought to have thrown herself under the hooves of the king's horse on Derby Day. Both pieces of information can be stored independently and pieced together in a temporal form later on to understand key events in the suffragette movement.

Retrieval

Recall of episodic memory is dependent on the context in which the event was initially learned or experienced. It is this context that aids the retrieval of episodic memories. However, semantic memory does not seem to be dependent on the context in which it is learned, so it assumed that retrieval of semantic memories is similarly not dependent on context to aid recall. Retrieval from semantic memory can be based on inferences, generalisation and rational, logical thought.

Retrieval from semantic memory leaves the memory trace relatively unchanged from its original form, so we can recall a fact without interfering with that knowledge. However, Tulving believed that episodic memory was susceptible to transformation.

Are the stores interrelated?

Semantic memory can operate independently of episodic memory. For example, we do not need to remember a classroom lesson about equations to be able to use the equations we learned. However, episodic memory is unlikely to operate without semantic memory as we need to be able to draw on previous knowledge of objects, people and events that occur in order to understand them. Tulving argued that, despite this and although the two systems may overlap, they can be treated as separate independent stores.

WIDER ISSUES AND DEBATES

The use of psychological knowledge in society

The concept of **cue dependent recall** has been extensively researched in psychology. It has been established that we encode, alongside the memory, the context and the emotional state we experienced at the time of learning. These context and state cues can be used to aid recall of the original memory. Godden and Baddeley (1975) found that when scuba divers learned and recalled a list of words underwater or on land, they performed twice as well as when learning and recalling in different contexts. Kenealy (1997) found that participants recalled more when in the same mood as when they learned rather than a different mood. These state and context cues can be useful in everyday life, for example, using colour cues for revision of certain topics or imagining being in your classroom when taking an exam in a different context. State and context cueing has also been useful in the development of police interviewing techniques (see page XXX)

Key term

Cue dependent recall:

Recall that is prompted by a specific context or physiological or psychological state that was encoded with the original memory.



Studies involving divers have shown that recalling information in the same context in which it was learned improves performance.

Table 2.2 Summary of differences between semantic and episodic memory.

	Semantic memory	Episodic memory
Nature of memory	Mental encyclopaedia	Mental diary
Time referencing	Independent of time referencing Input can be fragmentary	Time and context referenced Input is continuous
Retrieval and forgetting	Retrieval possible without learning Not cued retrieval	Retrieval using cues which are encoded at the point of learning
Forgetting	Memory trace more robust and less susceptible to transformation	Forgetting due to retrieval cue failure Memory trace can be transformed/ changed

Key term

Anoxic episode: lack of oxygen to the brain causing injury.

Evaluation

Brain damage

Evidence for the dissociation between semantic and episodic memory suggests that one store can be affected without affecting the other one. Amnesia patients are rich sources of information.

Ostergaard (1987) described a case of a 10-year-old boy with brain damage following an **anoxic episode**. Although his intelligence was intact, he suffered impairment to both his episodic and semantic memory. However, he did make educational progress and was able to store information in semantic memory. This offers some evidence for the independence of the two memory systems as Tulving suggested.

Support for the nature of episodic and semantic memory as separate long-term storage systems is also derived from case studies of KC (1951–2014). Following a serious motorbike accident, KC suffered specific long-term memory impairment to his episodic memory resulting in an inability to form or recall many personal events in his life; however his recollection of factual information was intact. This case study supports the distinction between the two long-term memory stores and indicates possible regions of the brain where the different types of memory are stored. Examining case studies of brain-damaged patients also points out a weakness in the model of long-term memory proposed by Tulving. Henry Molaison and Clive Wearing both suffered memory impairment that affected their ability to retain and recall long-term memory from episodic storage. However both men were still able to remember how to perform tasks, such as playing the piano, and could still learn new skills. This points to a further long-term store for remembering practised skills. Tulving (1985) outlined this additional store in subsequent reformulations of his idea, adding procedural memory for skills and abilities that we learn, such as learning the grammatical rules of language, or riding a bicycle.

INDIVIDUAL DIFFERENCES

The use of case studies of brain-damaged patients gives us an important insight into the nature of human memory, and the relative independence or links between the various memory stores and functions. However, the extent of such brain damage and the response of individual patients to that damage highlights important individual differences between these unique cases. Therefore it is important to acknowledge that care should be taken when generalising the findings of these unique case studies to our overall understanding of memory in the whole population.

A significant problem with describing long-term memory in terms of two separate systems is that it does not account for any interrelationship or continuity between each system. Clearly they work together when given an episodic memory task, such as learning a list of words, as a word can have a semantic feature (meaning of the word) and an episodic reference (when and where the word was remembered). This makes research into the separate stores problematic because they cannot be studied in absolute isolation from one another.

Additionally, experimental studies of learning word lists are problematic as evidence for either semantic or episodic memory because they do not take into account the ‘guesses’ that participants may make when recalling the list. If a participant makes an informed guess about a word that could have been on the list of words to remember, this would represent recall from semantic, not episodic, memory. The likelihood of semantic recall in an episodic memory test is high, which means that testing the separate stores independently becomes problematic.

Reconstructive memory (Bartlett, 1932)

Sir Frederic C. Bartlett (1886–1969) was one of the most influential cognitive psychologists of the last century; his most notable contribution was a collection of memory experiments published in his book *Remembering*. Contrary to much experimental research at the time, Bartlett insisted on representing memory in a real context. He stated that experiments should not just capture reactions, they should capture human beings. Bartlett believed that memory should not be divided into its constituent parts and treated as independent from other functioning, but rather should be studied in a special way to capture the relationship between memory and other cognitive processes.

Perception

Bartlett believed that in order to study memory, we must first understand what precedes it and what follows it. To understand perception as a precursor to what is remembered, Bartlett devised a series of experiments to test memory for shapes and objects. He found that participants often assigned verbal labels or names for each shape or object that they saw and that these names often shaped the representation of the object drawn afterwards. He concluded the perception of the shape or object determined how it was remembered.

INDIVIDUAL DIFFERENCES

How we perceive an object or event is based on individual interpretation. This interpretation is strongly influenced by our past experiences, knowledge we have learned and the attitudes and beliefs we possess. Therefore perception is an individual characteristic that is unique to every person.

Imaging

In order to understand what is remembered, Bartlett conducted a series of tests on imaging, as what is remembered is what is first imaged. Using ink blots, he asked participants to describe what they imaged in the pattern they saw. He noticed that participants often ‘rummaged about’ their own stored images to find one that would best fit the ink blot pattern they saw. Often describing the blot as a plant or animal, Bartlett suggested that the descriptions given were largely determined by the individual’s own interests and experiences, and even the mood that they were in at the time. He coined the term ‘effort after meaning’ to describe how participants spent considerable effort in trying to connect a stimulus that they are given with some knowledge or experience they possess. Once the stimulus gains meaning for the individual, it can be more readily assimilated and stored.

Taking it further

Use the Internet and find some images of ink blots or projective tests. Try to verbalise what you see in the picture. This will demonstrate Bartlett’s effort after meaning as you search for the meaning in the picture.



It is clear that perception is not simply the passive process of receiving an image, but an active construction of what we think we see using prior knowledge to guide the judgement. In Bartlett’s follow-up experiments on memory, he employed the same philosophy to his research, moving away from artificial laboratory investigations and the use of ‘non-sense’ or random letters and words. Instead he used images of faces and stories that participants were required to describe or repeat. In his most famous experiment, Bartlett asked participants to read and recall a North American folk tale called ‘The war of the ghosts’.

Remembering

Bartlett chose this folk tale for four reasons: it was culturally unfamiliar to participants so he could examine the transformations that the story may make when reproduced by participants, it lacked any rational story order, the dramatic nature of the story would encourage visual imaging, and the conclusion was somewhat supernatural and Bartlett wanted to see how participants would perceive and image this.

'The war of the ghosts' folk tale

One night two young men from Egulac went down to the river to hunt seals, and whilst they were there it became foggy and calm. Then they heard war-cries, and they thought 'Maybe this is a war party.' They escaped to the shore, and hid behind a log. Now canoes came up, and they heard the noise of paddles, and saw one canoe coming up to them.

There were five men in the canoe, and they said: 'What do you think? We wish to take you along. We are going up the river to make war on the people.'

One of the young men said: 'I have no arrows.'

'Arrows are in the canoe,' they said.

'I will not go along. I might be killed. My relatives do not know where I have gone. But you', he said, turning to the other 'may go with them.'

So one of the young men went, but the other returned home.

And the warriors went up the river to a town on the other side of Kalama. The people came down to the water, and they began to fight, and many were killed. But presently the young man heard one of the warriors say: 'Quick, let us go home: that Indian has been hit.' Now he thought: 'Oh, they are ghosts.' He did not feel sick, but they said he had been shot.

So the canoes went back to Egulac, and the young man went ashore to his house, and made a fire. And he told everybody and said: 'Behold I accompanied the ghosts, and we went to fight. Many of our fellows were killed, and many of those who attacked us were killed. They said I was hit, and I did not feel sick.'

He told it all, and then he became quiet. When the sun rose he fell down. Something black came out of his mouth. His face became contorted. The people jumped up and cried.

He was dead.

Key term

Repeated reproduction: a participant recalls information at increasing time intervals (e.g. after 10 minutes, a week, a month).

Each participant read the story twice and **repeated reproduction** was used to test the effect of time lapse on recall. Bartlett was interested in the form that the reproduced story would take, particularly after repeated reproductions. Twenty participants recalled the story after several minutes, weeks, months, and years; the longest time lapse was six and a half years. Bartlett found that the story became considerably shortened because of omissions made, the phrases used reflected modern concepts, and the story became more coherent in form. A number of transformations to the story were reported, particularly objects within the story were made more familiar – 'canoe' was changed to 'boat', 'hunting seals' changed to 'fishing'. Many participants did not grasp the role of the ghosts in the story, so simply omitted to mention them or rationalised their presence in some way.

Bartlett concluded that memory is reconstructed each time it is recalled. It is rarely accurate, and is prone to distortion, rationalisation, transformation and simplification. Even recall after several minutes elicited errors in recall, and these errors tended to be consolidated in subsequent reproductions. The process of remembering is constructive in nature and influenced by inferences made by an individual.

WIDER ISSUES AND DEBATES

Psychology as a science

Bartlett's experiments had a distinct lack of control and standardisation in the procedures he followed. Participants were reasonably free to deliberate over the objects and stories presented to them. In one instance, he simply bumped into a previous participant after six and a half years and suggested he recall 'The war of the ghosts' story. The findings were qualitative; he described the nature of recalled information in a descriptive way. Therefore, his experiments can be criticised for lacking scientific rigour and being open to subjective interpretation.

A theory of memory

Based on the numerous experiments he conducted, Bartlett proposed a theory of **reconstructive memory**. Rather than viewing memory as a passive and faithful record of what was experienced, he viewed memory as constructive in nature. He proposed that previous knowledge was used to interpret information to be stored and to actively reconstruct memories to be recalled. Rather like using a note pad, in order to remember something we interpret an event and make brief notes on it. When it comes to recalling the event we actively draw on past experiences to reinterpret the notes, fill in the gaps and transform it into a coherent story. It is an imaginative reconstruction of events. Bartlett drew on the concept of schema to explain this.

Schema theory

Schemas are parcels of stored knowledge or a mental representation of information about a specific event or object. Every schema has fixed information and variable information. For example, a schema for going to a restaurant would contain knowledge of fixed events, such as being waited on, choosing from a menu, eating and paying for the meal, and variable events, such as what was on the menu and how much the meal cost. Bartlett argued that we do not remember all that we perceive. We therefore draw on our schema when we recall an event to fill in the gaps. This means that recall is an active reconstruction of an event strongly influenced by previously stored knowledge, expectations and beliefs.

Schemas are also used in recognition and interpretation of unfamiliar objects and events. This can explain the 'mental rummaging' Bartlett's participants experienced when trying to find meaning in the ink blots: effort after meaning (the effort we put into trying to find the correct schema that offers some meaning to an object).

Triggering a schema

Read the following passage:

'When the man entered the kitchen, he slipped on a wet spot on the floor and dropped the delicate glass vase he was holding. The glass vase was very expensive and everyone watched the event with horror.'

(Bransford, 1979)

Now cover up the passage and write it down.

Compare your passage to the original, do you notice anything different?

You may have written down that the glass was broken. This is because the passage triggered your schema of broken glass because of the other details it contained – horror, wet spot, slipped, dropped. Yet it does not state in the passage that the glass broke; it was just your interpretation of the event.

Key term

Reconstructive memory: the idea that we alter information we have stored when we recall it, based on prior expectations/knowledge.

WIDER ISSUES AND DEBATES

Nature–nurture

Schemas are mental constructs that form the structural or hardware components of the human memory system and can be inferred to be biological structures or containment units (modules). However, the way in which schemas actually represent knowledge will vary between individuals and certainly across cultures. Because schemas represent stereotypical beliefs about an object or event, these will be affected by upbringing and so they are a product of nurture.

Evaluation

Bartlett based much of his research on story and object recall, but some have criticised his use of 'The war of the ghosts' story for having little relevance to everyday memory, and being a deliberate attempt to orchestrate evidence for his schema theory. However, Bartlett conducted his repeated reproduction experiments using eight different stories on different participants and found the same overall general shortening, transformation, familiarisation and omission. He also found similar effects on repeated and serial reproduction of pictures. Therefore, it can be argued that memory for any type of story or object is subject to the same memory errors.

Bartlett believed that schema had an effect at the recall stage of memory. That is, we actively reconstruct our memory when it is retrieved, and this retrieval process is affected by the schema we possess. However, others argue that sometimes schema have an influence at the point of learning because we draw on schema to comprehend a situation and make inferences about it.

A further criticism levelled at Bartlett is the overstatement of memory as inaccurate and flawed. This has led to a wealth of experimental research to demonstrate that eyewitnesses are unreliable when recalling witnessed events. Although we should maintain caution when using eyewitness testimony as a sole source of evidence in criminal cases, Steyvers and Hemmer (2012) argue that the experimental conditions of such research deliberately induce errors in recall; leading to the view that memory is unreliable. Their research demonstrates that in a real context without manipulated material, schematic recall can be very accurate. Therefore we should be cautious when assuming that eyewitness memory is completely unreliable.

Exam tip

Practise applying your knowledge of reconstructive memory to explain the following scenario.

Mary was witness to a shoplifting incident at her local shop. She reported to the interviewing police officer that the shoplifter had stolen high-value items including coffee and alcohol. When viewing the CCTV footage, the police noted that the shoplifter had actually stolen low-value items: frozen chips, tinned beans and toothpaste.

Using your knowledge of reconstructive memory, explain why Mary may have reported the incident inaccurately.

Remember that it is important that you relate your knowledge of the theory to the details given in the scenario.

Individual differences in memory

Memory has been examined so far in terms of general theories that account for the majority of people. However, it should be acknowledged that there are individual differences in memory that make us unique.

The speed at which we can process information differs between individuals. This is known as 'processing speed'. You may have noticed that some people take longer to write notes from the whiteboard than others in your class. This is likely to be due to the speed at which they can process information and their short-term store capacity. Processing speed and capacity is affected by age too. Younger children have a shorter digit span than older children, suggesting that memory capacity increases with age. This evidence will be discussed later in the study by Sebastián and Hernández-Gil, 2012.

Schemas and autobiographical memory (episodic memory)

Bartlett's reconstructive memory theory suggests that we all have relatively similar schemas, but that these schemas can be heavily influenced by experience. This in turn affects the way we perceive

information received by the senses and retrieve information held in memory. A teacher, for example, may perceive a simple cylindrical drawing as being a writing implement such as a pen, whereas a child may perceive it as an arrow or a drumstick. This experience-based perception will affect how the object is remembered. Similarly, the development of our schema will affect how we recall information.

It is also true that episodic memory is individual to the person as it is a collection of memories of their own life; an autobiography of personalised events. There are individual differences in autobiographical memory. In a large-scale investigation of 598 volunteer participants, Daniela Palombo and her colleagues (2012) conducted a Survey of Autobiographical Memory (SAM) designed to assess individual differences in naturalistic **autobiographical memory**. Using a design more commonly associated with measuring personality, they subdivided autobiographical memory into four domains: episodic memory (memory for events), semantic memory (memory for facts), spatial memory and prospective memory (imagination for future events). The questionnaire contained 102 items which participants scored on a five-point Likert Scale.

The findings suggested that the individuals who scored high or low on episodic memory also scored high or low on semantic memory. So we either have a good or poor memory overall.

Palombo et al. also found that men scored higher on spatial memory; this finding is consistent with other research indicating that men have stronger spatial ability than females. They also found that people who self-reported having depression scored low on episodic and semantic memory.

This survey gives a useful insight into self-reported accounts of naturalistic memory that could not be captured under laboratory conditions, and a useful insight into individual differences in autobiographical memory. However, it is possible that participants made inaccurate self-appraisal or lacked the insight to make accurate judgements of their own memory performance.

Developmental psychology in memory

Developmental psychology is a branch of the subject that investigates what happens to us as we age. Developmental psychology is concerned with both normal and abnormal behaviour as we grow up. For example, it is interested in how and when children learn language, but also when and why children may fail to learn language as they are expected. In memory research, dyslexia and Alzheimer's disease have been investigated in young and old participants.

Dyslexia

Dyslexia is a reading disorder defined as a problem in learning to recognise and decode printed words at a level that would be expected for the individual's age. This means that children with dyslexia find it difficult to read fluently and accurately, but have normal levels of comprehension (understanding). Dyslexia affects between 3 and 6 per cent of children (some estimate as many as 10 per cent) and is more prevalent in boys than in girls. It is characterised by having a particular difficulty with **phonology** which is critical for learning to read. The first indication of dyslexia is showing difficulty learning letter sounds and names, indicating a problem with learning to associate a word with its speech sound. This consequently leads to spelling and reading problems.

Children with dyslexia have a poor verbal short-term memory. Evidence for this comes from the phonological similarity effect (difficulty in remembering similar sounding words) and the word length effect (difficulty remembering sequences of long words compared to short words). So perhaps it is that children with dyslexia have an impaired short-term memory to deal with speech sounds.

McDougall et al. (1994) divided 90 children into three different reading ability groups: poor readers, moderate readers and good readers, and found that poor readers had significantly lower memory

Key terms

Autobiographical memory:

Like episodic memory, it is a memory for personal events.

Phonology: speech sounds.

Example items used in Survey of Autobiographical Memory

Episodic memory item:

When I remember events, I remember lots of details.

Semantic memory item:

I can learn and repeat facts easily, even if I don't remember where I learned them.

Spatial memory item:

After I have visited an area, it is easy for me to find my way around the second time I visit.

Prospective memory item:

When I imagine an event in the future, I can picture people and what they look like.

spans for words and slow reading rate. Good readers can articulate words quickly, leading to a greater number of words being represented phonologically in short-term memory. Poor readers sound out words more slowly, leading to fewer words being held in short-term memory. This basic inefficiency in phonological processing and storage may explain dyslexia.

Alloway et al. (2009) suggest that children with dyslexia have difficulty in processing and remembering speech sounds because of poor working memory. They cannot hold all of the speech sounds for long enough in working memory to be able to bind them together to form a word. They simply do not have the working memory capacity to store syllables for long enough to form them into a fluent word. Investigating 46 children, aged 6–11 years, with reading disability, she found that they showed short-term working memory deficits that could be the cause of their reading problems. Similarly, Smith-Spark et al. (2010) found that adults with dyslexia had unimpaired spatial working memory, but impaired verbal working memory, compared to a control group of non-dyslexic participants. They suggest that their results indicate a deficit with the phonological loop in dyslexic participants.

Research seems to conclude quite strongly that children and adults with dyslexia have an underlying cognitive impairment leading to a shorter memory span and difficulty processing and storing verbal information in short-term memory. However, it is difficult to establish exactly what role verbal memory plays in causing dyslexia, particularly because people with dyslexia present a range of sensory impairments in both the auditory and visual systems. Additionally, dyslexia is **comorbid** with other learning difficulties, in particular attention deficit hyperactivity disorder and other specific learning impairments. The interaction between dyslexia and other related difficulties makes it difficult to isolate phonological issues as a reason for reading impairment.

Key term

Comorbidity: the existence of more than one disorder in the same person at the same time.

Alzheimer's disease

Alzheimer's disease is a progressive, degenerative, neurological disorder associated with ageing that will affect around one in twenty people, although the risk of development increases with age. It is the most common form of dementia and typically occurs after 65 years of age, but can occur as early as 40 years old. Alzheimer's is characterised by memory loss, concentration loss, confusion, and changes in mood that progressively become worse.

The normal ageing processes result in a loss of general cognitive functioning, but Alzheimer's disease appears to selectively impair certain cognitive systems rather than deteriorating cognition globally. In particular, Alzheimer's initially deteriorates the memory system for new events and information whereas older information is preserved. It also affects working memory; central executive functioning becomes impaired, making complex tasks more difficult to coordinate, and visuospatial processing becomes impaired.

A major characteristic of Alzheimer's disease is the inability to recall autobiographical information from episodic memory, thus it affects both short-term and long-term memory recall. The extent of the memory loss is associated with the depletion of brain matter, particularly in the hippocampus and temporal cortex. The greater the brain damage, the more significant the impairment; typically this increases with progression of the disease.

Loss of executive functioning results in a lack of general coordination and difficulty with attention. Baddeley et al. (2001) conducted a series of attentional tests on individuals with Alzheimer's and control participants, one involving looking for the letter 'Z' among easy and difficult distractor letters (letters that either looked like the letter Z or not), and a dual task procedure. They found that patients with Alzheimer's performed worse on the difficult distractor task and were even more impaired on the dual task. This suggests that dual attentional tasks are specifically impaired by the disease.

2.2 Methods

Learning outcomes

In this section you will learn about the experiment and the case study of brain-damaged patients as research methods commonly used to investigate memory in cognitive psychology:

- how to design and conduct experiments
- hypothesis construction
- experimental research designs
- problems that arise when conducting experiments
- controls that can be used to ensure reliable and valid research findings
- how to analyse and present quantitative data
- the use of statistical testing
- the use of case studies of brain-damaged patients in memory research, including the most famous case of Henry Molaison (HM)
- the use of qualitative data.

Experiments

Memory is difficult to observe or accurately measure using a self-report method, so cognitive psychologists often use experiments to objectively quantify the capacity and duration of each memory store. Traditionally **laboratory experiments** have been used to investigate memory, but increasingly **field experiments** are being used to understand memory in more everyday contexts.

Experiments are investigations where a variable is manipulated or altered and its effect can be measured, while maintaining control over other variables that might interfere with this situation. Experiments 'set up' a situation where participants are required to perform a task and the performance of this task is measured. The extent to which this task reflects real life or is conducted in a realistic situation depends on the type of experiment being conducted.

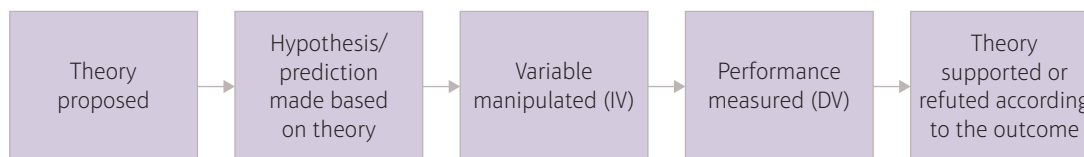


Figure 2.6 The experimental method.

Aim

The aim of an experiment is a general statement about what area or topic is being researched. An aim typically begins with 'To investigate...'. The aim is a concise and to-the-point statement that directs the overall ambition of the study.

Example aims

To investigate whether the type of food given to cats affects their purring

To investigate whether praise affects the time children spend washing dishes

Key terms

Laboratory experiment: an experiment conducted in a controlled environment.

Field experiment: A piece of research that takes place in the setting where the behaviour being studied would naturally occur.

Operationalisation: defining the variables specifically so that they are directly tested.

Exam tip

The aim is an important part of a research investigation because it clearly signposts the topic being investigated. An aim should be as clear and precise as a hypothesis. Once you have read about hypotheses and **operationalisation** later in this topic, it is important that you apply the same detail and accuracy to an aim.

Directional or one-tailed

The direction of the results can be predicted.

Non-directional or two-tailed

A change or difference is predicted, but not the direction it will go in.

Figure 2.7 Differences between hypotheses.

Key terms**Alternative hypothesis:**

a statement that lays out what a researcher predicts will be found. This is also known as an experimental hypothesis when the research methodology adopted is experimental.

Directional hypothesis:

A directional hypothesis predicts the direction of difference or relationship that the result is likely to take.

Non-directional hypothesis:

A non-directional hypothesis predicts that a difference or relationship will be found, but not the direction that the difference or relationship will take.

Null hypothesis: Predicts no difference/relationship will be found or that any difference/relationship is due to chance factors.

Hypotheses

Experiments begin with a prediction of what is likely to happen in the investigation based on previous knowledge, research or theory. This prediction of a likely outcome is known as the experimental hypothesis. An experimental hypothesis is a type of **alternative hypothesis**. An experimental hypothesis is a clear and precise statement predicting the results of the experiment.

Sometimes we can be certain of the outcome of an experiment because, perhaps, there is strong evidence to suggest the outcome may happen, or it is based on a robust theory. In such cases a **directional hypothesis** will be predicted. When we are not certain of the outcome of an experiment, because there are conflicting theories or a lack of relevant evidence, a **non-directional hypothesis** will be predicted. A non-directional hypothesis predicts that a difference or relationship will be found, but not the direction that the difference or relationship will take.

Examples of experimental hypotheses

Directional hypothesis:

Cats will purr for longer when they are fed tinned food compared to dry food.

Children will spend longer washing dishes the more praise they receive.

Non-directional hypothesis:

There will be a difference in the length of time a cat purrs when given tinned and dry food.

Praise will affect the time children spend washing dishes.

A **null hypothesis** is a default prediction that is supported if there is a greater likelihood of the results occurring by chance. When we conduct research we often find some difference or relationship; it is rare we would find nothing, but sometimes the difference or relationship found is too small or insignificant to be due to anything other than chance variation. For example, if we are investigating whether praise affects a child's inclination to tidy their bedroom, it is unlikely that we will find no/zero effect of praise on bedroom tidying. However, the change observed in bedroom tidying may be too small or insignificant to be due to praise alone and could be due to chance.

Example null hypotheses

There will be no difference in the length of time cats spend purring when fed tinned or dry food.

Any difference found will be due to chance factors.

There will be no effect of praise on the time children spend washing dishes. Any effect found will be due to chance factors.

Independent and dependent variables

An experiment always has an independent variable and dependent variable. The independent variable (IV) is the variable that is manipulated or changed by the researcher in order to demonstrate a difference between the experimental conditions. The dependent variable (DV) is the variable that is measured or the result of the experiment. The dependent variable measures any changes that occur because of the independent variable. This allows causality to be established (cause and effect).

Example IVs and DVs

'A researcher wished to investigate whether participants will recall more words from an organised list compared to a random list'

In this example, the researcher will have to change which list participants have to learn and recall from. This is manipulated by giving one set of randomised words and one set of organised words. The type of word list is the IV.

The researcher will then ask participants to recall the list of words and record how many words they remember. This is the measured variable or outcome of the investigation, so is referred to as the DV.

Operationalisation

Once the IV and DV have been decided, it is very important to make these variables precise and specific by operationalising them. This means deciding exactly how you are going to manipulate the IV and exactly how the DV will be recorded. Operationalisation of the IV and DV means that the study can be precisely replicated to check the conclusions are reliable. **Operational definitions** of the DV can increase objectivity in research; this is because the outcome is measured in the same way by all researchers, and the outcome is not open to interpretation. It also means that other psychologists can assess whether or not the researcher has conducted valid research.

Key term

Operational definitions:
what the variables are and how you will measure them.

Good and poor operationalisation

Poor operationalisation:

A researcher thought that children who came to school without a healthy breakfast had problems during literacy hour. The researcher decided to ask the children what they had for breakfast and split them into healthy and unhealthy breakfast groups. She then watched them read a book and decided how well they could read.

This is an example of poor operationalisation because the way in which the healthy and unhealthy breakfast groups are defined is unclear. It is also not clear how the researcher measured reading skill. A study such as this example would be difficult to replicate exactly to check for reliable findings. If more than one researcher was involved in the research, it would not be clear what is meant by reading skill, so they may reach different conclusions for the same child. A different researcher would not be able to assess how healthy breakfasts were defined or how reading skill was defined, so could not be certain that the study was valid.

Good operationalisation:

A researcher thought that children who came to school without a healthy breakfast had problems during literacy hour. The researcher asked the children and parents to make a record of what they ate for breakfast over the course of a week. A nutritionist was asked to categorise the breakfasts as health and unhealthy. Breakfasts with over the recommended meal allowance for salt, fat and sugar were defined as unhealthy. The researcher then timed how long a child took to read a story during literacy hour. All children read the same story out loud to the researcher, who timed the children and recorded any errors they made.

This is an example of good operationalisation because the IV (healthy and unhealthy breakfasts) are clearly defined and the DV (reading speed and errors) can be measured exactly without any ambiguity. This study is replicable and it would be easy for a different researcher to assess whether the definition of healthy and unhealthy breakfasts and reading ability were measuring what was intended.

Key terms

Extraneous variable: a variable that may have affected the dependent variable but that was not the independent variable.

Confounding variable: a variable that affects the findings of a study directly, so much that you are no longer measuring what was intended.

Exam tip

When considering control, it is common to suggest that noise, temperature and lighting conditions might affect the dependent variable without carefully considering whether they are relevant extraneous variables. In extreme, these variables could affect research, but they would have minimal influence on the dependent variable in most studies. It is important to consider the nature and aims of the investigation before you decide which extraneous variables are likely to have an effect.

Experimental variables

Extraneous and confounding variables

An experiment should try to establish control over factors that may have an unwanted effect on the dependent variable. These other variables are known as **extraneous variables**. Sometimes an extraneous variable can influence the dependent variable and make it look as though the effect was from the independent variable; this is called a **confounding variable**. This variable confounds the results of the study in such a way that you are no longer measuring the effect of the IV on the DV.

Extraneous and confounding variables can be divided into two types: situational variables and participant variables.

Situational variables

An extraneous variable that might affect the results of a study could be found in the environment in which the study is conducted. Situational factors such as lighting, noise, temperature, other people, disturbances, time of day, etc., may all affect the results of a study so should be controlled or eliminated. Controlling extraneous variables means that they are held constant for all participants, so that the variable affects everyone equally. Eliminating extraneous variables involves removing the possibility of them occurring in the first place.

Participant variables

Participants themselves may affect the results of the study. Participants may bring different characteristics to an experiment that could have an effect on the dependent variable, such as level of motivation, personality, intelligence, experience, age and skills. It is fairly easy to control participant variables such as age and gender, but controlling motivation or experience may take more thought.

It is not necessary, and would certainly be far too time-consuming, to control for all situational and participant variables. It is only really necessary to control those variables that might have an unwanted impact on the dependent variable. For example, controlling the temperature of a room is not vital unless you are testing something where the temperature might affect performance.

Careful control

List some situational and participant variables that could affect the following studies and then consider how you would control or eliminate them.

- An investigation into sporting experience and the ability to shoot a hole in one with a basketball
- An investigation to see if rehearsal was a better memory technique to learn a list of digits than creating a mental picture of the digits
- An investigation to see if more cars stopped at a zebra crossing on a busy street for men or women
- An investigation into essay writing skills of history and art undergraduate students
- An investigation into alcohol and driving performance

Experimenter effects

Experimenter or researcher effects refer to the way an experimenter may influence the outcome of an experiment by their actions or mere presence. These may be subtle cues that may influence the way a participant responds in an experimental situation. Sometimes these can be obvious effects, such as a female researcher asking a male participant about his attitudes towards gender equality, or a young researcher asking an older participant what they think about youth culture. However, some experimenter effects are more subtle. The **Hawthorne Effect** is one such example where the mere presence of a researcher can have an effect on performance.

Closely related to this is the concept of **demand characteristics**. This is when the effect of the experimenter causes participants to alter their behaviour to meet the expectations (whether real or imagined) of the experimenter. Rosenthal researched this expectancy effect over many decades. Rosenthal found that psychology graduates who were told one set of rats were brighter than another set of rats resulted in the bright rats being able to learn their way out of a maze faster than the dull rats. With no actual difference between the two sets of rats, Rosenthal concluded that the students may have treated the rats differently, pressed their stopwatch earlier or reported false findings as a result of expectancy effects.

Experimenter effects may explain why a researcher finds a result that other researchers fail to replicate.

Experimental control

In experiments using human participants, a great many variables can influence outcomes. It is important to be able to identify these variables and then put into place controls to help prevent them having any effect on the experiment. Various control techniques have been established to help deal with these control issues.

Standardisation

Standardisation refers to making an experiment the same experience for all participants. Standardised instructions are a set of instructions given to all participants that can be used to eliminate experimenter effects because it removes the potential for the experimenter to give verbal or non-verbal cues to participants. Standardised procedures (stages of the experiment, timings, apparatus, etc.) ensure that all participants are treated in the same way (other than the change in condition due to the independent variable) so there is no variation in the way they experience the research that may affect the way they behave. Standardisation also improves the replicability of the experiment.

Double- and single-blind experiments

To control for demand characteristics, participants may be unaware that they are part of an experiment, or may have been deceived as to the true nature of the study. This is known as a **single-blind procedure**, where the participants are unaware of the study aim so it does not influence how they perform. To eliminate experimenter effects, independent researchers who are not told the aim of the study may be employed by an experimenter to conduct the study on their behalf. If neither the participant nor researcher knows the aim of the study, it is referred to as a **double-blind procedure**.

Experimental design

Once the independent variable has been operationally defined, the levels of the independent variable can be identified and the conditions of the experiment established.

Key terms

Hawthorne effect: the presence of a researcher affects performance in a task.

Demand characteristics: Where participants alter their behaviour to meet the perceived demands of the experiment – try to please.

Single-blind procedure: to control for demand characteristics, participants may be unaware that they are part of an experiment, or may have been deceived as to the true nature of the study.

Double-blind procedure: neither the participant nor researcher knows the aim of the study.

Taking it further

Select one of the studies in this topic, read through the procedure and then write a set of standardised instructions for the participants to read.

Taking it further

In the exam you may be asked to identify extraneous variables associated with psychological research. Practise by assessing the extraneous variables and controls in the following research studies.

Identify:

- participant variables
- situational variables
- controls that the researchers used.

Studies:

- Godden and Baddeley (1975) scuba diver study of context dependent recall
- Schab (1990) chocolate cue research
- Pickel (1998) memory and weapon focus study

Try to find some more studies to assess.

Key terms

Control group: A group of participants that does not experience the experimental situation but acts as a baseline against which to judge any change.

Individual differences: natural variation in human characteristics.

Participant variables: natural variation in human characteristics.

Random allocation: participants are allocated to a condition of the study at random (names drawn from a hat).

Identifying levels of the IV and conditions of the experiment

For example: The effect of music (IV) on transcription speed and accuracy (DV)

Levels of the IV – Rock music or silence

Conditions of the experiment: Whether participants hear rock music while trying to transcribe verbally dictated information or transcribe in silence

The conditions of the experiment reflect directly the levels of the independent variable. More levels of the IV can be added, for example, classical music or popular music and therefore there will be more conditions involved in the experiment.

Note: Often one level of the independent variable is a **control group**, which receives no treatment. In the above example, the control group is the group that transcribes in silence. It is important to have a control group as a baseline comparison to determine the effect of the IV on the DV.

Participants recruited to take part will need to be allocated to one or both conditions of the experiment. There are several designs that can be used to achieve this: an independent groups design, a repeated measures design and a matched pairs design.

Independent groups design

This is when the participants are divided into groups and are only involved in one of the experimental conditions of the experiment. A strength of this experimental design is that participants are less likely to guess the aim of the investigation as they only take part in one level of the independent variable, they do not get to know about the other conditions. This means that the chance of demand characteristics or expectancy effects is somewhat reduced. However, it does mean recruiting twice as many participants because you need separate groups and there may be **individual differences** or **participant variables** between the participants in each group that make a comparison of the groups unreliable. One way of controlling for individual differences is to randomly allocate participants to one or other of the conditions. **Random allocation** means that it is probable, but not certain, that there will be an even distribution of participant variation because they all have an equal chance of being selected for each condition of the experiment.

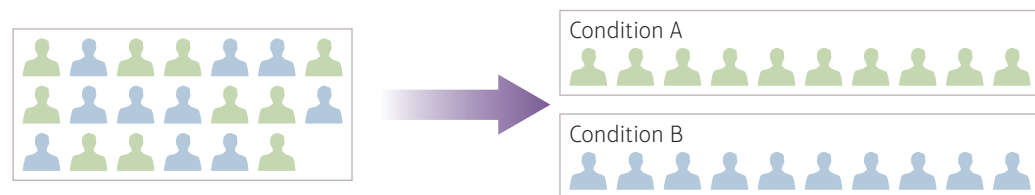


Figure 2.8 Independent groups design.

Repeated measures design

This is when all participants take part in all conditions of the experiment. This resolves the problem of individual differences because the same participants are in all levels of the independent variable, so the participant's results in one condition are compared to the same participant results in a different condition. Fewer participants are needed for a repeated measures design, because they are used twice, so it is more economical than an independent groups design. However, the chance of participants displaying demand characteristics is greatly increased because they have knowledge of all conditions of the study, and are therefore more likely to be able to guess the aim of the

study. There is also a problem of **order effects**; this is when the performance of participants in one condition is influenced by the previous condition of the experiment. Order effects include practice and fatigue; a participant may learn the task in the first condition so perform better in a second condition, or become tired and performance declines in a second condition.

One way of controlling for the effect of demand characteristics is to use a single-blind technique. To control for order effects, randomisation or counterbalancing can be used to ensure that participants experience the conditions in a different order. Randomisation involves selecting at random which of the conditions of the experiment a participant does first. This can be done by picking a card out of a hat. Counterbalancing involves the participants being placed into either a group that does Condition A then Condition B, or a group that does Condition B then Condition A. However, if the order effect (practice or fatigue) in one sequence order (AB) is not equivalent to the order effect in a different order (BA), a more complex counterbalancing technique may be required. The ABBA design is used to balance unsymmetrical order effects by getting participants to complete the conditions twice – A, B, B then A. The mean score for both conditions A and conditions B are then taken.

When there are more than two conditions in an experiment, a Latin square can be used to designate participants to one of the combinations of ordering. This means that, although order effects still occur, they are balanced out between each group.

A simpler way to overcome order effects is to leave a time gap between participants completing condition A and condition B. The effects of fatigue are likely to be reduced, although the same may not be true of practice effects depending on what the task is.

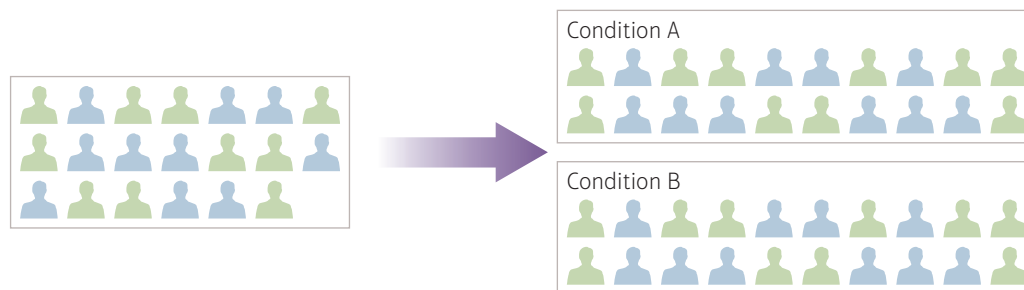


Figure 2.9 Repeated measures design.

Matched pairs design

To overcome the problems associated with repeated measures and independent groups designs, a matched pairs design can be used. This is when different participants are assigned to each condition of the experiment (similar to independent groups) but they are matched on characteristics important to the study. These characteristics are often established by pre-testing and researching the lives and backgrounds of all the participants. This control ensures that the participants in each condition can be compared fairly. This can be achieved by matching all participants on important characteristics and then randomly assigning them to each condition. It is important to match participants on characteristics central to the aim of the study; it would not be useful to match participants on hair colour, for example, in a study of driving ability, the matching would have to concern driving experience, eyesight, reaction time, or other characteristics where any variation could affect the results.

A matched pairs design ensures that the conditions can be compared more reliably and that any difference found between the results of each condition is more likely to be due to the manipulated variable, so causation can be established. However, a matched pairs design is time-consuming and many participants have to be excluded from the study because they do not meet the matching criteria. It is also very difficult to match participants on all possible characteristics that could have an effect on the dependent variable. For example, if a study was conducted into the effect of an unhealthy breakfast on reading ability, it would be useful to match participants' educational level and

Key term

Order effects: the problem with presentation order of stimulus material. Participants may become practised at the test so improve performance or they may become tired so that performance deteriorates.

A	B	C
C	A	B
B	C	A

Figure 2.10 Latin square used to counterbalance conditions of an experiment.

Exam tip

Understanding validity can be difficult, particularly as there are different types of validity that you will need to know. However, validity is important to know not just when you are designing your own research, but it can also be a useful tool to help you evaluate the research of others.

Key terms

Internal validity: the extent to which the outcome of the study is the direct result of the manipulated independent variable.

External validity: the extent to which the findings apply to other people and situations.

Construct validity: the extent to which the test measures what it claims to measure.

Predictive validity: a way of assessing internal validity by some future outcome that should be predicted by the test.

Ecological validity: the extent to which the findings still explain the behaviour in different situations.

Population validity: the extent to which the findings can be applied to other people.

eyesight. However, there may be variables that are much more difficult to match, such as how many books a child has at home, the educational level of parents, how much time parents spend reading with their children, etc. Therefore a matched pairs design cannot be truly matched on all possible variables.

Which experimental design?

Which experiment design is being described in the following investigations?

1. An investigation to see if boys or girls are better at mathematics.
2. A study to test whether sport improved self-esteem divided volunteer participants into sporting and non-sporting groups and gave them a questionnaire on self-esteem.
3. Researchers investigated the difference in attitudes between identical twins.

Reliability

Reliability refers to the consistency of findings from research, and it is an important criterion for being scientific. For experiments, test-retest reliability is important.

Test-retest reliability

If findings are consistent, and can be considered reliable, we can trust that the finding will happen again and again. In order to achieve reliability, research must be replicable. This requires very tight control of extraneous variables that, if not controlled, could result in different findings when a study is repeated.

Validity

Validity refers to whether the study is measuring the behaviour or construct it intends to measure. Understanding validity is an important skill for both designing and evaluating research studies. There are two broad categories of validity; **internal validity** and **external validity**. Internal validity refers to how well the procedure of a study establishes a causal relationship between the manipulated independent variable and the measured dependent variable, or whether it has been confounded by uncontrolled extraneous variables. Internal validity can be ensured by using standardised procedures, controlling for order effects and individual differences, and avoiding demand characteristics.

A way of assessing internal validity is by examining **construct validity**. Construct validity is how well the measure of a behaviour being used is a useful indicator of what is supposed to be studied. For example, recall of a previously learned list of words may not be a useful measure of episodic memory because a participant may draw on semantic memory and make a good guess. If you are measuring what you intend to be measuring, then another way to assess internal validity is through **predictive validity**; the extent to which the performance on the measure can predict future performance on a similar criterion. For example, if a test of intelligence can accurately predict future academic success, then it has predictive validity.

External validity refers to how well research findings study can be generalised beyond the study itself, that is, to other situations or other populations. There are two main types of external validity; ecological and population validity. **Ecological validity** refers to the extent to which the research can be generalised to other situations, for example real-life or everyday situations. Memory experiments conducted in artificial environments with artificial tasks may not be generalised to everyday use of memory. **Population validity** refers to the extent to which research findings apply to other populations than those used as the sample. External validity can be improved by ensuring that the sample is representative of the population it intends to represent, and by making the context of the study as realistic as possible.

Objectivity

Being objective refers to the need to be impartial and judgement free. It is important that the dependent variable is measured objectively, so that the opinions or judgements of the researcher do not affect how the dependent variable is recorded. For example, imagine that you are asked to guess the length of a table. Your judgement will be based on your own opinion or belief about length, and will probably differ from the guesses of others. Your guesses and those of others are subjective and therefore unlikely to be either reliable or valid. However, if you use a ruler to measure the length of the table, your recorded answer is objective, and will be exactly the same as others who measure the same table using the same ruler. This is an objective measure of the table length, and therefore will be both reliable and valid.

Cognitive psychology studies concepts, such as memory, that cannot be directly observed and measured. Cognitive psychologists would agree that we cannot objectively measure mental processes, but we can objectively observe the data produced by experiments and neuroimaging techniques. If we conduct a short-term memory test that records a participant recall of five words, this is an objective measurement of short-term memory. If we use a PET scan to test brain functioning during a memory experiment, we can objectively observe regions of the brain that are active during the task.

Laboratory experiments

A laboratory experiment is conducted in an artificial environment where an independent variable is manipulated and its effect on the dependent variable measured in some way. Removing participants from their natural environment eliminates the potential for extraneous variables affecting their behaviour; exposing the objective truth by stripping away the context ensures a human characteristic can be studied in an objective and value-free way. An artificial context provides the researcher with the level of control over relevant variables necessary to achieve a more scientific approach and ensure **causality**.

However, laboratory experiments can be criticised for lacking ecological validity as behaviour is measured in an artificial environment and artificial way. This makes the findings of laboratory research unlike normal life so they may not apply to a real-life situation. Participants are often invited to take part in laboratory research, so they are aware of their participation which can lead to demand characteristics and expectancy effects. The presence of the researcher during the experiment may influence the behaviour or performance of participants, so experimenter effects are more likely to have an influence on the results.

Field experiments

A field experiment is conducted in a natural environment where the independent variable is manipulated and the dependent variable measured. Participants are tested where they would normally display the behaviour being studied; this may be a classroom, supermarket or high street, and they may not be aware that they are taking part in an experiment until it is over. This means that field experiments have greater ecological validity as participant behaviour will be more natural and the environment in which they are tested is more realistic. If participants are unaware of their participation in the experiment they will not show demand characteristics. However, because the research is not conducted in a controlled environment, there is greater chance of extraneous variables having an effect on the dependent variable. There may also be ethical problems if a participant is unaware that they are taking part, as they have not given consent and do not have a right to withdraw from the experiment. In such cases, the experimenter may choose to debrief them after the experiment and offer them the right to withdraw their data from the study.

Taking it further



Using the studies and theories you have learned about, write a summary of the research (aim, procedure, results and conclusions) on a small card. Then rate the study/theory on a scale of 1 to 50 for reliability and validity. Play top trumps with these cards with other psychology students in your class.

Key term



Causality: the effect of the manipulated variable on the measured variable can be reliably established as a cause and effect relationship.

WIDER ISSUES AND DEBATES

Psychology as a science

The laboratory experiment is considered to be the most scientific of the research methods that psychologists can use. It is characterised by a high level of control and standardisation. This means that the study can be repeated to check the findings are consistent. As such, laboratory experiments are highly reliable. However, they may lack validity because they do not reflect real-life behaviour.

Key term

Inferential test: a test that shows how strong a difference between variables is.

Maths tip

Statistics and variables are linked when using an inferential test of significance, so it would be useful to refresh your memory on variables and hypotheses before reading this section. Pay particular attention to the types of alternative hypothesis and the null hypothesis.

Link

For quantitative data analysis including calculating measures of central tendency, frequency tables, measures of dispersion (range and standard deviation) and percentages, please see the Methods section of Topic 1: *Social psychology*.

Inferential statistics

Descriptive statistics, summary tables and graphs describe a data set, but to know whether there was a real effect of the independent variable on the dependent variable an inferential test of significance needs to be carried out. When data differs between two conditions (which it is likely to do as we rarely find no difference at all) we need to establish whether the effect is a real one or simply due to chance variation between the conditions. If there is a real effect we can accept the alternative hypothesis, but if there was no real effect we need to accept the null hypothesis. An inferential test of significance will indicate whether we should retain or reject a hypothesis.

Inferential tests rest on the concept of probability. Probability is the likelihood of an event occurring, so the probability of getting heads or tails on a single coin toss is 0.5 (or 50 per cent or one in two). When testing the probability of data we are actually testing the likelihood of the data (or rather difference between the data sets as defined by the independent variable) being due to random chance factors or something else. We use an inferential test to decide whether or not to accept the null hypothesis because it tells us whether the results were likely to be due to chance or not.

How small is small?

If the probability of the results is due to chance, we are assuming that the difference between the data is too small to be significant to show a real effect and the null hypothesis would be retained as the study conclusion. The question here is 'how small does the difference have to be to be too small?' In psychology it is generally accepted that the cut-off for making the decision about whether or not to reject the null hypothesis (and therefore make a judgement about whether the results are due to chance or not) is equal to or less than 0.05. This is expressed as $p < 0.05$. This means that we accept a 1 in 20 or 5 per cent probability that the results are due to chance. When we conduct an inferential test of significance it tells us whether we meet this 0.05 probability threshold or not. If the probability of the result occurring by chance is equal to or less than 0.05 we support the alternative hypothesis. However, if the probability of the result occurring by chance is greater than 0.05, we retain the null hypothesis.

If the inferential test is significant, we can support the experimental hypothesis because we are 95 per cent confident that our prediction is correct and the likelihood of the result occurring by chance is 5 per cent or less. If the inferential test is not significant, we accept the null hypothesis because we are less than 95 per cent confident that our prediction is correct and the likelihood of the results occurring by chance is greater than 5 per cent.

Maths tip

- Using decimals can be daunting. An easy way to convert a percentage into a decimal is to remove the % sign, place a decimal after the number (but not if it already has a decimal) and then move the number down two decimal places. For example, 20% becomes 20 then 20.00 then moves two decimal places to become 0.20.
- Notice that nowhere so far is there mention of 'proving' the results. We simply cannot prove the results are true even after conducting a statistical test. We can only claim that the test reasonably supports the alternative hypothesis we are stating, or that we are not confident in our results so we are retaining the null hypothesis.

Levels of significance and error

Although 0.05 is the accepted level of probability in psychology, if the result of the inferential test is equal to or less than $p < 0.1$ (10 per cent or 1 in 10 probability of the result occurring by chance) it may still be reported and followed up with more research. However, at a 0.1 level of significance, there

is a chance that the alternative hypothesis is accepted when it should not have been. Accepting the alternative hypothesis when the results were really not significant and the null hypothesis should have actually been retained, is known as a **type 1 error**. A type 1 error occurs because the level of significance is too lenient.

However, if the result of the inferential test is equal to or less than 0.01 (1 per cent or 1 in 100 probability of the result occurring by chance), it is this finding that should be reported as it is highly significant and therefore not likely to be due to chance. However, if we set 0.01 as the accepted level of significance in psychology we are likely to reject a number of alternative hypotheses when there was a real effect. Retaining the null hypothesis when there was actually a real effect is known as a **type 2 error**, and this occurs because the level of significance set is too stringent.

Inferential tests of difference

Different inferential tests are used on different types of data. The test you choose will depend on the following features:

- are you investigating a difference or relationship between variables?
- are you using a related or unrelated design?
- what type of data are you analysing?

The last feature refers to what type of data you will analyse. There are four different types of data, nominal, ordinal, interval and ratio.

Nominal level data

Nominal data is the most basic form of data you can gather because it does not tell you very much information about the data set or results. This is because the data gathered are categorical or grouped and the total number of values in each category or group is calculated. We know nothing about each value within the categories; we just know the category totals. For example, if you conducted a class survey on pet ownership, you are likely to gather data on how many students own a pet or not, or what types of pet the students in your class own.

The class will be asked whether they own a pet, and the frequency of pet owners or individuals without a pet will be calculated. We know very little about the individual differences in pet or non-pet owners, just the totals for each category. Similarly, if you divided the class into students under 1.85 metres tall and over 1.85 metres tall, and calculate the frequency in each category, you would have nominal level data. However, you would not know the actual heights of each individual student or their height in relation to one another.

Ordinal level data

Ordinal data tells us a little more information about the values in the data set. Ordinal data is data that are ranked into an order or position. For example, your school may collect house points and present a prize to the house with the greatest number of points at the end of the year. Each house will be placed in rank order of first, second, third, fourth. This data tells us about the position of each house, but it does not tell us how many points were achieved or the difference between each rank. So, the house in first place may have only ten points more than the one in second place, but the house in third place may be way behind second place with 100 fewer points. Ordinal data is often derived from arbitrary scales, such as grades for a test, or ratings of a characteristic such as attractiveness from 1–10. Because the scales are arbitrary, the intervals between each value are not equal in reality. The difference between a grade A and a grade B is not the same as the difference between a grade C and grade D, nor will someone rated as 5 on the attractiveness scale be half as attractive as someone rated as 10.

Key terms

Type 1/type I error: when the null hypothesis is rejected and the alternative hypothesis supported when the effect was not real.

Type 2/type II error: when the alternative hypothesis is rejected and the null retained when there was actually a real effect.

Matched pairs design

A matched pairs design is an independent groups design where participants in one group are matched on important factors, such as IQ, to participants in another group. For the purposes of selecting an appropriate inferential test, because the groups are matched, it should be treated as a repeated measures design.

Interval and ratio level data

With interval and ratio level data, you do know the differences between each value within a data set because a scale is used where the intervals between each value are equal. Typically interval and ratio level data are gathered using a recognised scale or tested psychological instrument. The only difference between interval and ratio level data is that ratio data will have an absolute zero. Measurements such as height in centimetres, speed in seconds and distance in kilometres are ratio level data because they start at zero on the scale.

For the purpose of selecting which inferential test to use, you will only need to decide between nominal and 'at least' ordinal level data (interval and ratio level data can be treated as ordinal level data).

You will only have to learn about a few inferential tests, so you can use this decision tree to work out which test you should use:

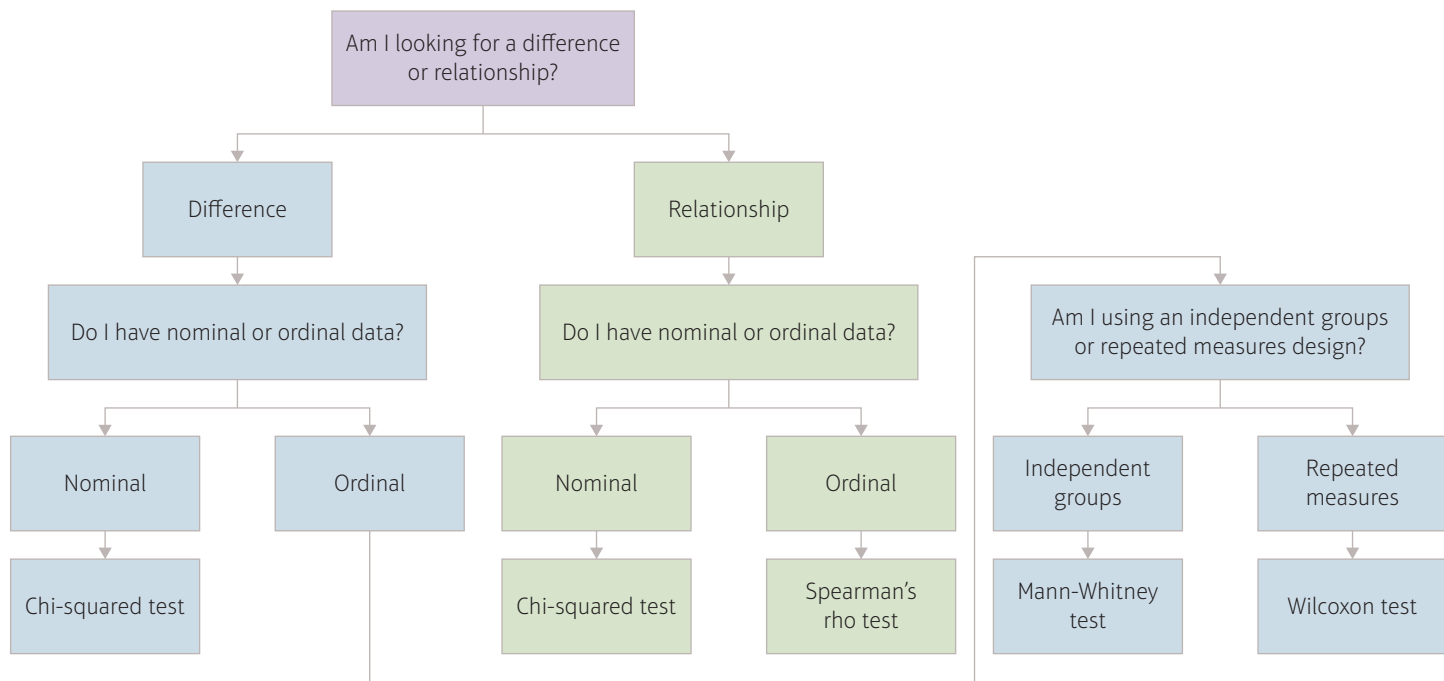


Figure 2.11 Inferential test options.

Key terms

Repeated measures design:

where all participants complete all conditions of the experiment.

Matched pairs design:

where different participants are allocated to only one experimental condition (they do not do both) but are matched on important characteristics.

Wilcoxon Signed Ranks test

The Wilcoxon Signed Ranks test is used as a test of difference between two conditions when the data achieved is at ordinal level or above and the experimental design being used is a **repeated measures design** or **matched pairs design**.

Calculation procedure

1. Calculate the difference between the pairs of scores achieved by each participant on the two tests. In the example here, this is done by subtracting the column A score from the column B score.
2. Ignoring any plus or minus signs, rank the score differences.
3. Calculate the sum total of the ranks for positive differences and total sum of ranks for negative differences.
4. The smaller of these scores is referred to as the T value (the test statistic or calculated value of the test).

Maths tip

Assigning ranks to a set of scores literally means to give each score a position on a scale; position 1, position 2, etc. However, if you have scores of equal value, they cannot share the same rank position, but the positions need to be divided between them.

For example:

Rank position	1	2.5	2.5	4	5	6	7.5	7.5	9
Scores	3	4	4	7	8	9	10	10	13

Notice that the scores of 4 and 10 do not get a rank position of 2 and 3 or 7 and 8, the ranks are divided between them.

Table 2.3 An example of assigning ranks.

Participant number	Number of words recalled from a non-categorised list	Number of words recalled from a categorised list	Difference	Rank of difference
N = 10	A	B	(B-A)	
1	8	11	3	4
2	7	7	0	
3	9	16	7	6
4	11	12	1	1.5
5	13	18	5	5
6	9	8	-1	1.5
7	8	16	8	7
8	5	17	12	9
9	13	11	-2	3
10	6	17	11	8

Sum of ranks for positive differences: $1.5+4+5+6+7+8+9 = 40.5$

Sum of ranks for negative differences: $1.5+3 = 4.5$

The smallest value is 4.5, so this is accepted at the calculated value of $T=4.5$.

In order to find out whether the calculated value of the Wilcoxon test is significant (showing a real difference in recall) we need to compare the Calculated value of $T=4.5$ to a table of critical values for a Wilcoxon Signed Ranks test.

Table 2.4 Critical values for a Wilcoxon Signed Ranks test.

	Level of significance for a one-tailed test		
	0.05	0.25	0.01
	Level of significance for a two-tailed test		
n	0.1	0.05	0.02
n=5	0	–	–
6	2	0	–
7	3	2	0
8	5	3	1
9	8	5	3
10	11	8	5
11	13	10	7
12	17	13	9

The calculated value of T must be equal to or less than the table (critical) value for significance at the level shown.

Suppose the hypothesis is that there will be more words recalled from a categorised list than a non-categorised list of words. This is a directional hypothesis, because the direction of difference between the conditions is predicted. This means that a one-tailed test is used. The accepted level of significance in psychology is 0.05, so will need to consult the first column until it reaches the row where $n=9$ (as 10 participants were used but N is the number of scores left ignoring those with 0 difference). The critical value we need to compare the calculated value to is 8. Now we need to consult the instructions below the table. 'The calculated value of T must be equal to or less than the table (critical) value for significance at the level shown.' This instructs us that the calculated value of $T=4.5$ must be equal to or less than the critical value of 11 to be significant at 0.05. Because 4.5 is less than 11, the result is significant and the alternative hypothesis can be supported.

Key term

Independent groups

design: where only one group of participants complete one condition of the experiment and a different group complete another condition.

Mann-Whitney U test formulae

$$U_a = n_a n_b + \frac{n_a(n_a + 1)}{2} - \sum R_a$$

$$U_b = n_a n_b + \frac{n_b(n_b + 1)}{2} - \sum R_b$$

(U is the smaller of U_a and U_b)

Maths tip

Always compare the observed/calculated value of your test (the test statistic) to the table (critical) value to check for significance, not the other way around. If you forget, refer to the guidance given under each table of critical values and read it carefully.

One- and two-tailed tests

A one-tailed test is used because the direction of difference can be predicted and a directional hypothesis is stated. A two-tailed test is used when the direction of difference cannot be predicted and a non-directional hypothesis is stated.

Mann-Whitney U test

The Mann-Whitney U test is used as a test of difference between two conditions when the data achieved is at ordinal level or above and the experimental design being used is an **independent groups design**.

Calculation procedure

1. Use the Mann-Whitney U Test formula

Rank all of the scores as a whole group:

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Score	5	6	7	7	8	8	8	9	9	11	11	11	12	13	13	16	16	17	17	18
Rank	1	2	3.5	3.5	6	6	6	8.5	8.5	11	11	11	13	14.5	14.5	16.5	16.5	18.5	18.5	20

2. Now you will need to find the sum (total) of the ranks for both groups, so each group will need to be divided back into their original sets:

Number of words recalled from a non-categorised list Group A	Ranks	Number of words recalled from a categorised list Group B	Ranks
8	6	11	11
7	3.5	7	3.5
9	8.5	16	16.5
11	11	12	13
13	14.5	18	20
9	8.5	8	6
8	6	16	16.5
5	1	17	18.5
13	14.5	11	11
6	2	17	18.5
Sum total of ranks	75.5	Sum total of ranks	134.5

3. Now use the formulae to calculate U_a and U_b

Note that R_a is the sum total of ranks for list A and R_b is the sum total of ranks for list B

$$U_a = N_a \times N_b + N_a \times (N_a + 1) / 2 - R_a$$

$$U_a = 10 \times 10 + 10 \times 11 / 2 - 75.5$$

$$U_a = 100 + 110/2 - 75.5$$

$$U_a = 79.5$$

$$U_b = N_a \times N_b + N_b \times (N_b + 1) / 2 - R_b$$

$$U_b = 10 \times 10 + 10 \times 11 / 2 - 134.5$$

$$U_b = 100 + 110/2 - 134.5$$

$$U_b = 20.5$$

The lowest value of U_a or U_b is the U value taken. In this case the U value is 20.5.

The U value = 20.5, which is less than the critical value of 27 for a one-tailed test (which we will assume in this instance), therefore the results are significant.

Table 2.6 Critical values for a Mann-Whitney U test.

n	1	2	3	4	5	6	7	8	9	10
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	0	0	0	1	1	1
3	-	-	0	0	1	2	2	3	3	4
4	-	-	0	1	2	3	4	5	6	7
5	-	0	1	2	4	5	6	8	9	11
6	-	0	2	3	5	7	8	10	12	14
7	-	0	2	4	6	8	11	13	15	17
8	-	1	3	5	7	10	13	15	18	20
9	-	1	3	6	9	12	15	18	21	24
10	-	1	4	7	11	14	17	20	24	27

Critical values of U for a one-tailed test at 0.05; two-tailed test at 0.1 (Mann-Whitney)

The observed value of U is significant at the given level of significance if it is equal to or less than the table (critical) value above.

Maths tip

The Mann-Whitney U test has several different critical values tables that can be referred to in order to determine significance. You will first need to decide which table to use by referring to the titles of each table:

Critical values of U for a one-tailed test at 0.005; two-tailed test at 0.01 (Mann-Whitney)

Critical values of U for a one-tailed test at 0.01; two-tailed test at 0.02 (Mann-Whitney)

Critical values of U for a one-tailed test at 0.025; two-tailed test at 0.05 (Mann-Whitney)

Critical values of U for a one-tailed test at 0.05; two-tailed test at 0.1 (Mann-Whitney)

First, decide whether the hypothesis is directional (one-tailed) or non-directional (two-tailed).

Next, decide on the level of significance to be used. This is typically 0.05, but you may be asked to refer to a significance level of 0.1 or 0.01.

Maths tip

It is critical that you show all of your calculations/ workings in the exam. Using the formulae, write down step by step how you are calculating the Mann-Whitney as shown above.

Maths tip

Remembering which test to use can be difficult, but imagery can help. Imagine Mr Mann, Mr Whitney and Mr Wilcoxon. Mr Wilcoxon is cross (x) because he has to do both conditions of the experiment (repeated measures design) which is taking up his time. Mr Mann and Mr Whitney are happy because they only have to do one condition of the experiment (independent groups design) and then can go home early.

In addition to gathering quantitative data, we can also gather qualitative data from research. Case studies are a research method where both qualitative and quantitative data can be gathered.

Case studies of brain-damaged patients and the use of qualitative data

Case studies of brain-damaged patients have been critical to cognitive psychology in order to investigate how brain injury affects cognitive functioning. Sometimes we can understand cognitive functions, such as memory, more in their absence, as is the case in brain-damaged patients.

Taking it further

A biography of the surgical procedure and subsequent memory loss has been depicted in a short film. You can find this online by searching for the key words 'Amnesiac Henry Molaison'.

Key terms

Temporal lobe: an area of the brain, called a lobe, situated below the ear.

Hippocampus: a structure of the brain responsible for learning, emotion and memory.

Anterograde: the loss of ability to make new memories, while memories before the injury remain relatively intact.

Retrograde: the loss of ability to recall events prior to the injury.

Taking it further

The case of Henry Molaison and his brain atlas can be found online at the Brain Observatory. You can also do an Internet search of the Science Museum to read one of the transcripts of an interview with Henry.

Henry Molaison (HM)

An invaluable case study was that of Henry Molaison who suffered brain injury as a result of a surgical procedure to relieve him from seizures caused by epilepsy.

Henry Molaison, known by thousands of psychology students as 'HM', lost his memory on an operating table in a hospital in Hartford, Connecticut, in August 1953. He was 27 years old and had suffered from epileptic seizures for many years. He was operated on by William Scoville, who removed a brain structure within the **temporal lobe** called the **hippocampus**. The procedure did reduce his seizures, but left him with severe memory loss.

Henry was quickly referred to two neuropsychologists, Wilder Penfield and Brenda Milner, to assess the extent of his amnesia. The hippocampus was known to be associated with consolidating memories so the removal of this structure was devastating and irreversible.

Having already established themselves by conducting memory research on other case studies of brain-damaged patients, Penfield and Milner realised that Henry was an ideal amnesia case because his injury was specifically localised and his personality and intelligence were virtually intact.

Taking it further

Penfield and Milner's research can be found by searching for the title 'Loss of recent memory after bilateral hippocampal lesions, on the National Center for Biotechnology Information website. Read the summary of the case of HM and other cases of amnesia.

Henry was assessed as having **anterograde** and **retrograde** amnesia. His anterograde amnesia resulted in an inability to form any new memories after the operation (he could not store memories for new names, faces, events or information). Despite this, he did learn new skills, although he had no memory of being able to learn them. His retrograde amnesia meant that he lost the ability to retrieve memories from 19 months to 11 years prior to the operation; he was 27 years old at the time of his surgery, so this meant he could only remember partial events after the age of 16 and virtually no events after the age of 25. His retrograde amnesia may not have been due to the surgery, but is likely to have been affected by epilepsy medication and the frequency of his seizures prior to the operation.

During his life, Henry was interviewed many times, and this qualitative information has informed an understanding of which cognitive functions were still intact and which were impaired. Following his death, HM's brain was gifted to psychological research; it was spliced into over 2 000 segments to map the human brain at the Brain Observatory in San Diego.

The use of qualitative data

Unlike quantitative data, which presents data as numbers and statistics, qualitative data presents descriptions of findings in prose. In cognitive psychology, memory research is often reported as quantitative data, but research using case studies of brain-damaged patients is often qualitative in nature, describing what functioning is intact or lost as a result of amnesia and gaining an understanding of the patient's subjective experiences. Qualitative data provides us with detailed accounts of a person's experiences, feelings and beliefs. Some argue that this is the essence of psychology, but others argue that it is at the expense of objectivity as qualitative data requires interpretation, which can be biased.

Qualitative research is not straightforward or mechanistic; quantitative research involves working through a step-by-step procedure resulting in data analysis, whereas qualitative research is defined by the nature of the investigation and the choices made by the researcher along the way. It is a process of making meaning from responses given by participants, and as such is open to the individual interpretation of the researcher. As a researcher establishes the themes that emerge from the discourse, they apply meaning to its content and reach subjective conclusions. This does not mean that the emergent themes found are invalid, but it is up to the researcher to explain and justify the emerging conclusions using evidence in the discourse.

Rather than following the hypothetico-deductive model, which proposes a hypothesis and then tests it, qualitative research is an inductive process whereby a research question is proposed and the answer emerges from careful decoding of the information gathered. Information can be gathered using a variety of methods, such as unstructured or semi-structured interviews, questionnaires with open-ended question types, group discussions, speech analysis and a literature review. The non-numerical information gathered is carefully transcribed and notes are taken on the emerging themes or ideas that run through the text. There is no single type of qualitative research, and no single way of conducting qualitative analysis. However, they generally follow a similar format.

Common to all qualitative research is the way it is used to understand how individuals make sense of their own experiences. Qualitative research aims to understand how people perceive their world and make sense of it. This results in rich descriptions based on what people disclose about themselves, the connections they make between events that happen and the meanings they attribute to them, and how they feel.

Qualitative analysis is idiographic; it does not claim any general rules that apply to other people, but only that the results are specific and unique to the individual involved. Although some research can claim that emergent themes are general to others, qualitative research is often based on small sample sizes and built up into a case study.

Once qualitative data has been gathered, transcriptions are made of the discourse and the researcher immerses themselves in the text, making notes on the feelings, beliefs and meanings given to experiences by the participants. Then the researcher reflects on these notes, checks that the notes reflect the content of the transcript and develops from these notes the emerging themes from the transcript. These themes are presented as conclusions with extracts from the transcript to support the interpretation given to them.

Evaluation

Qualitative analysis gathers rich descriptions based on meaning, which can often be missed when using quantitative methods. However, it is laborious and difficult to conduct because data analysis and transcription takes a lot of time. It does not follow any particular standardised format and has been criticised for being unscientific and highly subjective. Additionally, many argue that it is largely a descriptive rather than explanatory method. However, qualitative research goes beyond merely describing discourse, it is a process of comprehending the information, synthesising the material and theorising about why the themes exist. A strength of qualitative research is that it is very important when trying to understand some of the important issues in health and clinical psychology, such as how patients experience palliative care, or what caregivers believe could help them as carers for those with long-term illness. These big questions could not be addressed by simply administering a questionnaire which would be unable to address people's deeply held beliefs and feelings.

Types of qualitative methods

Content analysis (although some dispute this method as being truly qualitative as it quantifies qualitative material).

Discourse analysis

Grounded theory

Interpretive

phenomenological analysis

Taking it further

Download the lyrics to the song 'Barbie Girl' by the pop band Aqua. Conduct your own qualitative analysis using the following steps:

1. Read the lyrics through (without singing them!)
2. In the margin of each line, write a summary of the lyrical content, and consider the meaning of the lyrics.
3. Reflect on your notes, synthesise them and consider any overall message being delivered in the song.

Hint: Consider gender roles and themes of dominance and power.

4. Drawing together your themes, suggest possible reasons for these themes existing and present them using evidence from the lyrics in the song.

2.3 Studies

Learning outcomes

In this section you will learn about one classic study:

- Baddeley (1966b) on working memory

and three contemporary studies, from which you will need to choose one to learn about:

- Schmolck et al. (2002) on HM and other brain-damaged patients
- Steyvers and Hemmer (2012) on reconstructive memory
- Sebastián and Hernández-Gill (2012) on the developmental pattern of digit span.

WIDER ISSUES AND DEBATES

Psychology as a science

The independent variable in this investigation was the type of similarity between words in a list and the dependent variable was the recall of the list sequence from long-term memory. Baddeley operationalised the independent variable by giving the groups either a word list that was acoustically similar, semantically similar or a control list. He operationalised the dependent variable by measuring the accuracy of recall of the words in the correct sequential position. Importantly, he gave some participants a list of same frequency words as a baseline for recall comparison. This was to show the effect of semantic and acoustic similarity compared to dissimilar words. Any differences between the experimental and control lists were a result of similarity and not other factors affecting recall.

The influence of acoustic and semantic similarity on long-term memory for word sequences (Baddeley, 1966b)

Alan Baddeley, a prominent researcher in memory, wanted to test whether long-term memory and short-term memory were different or whether the emergent view of the time that memory existed on a continuum was accurate. However, investigations into short-term and long-term memory employed different research techniques, and Baddeley suggested that it would be impossible to tell whether short-term and long-term memory were different or the same unless the same research techniques were used on both. He set out an investigation to explore the effects of both semantic and acoustic coding in both long-term and short-term memory.

Aim

To investigate the influence of acoustic and semantic word similarity on learning and recall in short-term and long-term memory.

Procedure

A laboratory experiment was designed to test sequential recall of acoustically and semantically similar word lists. Three different experiments were conducted, but here we will focus on experiment three.

Experiment three

Four lists of 10 words were used:

- List A contained 10 acoustically similar words (man, can, cat, map, etc.)
- List B contained 10 acoustically dissimilar words that were matched in terms of frequency of everyday use to List A (pit, few, cow, mat, etc.)
- List C contained 10 semantically similar words (great, large, big, broad, etc.)
- List D contained 10 semantically dissimilar words that were matched in terms of frequency of everyday use to List C (good, huge, deep, late, etc.)
- List B and D acted as baseline control groups for List A and C.

The participants were men and women recruited from the Applied Psychology Research Unit subject panel and were assigned one of the four list conditions as an independent groups design.

Each list of 10 words was presented via projector at a rate of one word every three seconds in the correct order. After presentation the participants were required to complete six tasks involving memory for digits. They were then asked to recall the word list in one minute by writing down the

sequence in the correct order. This was repeated over four learning trials. As it was not a test of learning words, but a test of sequence order, the word list in random order was made visible on a card in the room. After the four learning trials, the groups were given a 15-minute interference task involving copying eight digit sequences at their own pace. After the interference task participants were given a surprise retest on the word list sequence.

Table 2.7 Procedure order.

Hearing test	Learning trials				Interference task	Retest
Listening and copying each word presented in random order from the list	Trial 1 Visual presentation of list followed by a 6 eight-digit sequence recall task, followed by recall of the list.	Trial 2 Visual presentation of list followed by a 6 eight-digit sequence recall task, followed by recall of the list.	Trial 3 Visual presentation of list followed by a 6 eight-digit sequence recall task, followed by recall of the list.	Trial 4 Visual presentation of list followed by a 6 eight-digit sequence recall task, followed by recall of the list.	Copying sequences of digits	Recall of the word list in the correct order.

Results of experiment three

Recall of the acoustically similar sounding words was worse than the dissimilar sounding words during the initial phase of learning (trial two in particular). However, recall of the similar and dissimilar sounding words was not statistically significant. This demonstrates that acoustic encoding was initially difficult, but did not affect long term memory recall. Participants found the semantically similar words more difficult to learn than the semantically dissimilar words and recalled significantly fewer semantically similar words in the retest.

Conclusion

The fact that participants found it more difficult to recall list one in the initial phase of learning suggests that short-term memory is largely acoustic, therefore acoustically similar sounding words were more difficult to encode. Later retest recall of list three was impaired compared to all other lists because they were semantically similar, suggesting that encoding in long-term memory is largely, but not exclusively, semantic.

Evaluation

Laboratory research, such as this, employs the use of experimental techniques that are not typical of the way in which we use memory in an everyday context; we do not often learn lists of random monosyllabic words. Therefore the ability to generalise these findings to everyday contexts is questioned. However, memory researchers would argue that in order to understand memory we need to remove the context in which normal memory is used and simplify the nature of the to-be-learned information in order to isolate the aspects of memory we are concerned with.

This experiment relied heavily on the role of rehearsal during the four learning trials in order for information to become established in long-term memory. The very concentrated nature of rehearsal is likely to have exaggerated this memory process with the result found being an artefact of the experimental procedure. Under normal conditions we would not be expected to use rehearsal in such a contrived way, so this study lacks **mundane realism**.

However, the study was scientific in that it was conducted in a controlled laboratory environment with a standardised procedure. Therefore the study can be regarded as replicable and the reliability of the results can be established. Due to the highly controlled nature of the experiment, Baddeley can also establish a cause and effect relationship between the independent variable (semantic or acoustic word list similarity, and the dependent variable (long-term memory).

Key term

Mundane realism: The extent to which the test used in an experiment represents a realistic activity.

Semantic knowledge in patient HM and other patients with bilateral medial and lateral temporal lobe lesions (Schmolck et al., 2002)

Case studies of brain-damaged patients have been invaluable in understanding the nature and function of human memory. Amnesia patients have been investigated in neuropsychological research to establish which regions of the brain are responsible for which stores and processes involved in encoding new and recollecting previously learned information. It is widely accepted that damage to the temporal lobe of the brain is associated with memory loss, in particular anterograde and retrograde amnesia, but often well-established long-term semantic knowledge is intact.

Aim

Heike Schmolck, Elizabeth Kensinger, Suzanne Corkin and Larry Squire attempted to investigate the effects of specific brain damage on semantic memory using case studies of brain-damaged patients compared to a control group of 'normal' participants. Specifically they wanted to test the relationship between semantic test scores and **temporal lobe** damage and to determine whether Henry Molaison (HM) was unique in the way the brain damage he sustained affected his memory compared to similar damage in other cases.

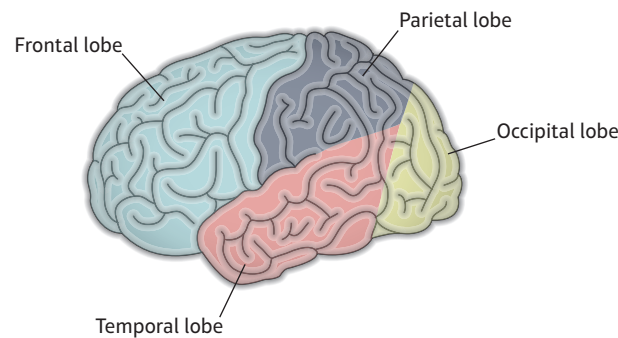


Figure 2.12 The lobes of the human brain.

Procedure

Participants

Six participants with amnesia were compared to eight 'normal' control participants. The control group was matched for age (74 years old), sex (male) and education (12.4 years) to the amnesia patients (apart from one female). The six amnesia patients were divided into groups according to the level of brain damage they suffered. Two patients had brain damage largely restricted to the hippocampus (HF); three patients had suffered **encephalitis** resulting in large **medial** temporal lobe and **anterolateral** temporal cortex damage (MTL+) and Henry Molaison (HM) had medial temporal lobe damage with some **lateral** temporal lobe damage following surgery to resolve his epilepsy. All patients had suffered **bilateral** damage to varying degrees. A biography of each patient was compiled.

Apparatus

Nine tests were conducted over three to five different sessions with participants. Seven of these tests were from the Semantic Test Battery and two tests were constructed by the researchers. The tests were all based on line drawings of 24 animals and 24 objects. The 48 line drawings were further categorised into groups of eight domestic land animals, foreign land animals, water animals, birds, electrical household items, non-electrical household items, vehicles and musical instruments.

Key terms

Encephalitis: inflammation of the brain causing damage to the structures of the brain.

Medial: situated in the middle.

Anterolateral: to the front and side of.

Lateral: towards the side of.

Bilateral: both hemispheres of the brain are involved.

Tests

The nine tests were designed to measure semantic knowledge related to identifying, sorting or defining the line drawings. A further four semantic tests were conducted on some of the patients and control participants (HM only received test 10 of these additional tests).

Table 2.8 Test conditions.

Tasks 1–4	Pointing to or naming a picture	Participants were asked to point to or name a picture when given the name or a description of the object.
Task 5	Semantic features	Participants were asked to answer yes/no questions about the physical and associated features of an object.
Tasks 6 & 7	Category fluency and sorting	Participants were asked to name or sort into categories as many examples within a category or class (living/non-living) of objects without a picture cue.
Tasks 8 and 9	Defining task	Participants were given the name or picture of the 24 less common objects and they were asked to provide a definition.
Task 10	Pyramid and palm tree test	Participants were given a target picture and two test pictures and asked which test picture went with the target picture. For example, a target picture of a saddle was presented with two test pictures of a horse and a goat, and participants were asked to say which test picture went with the target.
Task 11	Object/non-object discrimination task	Participants were asked whether the object presented to them was real or not.
Task 12	Colouring object task	Participants were asked to colour 28 line drawings of objects using appropriate colours from a selection of four coloured pencils.
Task 13	Nouns and verbs test	Participants were given a fill-in-the-gaps exercise designed to test knowledge of regular and irregular verbs and tenses. For example, 'A hoof is hard, in fact most _____ are hard'.

The percentage of correct responses was scored for all tests other than test 6, 8 and 9, which were recorded and transcribed and were given an accuracy rating of between 0 and 4 by the researchers. These transcripts were also assessed for errors in grammar, expression, confusion and word intrusions. **Inter-rater reliability** was established for the scoring.

Results

Tasks 1–9

Patients with damage restricted largely to the hippocampus (HF) were able to name, point out and answer questions about objects they were given with considerable accuracy. They were also comparable to the control group when asked to generate examples of a given category or give definitions of objects. Patients with damage to the medial temporal lobe and anterolateral temporal cortex (MTL+), performed less well at naming, pointing out or answering questions about objects. They also had considerable difficulty generating examples in a given category. Notably one MTL+ patient could not generate names of dog breeds despite previously being a dog breeder. They also had difficulty defining objects, often giving less detail which contained more errors; HM performed worst among these patients. Interestingly the MTL+ patients found it most difficult to identify and recall facts about living objects compared to non-living objects in all tasks.

When the participants were ranked in terms of their overall performance on these tasks, their rank appeared to correspond directly with the extent of their brain damage. In particular, damage to the anterolateral temporal cortex seemed to cause impairment in semantic knowledge.

WIDER ISSUES AND DEBATES

Socially sensitive research

The use of case studies of brain-damaged patients can be regarded as socially sensitive research because it is sensitive for the individual patient and their family. The amnesia patients have suffered injury or disease resulting in fundamental impairment to possibly the most vital of human cognitive processes: memory. Memory anchors us to our past and enables us to project ourselves into the future; it links us to those we are close to and enables us to function normally in everyday life. Deficits in memory have catastrophic implications not only for the individual and their ability to live a full life, but also on the family responsible for their care. This is very sensitive when amnesia occurs later in life when families have to adapt to significant lifestyle changes and potential loss of the person they once knew.

Key term

Inter-rater reliability: the degree of agreement and consistency between two or more observers.

Key terms

Semantic dementia: a degenerative neurological disorder resulting in loss of semantic memory.

MRI scan: a brain scan that produces an image of the structure of the brain, a bit like an X-ray but with more detail.

Other semantic tests (test 10–13)

When asked to decide whether an object was real or not two of the MTL+ participants performed well, but one made eight errors. All MTL+ patients scored well on the colouring task. On the Pyramid and palm tree test, the MTL+ patients and HM scored either below the required 90 per cent accuracy or performed below the control group. The MTL+ group were able to produce regular plurals and verbs but performed less well at producing irregular verbs and plurals. In contrast, HM performed well on both tasks, suggesting that the difficulty with irregular items is associated with anterolateral temporal cortex damage.

Conclusions

The MTL+ patient data shows that damage to the anterolateral temporal cortex is consistent with a loss of semantic knowledge that results in a ‘blurring’ or overlap of conceptual knowledge that leads to confusion. This semantic knowledge is associated with the anterolateral region and is not associated with the medial temporal lobe. This is consistent with patients with **semantic dementia** whose impairment is restricted to the anterolateral temporal cortex and the medial temporal lobe is relatively unaffected. Additionally, **MRI scans** seem to suggest that the more progressed the disease, the greater the anterolateral damage.

HM – a special case

HM was similar to the MTL+ patients in tests of definitions suggesting that his impairment had a similar physiological basis. However, in many respects his semantic knowledge was in the normal range in other tests. Unique to HM was the large number of grammatical errors he made during these tests. The researchers suggest that his deficit in language production was unlikely to be related to his temporal lobe damage but due to other factors during his childhood. HM suffered from a seizure at age 10, was from low socioeconomic status and his schooling was interrupted. These factors could have contributed to poor language development.

The researchers conclude that the hippocampus is not involved in semantic knowledge because HF patients performed similarly to the control group. HM was less affected than the MTL+ patients, which leads to the conclusion that the anterolateral temporal cortex and not the medial temporal lobe is involved in semantic knowledge. The language impairment displayed by HM was unrelated to his neurological condition and probably due to his upbringing.

WIDER ISSUES AND DEBATES

Nature–nurture

Schmolck et al. believed that HM’s language impairment had developed due to causes other than the neurological impairment caused by his surgery, that it was perhaps due to nurture rather than nature. It is possible that his low socioeconomic status and interrupted education had a negative effect on his language development.

The following transcript was made of HM describing a motorcycle:

‘... well...it can be...uh,... a motorcycle is...uh...maybe, ... it’s on two wheels...And it could be have ‘cause my father used to ride one at one time...and he stopped himself because the doctor told him not to.’

It seems somewhat questionable whether these errors in grammar and form could be solely attributed to educational disruption and economy. However, the nature–nurture debate will never be resolved in this case because HM’s language was not tested prior to the surgery.

Evaluation

Case studies of brain-damaged patients are rare and therefore small in number. The small sample size involved in this investigation limits the **generalisability** of the conclusions made. However, findings from semantic dementia, neuroimaging, **brain stimulation** and **unilateral lobectomy** all support the finding that the anterolateral and, in particular, the lateral temporal cortex is involved in semantic knowledge, strongly reinforcing the conclusion of this study.

Exam tip

It is easy to criticise research for its shortcomings without understanding the reason for such problems or trying to understand whether the problem is actually well founded. Answers in psychology are rarely agreed on, so it is important to discuss evaluation from alternative points of view rather than taking a single-sided or definitive approach. To be able to evaluate effectively and demonstrate a mature and considered approach to evaluation, it is worth considering these questions:

Is the criticism justified?

Is there any further support for or against the criticism being levelled at the research?

Does the criticism demonstrate the view of certain psychologists or groups of people? If so, could an alternative view be considered?

The special case of HM reported in this investigation was seen as a product of upbringing and events prior to his surgery for epilepsy. However, it could be argued that the individual differences found in this investigation demonstrate individual variation in neurology which may account for the differences between them. It is often the case that retrospective research, such as this study, cannot establish causal relationships between the injury sustained and the resulting impairments tested. The brain is adaptable and can compensate for injury. The findings of tests may reflect the ability of the brain to adapt to injury rather than the injury itself. However, prospective research is not possible as it would involve predicting those individuals who are likely to sustain such brain damage.

Also the stimuli that are common to many cognitive investigations used to test semantic knowledge, such as the line drawings used, lack mundane realism and may not tap into semantic knowledge as it is used in everyday life. Such research may be said to lack ecological validity, as the findings cannot be generalised to everyday use of semantic memory.

WIDER ISSUES AND DEBATES

Ethical issues

Doctor Scoville, the surgeon responsible for HM's surgery, was vilified for his reckless approach. However, the case of HM was fundamental to our understanding that memory is a distinct cognitive process, independent of language and thought. Damage to his hippocampus and temporal lobes enabled neuroscience to establish a location for memory in the brain. This is arguably the most important advance in our understanding of memory functioning and HM was the most researched individual in the field of neuroscience.

Key terms

Generalisability: the ability to apply findings to other people, situations and contexts.

Brain stimulation: the use of electrodes to stimulate regions of the brain and examine resulting behavioural or cognitive changes as a result.

Unilateral lobectomy: the surgical removal of parts of the brain from one hemisphere.

WIDER ISSUES AND DEBATES:

Psychology as a science

Previous research into reconstructive memory adopted an experimental approach. This design was used to investigate memory independent of the stimuli (to-be-remembered material), and items or words withheld from the stimuli in order to study the effect of prior knowledge on recall. While such controls and experimental manipulation are important, Steyver and Hemmer argued in favour of greater ecological validity at the cost of experimental control, to establish findings that would be more representative of everyday memory. This is often an issue in psychology because experimental control is important to establish independent, objective and reliable findings; it is important to be scientific, but not at the cost of greater realism. Despite their claims for greater realism and more naturalistic contexts, they still used a laboratory experiment and asked participants to recall photographs. Some might suggest that their design only went a little way to establishing the ecological validity they claimed to be important.

Reconstruction from memory in naturalistic environments (Steyvers and Hemmer, 2012)

Mark Steyvers and Pernille Hemmer investigated the interaction between episodic and semantic memory, and the reconstructive nature of memory recall. Previous research into reconstructive memory suggested that prior knowledge stored in semantic memory had a detrimental effect on recall, often resulting in false memories of an object or event. However, Steyvers and Hemmer argued that research focused on the fallibility of memory often derived its findings from laboratory-based investigations designed to deliberately induce these errors in recall. For example, asking participants to recall objects in a photograph of an office with no books or computer in the picture would deliberately induce a false memory for such items. Removing such highly probable items would only result in a high likelihood of such items being expected and subsequently falsely remembered. Rather than seeing the recall of books or a computer as a typical everyday error in recall, Steyvers and Hemmer argued that it is only an error because of the experimental manipulation of the environment (withholding objects from the image), and that this was not representative of naturalistic environments.

Therefore, rather than accepting that memory is prone to error, as much previous research concluded, they felt that these errors in recall could provide important insights into the nature and function of memory, and that memory should be studied in a more naturalistic way where environments were not manipulated to elicit certain responses.

Aim

The aim of the research was to investigate the interaction between episodic and prior knowledge in naturalistic environments. They wanted to see how prior knowledge (semantic memory) was used to reconstruct memory for photographs of normal everyday settings (episodic recall), such as hotel, kitchen, and office.

Procedure

Initial testing

An important element of the investigation was to first assess prior knowledge, and therefore expectations, about the naturalistic scenes they would show participants. A random sample of 22 participants was recruited from an experimental participant pool at the University of California, Irvine. To assess prior expectations, one group of participants was required to list objects that they would expect to find in five naturalistic scenes (office, kitchen, hotel, urban and dining). Participants were required to enter their responses on a computer for at least one minute per scene. The frequency of objects named was recorded as a measure of prior expectation.

A separate group of 25 participants was shown 25 images of the five scenes; office, kitchen, urban, hotel and dining (there were five images of each scene), and asked to name all the objects they could see as a measure of perception. This initial testing was an important control to ensure that objects were not overlooked because they were not perceptible in the image.

The frequency of objects named in the expectation test and then identified in the perception test was recorded. The top ten most frequently recalled objects were analysed along with low frequency recall objects. Expectation of high frequency objects tended to be associated with iconic objects from each scene, such as television in a hotel room (22/22 participants), a table in a dining room (19/22 participants), and a computer in an office (20/22 participants). This prior testing suggested that people have good prior knowledge of each scene that seems largely representative of each naturalistic environment.

The experimental memory condition

Using the same experimental pool, 49 participants who had not taken part in either the expectation or perception test were randomly selected. Ten of the stimulus images from the prior tests were chosen to be used in the experiment (two from each scene that elicited the most objects named in the perception test). From these, two sets of five images, one from each scene, were formed. Participants only viewed one set of five images to avoid carry-over effects from viewing more than one image from the same scene type.

Participants were shown the five images for either 2 or 10 seconds to control for exposure duration. There were four possible trial time orderings, and participants were randomly allocated to one of these time orderings.

So, for example, one participant might see:

Set 1

The kitchen scene for 10 seconds
 The hotel scene for 10 seconds
 The urban scene for 10 seconds
 The dining scene for 2 seconds
 The office scene for 2 seconds

Exposure duration was manipulated to alter the extent to which participants used prior knowledge in episodic memory retrieval. It was thought that recall from short exposure duration of 2 seconds would rely more heavily on prior knowledge, as the event would have had little opportunity to be encoded as an episodic memory. It was also thought that the correct recall of objects not consistent with a scene (e.g. a microwave in an office) could only be recalled from episodic memory, and recall of objects that were missing from the image (e.g. a table cloth missing from the dining scene) could only be recalled using semantic memory/prior knowledge. The trials were randomised and participants were asked to carry out **free recall** of objects they remembered from each scene in their own time.

The researchers noted down all objects that were recalled by participants and the order in which they were remembered. Responses were normalised to remove plurals ('chairs' was treated as 'chair') and additional descriptive content ('silver car' was treated as 'car').

Results

Analysis of errors:

Recall of objects that were also listed in the perception test was recorded as accurate.

Table 2.10 Average recall rate.

	2 second exposure duration	10 second exposure duration
Mean number of objects recalled during free recall	7.75	10.05

Steyvers and Hemmer used the initial analysis of high and low probability of recall rates for objects based on expectation to analyse the results. It was found that incorrect recall of highly probable objects was 9 per cent and incorrect recall of low probability objects was 18 per cent.

These error rates ran in contrast to previous research that suggested that error rates were high for high probability objects. However, this low error rate for high probability objects is unsurprising as they were likely to be present in the unmanipulated naturalistic scenes. This suggests that when participants are presented with scenes that are representative of naturalistic contexts and unmanipulated by experimental control, memory of such scenes is quite accurate. Where scenes do not represent real-life context accurately, such as a dining scene without a table cloth, the error rate increased to 19 per cent.

Table 2.9 Time orderings (duration of exposure in seconds).

10	10	10	2	2
10	10	2	2	2
2	2	2	10	10
2	2	10	10	10

Key term

Free recall: recall of stimulus material in any order and without memory cues.

The effect of prior knowledge:

The effect of prior knowledge (semantic memory) was assessed by comparing the correct number of objects guessed in the expectation test, to those objects actually recalled in the two experimental conditions (2- and 10-second duration exposure). The cumulative accuracy of object guesses based on the expectation test was over 55 per cent from semantic memory under initial testing, and the actual recall in both conditions was much higher, over 80 per cent, suggesting that episodic memory played a significant role in recall.

Unsurprisingly, they found that longer duration improved recall overall; with short exposure to the picture, seven objects were correctly recalled on average compared with nine objects recalled with longer exposure to the picture.

Conclusions

It seems that in recall of naturalistic scenes, prior knowledge drawn from semantic memory can contribute to accurate recall in episodic memory tasks, when such scenes are unmanipulated. We draw on general knowledge as good guesses of what is expected to be seen in such contexts. Prior knowledge contributes greatly to recall of naturalistic environments, but this is not at the expense of accuracy; in fact we are more likely to notice novel items more readily than previous research might suggest.

Adopting a naturalistic approach to the study of memory has highlighted that prior research tends to be unrepresentative of everyday event recall; removing high probability objects from a familiar context will induce false memory and give a misleading view of memory as unreliable. When using untampered naturalistic contexts, guesses can be effective because of the high probability of the objects being present. This guessing frees up cognitive resources to be better spent focusing on novel and unexpected objects in a scene. In this sense, both recall of inconsistent and consistent objects is benefitted using a more ecologically valid approach.

Evaluation

Steyvers and Hemmer are strong advocates for increased ecological validity in memory research to be able to generalise findings to everyday use of memory. But they acknowledge that their research is not as naturalistic as it could have been. Using photographs rather than exposing participants to real environments, and using laboratory rather than real conditions. As such, this research goes some way to trying to establish greater ecological validity in the field of memory research, but does so without compromising generalisability and operationalisation of concepts.

Important controls were used in this investigation. A control during the memory experiment was that the participants only viewed one image from each of the five scenes rather than multiple images of each scene. This was to prevent interference from a previously viewed scene of a similar nature affecting subsequent recall. Time orderings were manipulated using a Latin square design, and participants were randomly allocated to one of the time ordering sequences.

This research has important implications for the way in which eyewitness testimony is viewed in the justice system. It suggests that contrary to previous research, prior knowledge from semantic memory can enhance recall of episodic events and even allow greater cognitive effort to be spent on recognising unexpected features of a context. This implies that eyewitnesses are effective when recalling from familiar contexts and effective at encoding novel features.

Sebastián and Hernández-Gil's (2012) study of the developmental pattern of digit span

Working at the University of Madrid, Mariá Victoria Sebastián and Laura Hernández-Gil examined the developmental pattern of digit span in the Spanish population to test the phonological loop component of working memory (Baddeley and Hitch, 1974). They set out to investigate the capacity of the phonological loop to understand whether it would differ in a Spanish population across different ages. Anglo-Saxon research concluded that digit span increased with age, so Sebastián and Hernández-Gil wanted to see whether the same developmental trend occurred in a different culture to assess whether Anglo-Saxon findings could be generalised using the same digit span procedure.

Aims

To investigate the development of the phonological loop in children between the ages of 5 and 17 years using digit span as a measure of phonological capacity. They also wanted to compare the findings to their previous research of adult, aged and dementia patients.

Procedure

A sample of 570 volunteer (or volunteered) participants were taken from schools in Madrid. All participants were native Spanish and impairments in hearing, reading and writing ability were controlled. Participants were divided into five different age groups and the average digit span was recorded for each age and age group. Tested individually, participants were read increasing sequences of digits to recall in the correct order. The digits were read out at a rate of one per second and the digit list increased one digit per sequence. The digit span for participants was recorded as the maximum digit recalled in the correct order without error.

Table 2.11 Example of digit span measure.

Read out digits	Recall of digits in sequential order	Digit span
2 5 9 4 5	2 5 9 4 5	Correct
3 7 8 1 6 9	3 7 8 1 6 9	Correct
9 0 1 5 2 6 8	9 0 1 5 2 6 8	Correct Maximum digit span of 7
4 3 7 5 9 2 1 5	4 3 7 - 9 2 7 2	Errors and omission

Results

Table 2.12 Mean average (and standard deviation) digit span for each age and age group.

	Age groups mean (SD) digit span
Preschool (5 years)	3.76 (.52)
Primary school (6–8 years)	4.34 (.58) aged 6–8 years
Primary school (9–11 years)	5.13 (.81) aged 9–11 years
Secondary school (12–14 years)	5.46 (.85) aged 12–14 years
Secondary school (15–17 years)	5.83 (.84) aged 15–17 years

The table shows clearly a developmental trend of increasing digit span with age. Children aged 5 years have a very low digit span that rises steadily until around 11 years old where it slows. The digit span between 15 and 17 years remains fairly stable.

Comparing the findings to previous research

Comparing the findings of this study to previous related research conducted by Sebastián and Hernández-Gil, they found that elderly participants had a significantly higher digit span compared to the 5-year-olds in this study, but it was not significantly different from other age groups. Patients with **advanced dementia** (AD) showed a similar profile (mean digit span 4.2). However, patients with **frontal variant frontotemporal dementia** (fvFTD) had a digit span that was significantly similar to the younger age group. Comparing the elderly group to the dementia patients showed no significant difference, suggesting that impoverished digit span was a consequence of ageing rather than dementias.

Key terms

Frontal variant frontotemporal dementia: A degenerative neurological disease that affects the frontal lobes of the brain.

Advanced dementia: The later stages of dementia where symptoms are more profound.

Consistent with Anglo-Saxon research, this investigation showed a continued increase in digit span over time in the Spanish population. However, the overall capacity of digit span was far lower in the Spanish population compared to the digit span of seven found in Anglo-Saxon studies. This decrease in phonological capacity could be accounted for by the nature of the Spanish language. Digits in Spanish tend to be two or more syllables (e.g. uno, cuatro, cinco, ocho), compared to the monosyllabic Anglo-Saxon numerals (e.g. one, two, three, four). This word (or digit) length effect means that it takes more time to sub-vocally repeat and rehearse Spanish words, taking up more space in the phonological loop, resulting in a lower digit span.

To further support the word length effect as an explanation for the difference in digit span, differences at each age was examined. As sub-vocal rehearsal does not appear until the age of 7–8 years, there should be no difference in digit span as a result of word length effect until after this age. This was found to be true as, before the age of 7 years, differences between Spanish and Anglo-Saxon counterparts were not found. At age 9 years, there is a noticeable difference in digit span, suggesting that word length effect occurs once sub-vocalisation appears in phonological development. However, unlike previous research, this study speculates that digit span in the Spanish population increases beyond the age of 15 years.

Conclusions

Digit span was found to increase with age; the starting point of this development occurs when children are able to sub-vocalise at around 7 years. Digit span in the Spanish population is significantly shorter than Anglo-Saxon culture, probably due to the word length effect associated with digits. Comparing the findings to research into patients with degenerative neurological disease and the aged population, it is possible to speculate from this research that poor digit span is a result of ageing rather than dementias.

Evaluation

Digit span experiments are measures of the phonological loop proposed by Baddeley and Hitch (1972). However, we rarely use verbal memory to memorise lists of digit in everyday life, other than when trying to rehearse a telephone number. Everyday verbal memory is used to hold sequences of words in order to comprehend sentences, master new languages or aid reading of complex information. Therefore it is open to question whether or not digit span experiments reflect everyday use of verbal memory. However, digit span tests have been reliably linked to performance in reading ability and intelligence, suggesting they are a good general measure of verbal memory. Digits, rather than word sequences or sentences, are also considered to be a culture-free and meaning-free way of measuring pure verbal memory. However, based on the cultural differences found, digits may not be the best culture-free determinant of verbal memory capacity.

Cultural differences in digit span have been reported by other researchers. Ellis and Hannelley (1980) reported poorer digit span in Welsh-speaking children compared to English children, largely because Welsh words for digits take longer to pronounce than English digit words. Longer digit spans have been reported in Chinese because the words for digits are short (Stigler et al., 1986). This research supports the finding that language and the phonological loop are interrelated.

A large sample size was tested in this study, allowing the findings to be considered reliable and generalisable to the Spanish population as a whole. The sample size gathered was important for this research because comparisons were made across different cultures. The study also excluded participants with any hearing, reading or language impairments, known to diminish digit span, which could have affected the results.

INDIVIDUAL DIFFERENCES

There are several individual differences that can be detected by digit span testing. Dyslexia, which is a problem with learning to recognise words at the level appropriate for age, is associated with a poor digit span (Helland and Asbjørnsen, 2004).

2.4 Key questions

Learning outcomes

In this section you will learn about one key issue of relevance in today's society. You will need to be able to:

- describe the key issue and its importance to today's society
- apply concepts, theories and research used in cognitive psychology to explain the key issue.

This section will describe an example of the key issue of how our knowledge of working memory can be used to inform the treatment of dyslexia as a reading disorder. However, you can choose your own key issue and relate it to theories, concepts and research used in the cognitive approach.

Can knowledge of working memory inform treatments for dyslexia?

Dyslexia is a reading disorder associated with poor or inefficient working memory. Children with dyslexia find it difficult to hold enough information in working memory to be able to blend sounds to form a word and find associating letters to sounds problematic. This results in slower reading and writing ability. They have particular phonological deficits too, meaning that they code phonology inefficiently in the brain, causing problems with short-term verbal memory such as difficulties with non-word repetition, rapid naming and learning a new language. Ultimately, the memory problems associated with dyslexia mean that skills associated with reading, writing, spelling and grammar are impaired.

These difficulties are often detected during preschool and early years education, and a number of classroom strategies have been identified in order to help students with dyslexia.

Interventions based on working memory

There are currently two main interventions used to help children with dyslexia in schools. One is a classroom-based approach that aims to alter the teaching and learning environment to better suit children with working memory problems. These classroom strategies are easy to implement by educators and can be used with all children to aid learning. The second is direct intervention to help children with literacy difficulties to improve their working memory. There are several types of direct intervention programmes, but all aim to help children practise and develop working memory using specific or a variety of tasks targeted at increasing processing speed and strategies for remembering.

Classroom strategies approach

Strategies used in the classroom to help children with dyslexia include:

- clearly stating lesson aims
- using checklists
- simplifying instructions
- highlighting or colour coding information
- using audio and visual materials
- avoiding asking a child to read out loud.

By simplifying and breaking down classroom tasks it avoids overloading the limited working memory capacity associated with dyslexia. Because dyslexia is also associated with slower processing speeds, avoiding lengthy periods of teacher talking and using alternative delivery methods can work better to prevent phonological loop overload.

Taking it further

Consider whether the introduction of PowerPoint® into the classroom has been of benefit to children with dyslexia. Make a list of the arguments for and against using PowerPoint® with children with a literacy impairment.

Taking it further

Using the classroom strategies above, design specific classroom objects, signs, devices or rules that could be used in any classroom environment. For example, vocabulary books could be used when new words are being taught, and the aims of the lesson could be written in short simple statements at the top of every worksheet.

Taking it further

Conduct an Internet search into specific memory improvement packages, such as Cogmed. Make a list of the strategies used to improve working memory described in this section and from your research. For each strategy, make a list of concepts, research and theories you have studied in cognitive psychology. You may find it useful to read through Baddeley's working memory model and developmental psychology and memory.

Spelling can be difficult for a child with dyslexia because they find it hard to associate a letter sound with the printed letter. Phonics is a literacy strategy that uses phonological rules to learn letter sounds and encourages sound blending. Mathematics can also be difficult for a child with dyslexia because they are required to take different steps to solve a mathematical problem, which can overload working memory. Each arithmetic step can be written down or verbally discussed to ensure that it is broken into stages.

Direct intervention programmes

Different intervention strategies have been designed to help children with literacy difficulties in schools by directly targeting memory skills. Some of these interventions are computer based and target a range of working memory skills, such as Cogmed, or target specific memory skills, such as the N-Back programme (Klingberg et al., 2005; Jaeggi et al., 2011). These programmes have been shown to enhance working memory with long-lasting cognitive gains and academic improvement in both Maths and English.

Are interventions effective?

In a review of dyslexia interventions, Snowling and Hulme (2011) commented that for dyslexia interventions to work there should be targeted training in phonological awareness, letter-sound recognition, and practice in reading and writing. However, children present different literacy difficulties, so it is impossible to implement a 'one fits all' strategy. They also highlight that there is currently a delay in diagnosing literacy difficulties, which can sometimes be mistaken for attention problems, making early intervention difficult.

Dyslexia, like many learning impairments, can cause social and emotional difficulties, such as a loss of self-esteem and confidence. These aspects of the condition are not treated in intervention programmes per se, but should be addressed as much as memory enhancement techniques because they may not naturally recover with working memory improvements.

In conclusion, the evidence so far suggests that there are cognitive benefits shown from both classroom-based and direct intervention strategies, particularly early interventions; however the long-term gains and transferability of these benefits to daily tasks and activities is questionable.

2.5 Practical investigation

Learning objectives

In this section you will have to design and conduct a practical investigation using a laboratory experiment in an area relevant to the topics covered in cognitive psychology. In conducting the practical research exercise, you must:

- design and conduct a laboratory experiment to gather quantitative data on a topic in cognitive psychology
- make design decisions in your planning
- collect and present the data you have gathered using appropriate tables, graphs, descriptive statistics and a non-parametric tests of difference, and draw conclusions from your data
- consider the strengths and weaknesses of your experiment and suggest possible improvements that could be made
- use typical reporting conventions to document your procedure, results and discussion.

There are many laboratory experiments in cognitive psychology that you could replicate or modify. In this section you will follow an example of a laboratory experiment used to investigate the influence of acoustic similarity on short-term memory recall. Although you may choose a different area of cognitive psychology to investigate, this section will provide a worked through example of how to go about designing, conducting and discussing a practical investigation.

Before you begin planning your practical investigation, you should review the methodology section in this topic to familiarise yourself with key terms and concepts concerning laboratory experiments.

Aim

All research begins with an aim that is typically based on current theory or research into an area. The aim of this experiment is to investigate the effect of acoustic similarity on short-term memory. This is based on the theory that the short-term store uses acoustic encoding, so similar sounding words and letters are more difficult to sub-vocalise and encode, resulting in poor recall performance. It is important that you read around the topic before you plan your practical investigation to establish a rationale for your own aim.

Hypotheses

Your practical investigation should have an experimental hypothesis and a null hypothesis. Once you have read around the topic you are interested in, you will need to decide whether your experimental hypothesis is directional or non-directional. If prior research and theory indicates the likely direction in which your results will go, you must use a directional hypothesis, but if there are conflicting theories and research, it may be more prudent to use a non-directional hypothesis.

Before a clear hypothesis can be written, the independent and dependent variables should be defined and operationalised. This practical investigation is looking to see if acoustically similar or dissimilar sounding words (the independent variable) will have an effect on recall (the dependent variable).

WIDER ISSUES AND DEBATES

Psychology as a science

Science follows the hypothetico-deductive method. This means that in order to be scientific (objective, reliable and empirical) we must first propose a testable hypothesis and then conduct an experiment to gather empirical data that will support or refute this hypothesis. In this experiment, a clear hypothesis has been predicted and measures taken to collect data that can be used to test this hypothesis.

Key terms

Order effects: the effect of practice or fatigue due to taking part in both conditions of the study.

Demand characteristics: participant behaviour altered because they may guess the study aim.

Homogenous: equal or similar.

Randomly allocated: randomly dividing the participants into each condition by, for example, picking their names out of a hat.

Counterbalancing: alternating the conditions of the study for each participant in a repeated measures design.

Randomisation: randomising the conditions of the study for each participant in a repeated measures design.

WIDER ISSUES AND DEBATES

Psychology as a science

In all psychological research, it is very important to use a sample of participants that is representative of the target population. If we do not have a representative sample, we cannot generalise the findings of the experiment to the target population.

Experimental hypothesis

The experimental hypothesis for this practical investigation will be directional because prior theory and research indicates the direction of difference that is likely to be found between recall of acoustically similar and dissimilar sounding words, that is, more acoustically dissimilar sounding words will be recalled than acoustically similar sounding words.

Null hypothesis

Remember that your practical should also have a null hypothesis. For this practical investigation the null hypothesis is that there will be no difference in the number of acoustically similar and dissimilar sounding words, and any difference found will be due to chance.

Experimental design

When choosing an experimental design, it is worth considering the strengths and weaknesses of each. An independent groups design is a good design to select if you want to avoid **order effects** and **demand characteristics**, but it can mean that the individual differences between participants in each group may affect your results. A repeated measures design avoids individual differences, but has the problem of order effects and demand characteristics.

In this experiment the aim is to examine encoding in short-term memory which, unless affected by age, illness or a learning impairment, is relatively similar between participants. If the sample you select is fairly **homogenous**, individual differences should not be a significant problem. However, order effects are likely to be a problem if participants are asked to repeat the memory test, particularly immediately after one another, and they may guess the aim of the study if you are involved in both conditions of the experiment.

On balance, an independent groups design should work to avoid order effects and demand characteristics, and you can be reasonably assured that the individual differences in memory between participants is not going to impact on your results. However, to evenly distribute any individual differences in short-term memory span, participants can be **randomly allocated** to each condition of the experiment.

If you chose to use a repeated measures design for your experiment, it is worth considering using **counterbalancing** or **randomisation** of conditions.

Sampling

Selecting a sampling method involves considering your target population and using a sampling technique that draws out a representative sample of people. This means that you can confidently generalise your findings back to the target population. For this experiment, the target population is very large as it can involve any individual with a reasonably intact and unimpaired short-term memory. This means that it would be difficult and time-consuming to use a random or stratified sampling technique, so either a volunteer or opportunity sample would be more efficient.

The volunteer sampling technique encourages participants with a particular compliant nature. This would be a problem for social psychological research, but as cognitive processing is relatively unaffected by personality type and an independent groups design is being used, the volunteer sampling technique is probably more ethical than an opportunity sample. No one is being directly asked and put under pressure to participate.

Twenty participants will be selected from the first twenty who respond to an advert placed in a sixth-form common room, excluding anyone with short-term memory impairment.

Operationalisation

Operationalisation means that you need to make your independent variable and dependent variable specifically defined. The independent variable in this experiment is whether the words presented to participants are acoustically similar or dissimilar in sound. This will be operationalised by presenting one group of participants with ten monosyllabic words that rhyme (acoustically similar) or ten monosyllabic words that do not rhyme (acoustically dissimilar). The dependent variable will be the total number of accurately recalled words from the original list in a free recall memory test. It is very important that you operationally define both your independent and dependent variables.

WIDER ISSUES AND DEBATES

Psychology as a science

Operationalisation is very important to establish objectivity and reliability in psychological research. In this experiment operationalisation has been achieved by defining the type of words each group of participants will receive, and exactly what will be measured as an outcome. With good control over extraneous variables, it is possible to establish a cause and effect relationship between the IV and the DV in this experiment.

Controls

Situational variables

Because you are conducting a laboratory experiment, the environment will be reasonably well controlled already. However, it is worth considering any situational variables that are likely to have an effect on participants. In this experiment it would be important to control for any noise or interruptions that might affect learning and recall, so participants will be tested individually and a sign will be placed on the door to prevent interruptions. To prevent conferring, and therefore the potential for demand characteristics, all participants will be placed in a room, called out individually to do the memory test, and will be told not to return. The procedure will also be standardised to prevent experimenter effects occurring.

Participant variables

Although cognition is reasonably similar in the majority of people, individual differences are not likely to have a huge impact on your investigation. However, it is worth considering significant individual differences such as age and learning impairments. Once you have identified potential individual differences between your participants, you will need to either control them or eliminate them. In this practical investigation individual differences in short-term memory will be controlled by equally distributing them using random allocation of participants to the conditions of the experiment. However, a short questionnaire will be conducted prior to the experiment to check for any short-term memory problems by asking participants about their educational needs. There will, of course, be participant variables that are not controlled for, such as motivation. However, the experiment will be conducted in the morning to prevent any possible effects of fatigue that might occur later in the day.

Developing a procedure

A procedure should be a schedule of what happens, where, when and how. This ties into how you will control for extraneous variables and it is important that the procedure stays the same for all participants. In this experiment, participants will be read a set of standardised instructions by the researcher and asked to sit at a desk directly in front of a whiteboard and projector. To prevent

Example standardised instructions

Thank you for volunteering to take part in this memory experiment.

You will see a set of ten words appear one at a time on the whiteboard in front of you. Each word will appear for 3 seconds and you will need to learn as many as you can. Immediately after the tenth word, you will see a blank screen, this is a cue for you to write as many words as you can remember on the piece of paper in front of you. You may write them down in any order and you will have 1 minute to remember all the words that you can.

If you wish to take part, please sign the consent form in front of you. If you do not wish to take part, please let me know now. If you wish to leave the experiment, you are free to do so at any point. This is not a test of intelligence.

Do you have any questions you would like to ask before we begin?

demand characteristics, the participants will be told what they will be required to do, but not why they are doing it or what other participants will be doing. The words will be presented one at a time for a duration of 3 seconds per word. Participants will be given a pen and paper to recall in any order the words they have learned immediately after the words have been presented. They will be given 1 minute to recall the word list. This standardised procedure will mean that all participants will be treated in exactly the same way, and will minimise any experimenter effects.

Apparatus

Any research into memory typically involves participants learning something, whether it is a list of words, letters or digits, a set of images, or a simulated event. Your apparatus will depend on your aim, but it is worth considering the nature of the apparatus you ask participants to remember. A word list may seem fairly straightforward, but you need to remember that some words are easier to remember or more memorable than other words. It may be worth considering using a list of high frequency words, words of similar syllable length (particularly for short-term memory research) or using letters or digits instead.

This practical investigation uses monosyllabic words to ensure that each word takes up an equal amount of short-term storage capacity. The words have also been selected for being high frequency, so that each list is equal in familiarity and difficulty.

Table 2.13 Apparatus: word lists.

Acoustically similar sounding words	Acoustically dissimilar sounding words
Cat	Pan
Mat	Ten
Hat	Mill
Lot	Hit
Hot	Gun
Dot	Dog
Cot	Get
Den	Hot
Pen	Bun
Hen	Pit

Ethical issues

Before undertaking any psychological research it is essential you consider the ethical implications of your research. Both the British Psychological Society (BPS) and British Education Research Association (BERA) guidelines should be consulted and adhered to as closely as possible, even for a small A-level practical investigation. Any research can make participants feel pressured, intimidated, embarrassed or concerned. It is important that ethical issues are given careful thought before proceeding with your experiment. If you are unsure whether your experiment will present any ethical issues, you may wish to conduct a pilot study on family and friends first and ask them how they felt during the experiment.

Valid consent

In this experiment, participants have been asked to volunteer for an experiment into short-term memory. This is clearly stated on the recruitment advertisement. However, participants will not be entirely aware of the full aim of the experiment until after they have completed the memory test. This means that, although consent to take part has been given, fully informed consent has not been achieved because the true nature of the experiment has been partially withheld. When deciding on whether to gain fully informed consent for your own experiment, it is worth considering whether knowledge of the aim will affect the performance of participants and whether the participants are likely to refuse to take part if they did know the full aim. It might be prudent to ask other people whether they would object to taking part in your experiment; if they would not mind, you may assume presumptive consent. Where possible, fully informed consent should be gained or otherwise fully justified, and no offer of incentives should be given for taking part in the investigation.

Example advert for a psychology experiment

We are looking for volunteers for a psychology experiment on memory. You will be asked to learn a list of words to remember and recall; this will measure your short-term memory. This is an experiment for my A-level practical investigation, which may be used in my exam.

The study will take place in the psychology classroom on Monday morning. You will be required for most of the morning, but the actual memory test will take only 2 minutes. You will be tested

individually and no details of your memory score will be shared with any other participant. You will be told your memory score and the full aim of the study once you have finished. You may use your right to withdraw before, during and after the study has taken place. Any of your details will be destroyed following my A-level examination.

If you are interested in taking part, please place a note with your name and school email address in my pigeon hole.

Because the participants being recruited for this experiment are under the age of 18 years, it is necessary to gain consent from a parent or guardian of the child. In this experiment, details of parents/carers were gained from the volunteers and a consent form was sent out to parents with information about the experiment. You will also need to consider whom consent needs to be gained from if your participants are considered to be children. You should provide an information sheet for both parents/guardians and participants setting out the nature of your experiment.

Right to withdraw

In any psychological investigation, it is very important to offer participants a right to withdraw. This means that they can elect to leave the study before, during or after the experiment has taken place. If they withdraw from the study after it has happened, the participant's results should be destroyed. In this experiment, participants were offered a right to withdraw in the recruitment advertisement, the standardised instructions and debrief.

Example debrief

Thank you for taking part in this psychology experiment into memory.

You were given a list of ten words to learn and recall. The words you were given either rhymed or did not rhyme. This was to test whether dissimilar sounding words were more easily recalled from short-term memory than similar sounding words. Psychological theory predicts that, because we use rehearsal to hold information in short-term memory, we will be better at rehearsing dissimilar sounding words. Similar sounding words will be more difficult to rehearse because they can be confused.

Your memory test score was X out of ten, which is in normal range for this type of experiment.

This result will only be used for my A-level practical investigation. Your result will be anonymised and the data destroyed after the exam. If you feel uncomfortable with this, you may withdraw your results.

Do you have any questions?

Thank you for your time.

Information sheet contents

The aim of the study

The type of data to be collected

The method of data collection

Confidentiality and anonymity conditions

Compliance with the Data Protection Act and Freedom of Information Act, how the results will be made available and details on destruction of data

The time commitment participants should expect

A right to decline or withdraw from the study without consequence

The possible risk to the participants

The nature of debriefing

How the data will be used and the benefits of the study

The name and contact details of the researcher and supervisor

(Adapted from the BPS Code of Conduct 2010)

Risk

It is important to consider whether your participants will be protected from harm. Harm can be physical or psychological. Under no circumstances should you physically harm your participants, and you will have to think very carefully about whether they will suffer any psychological harm, even modest harm such as embarrassment or stress. In this experiment participants are reminded of their right to withdraw, the results were anonymised, and they were told that the test is not a measure of intelligence. It is also important that participants are given an opportunity to ask any questions they may have arising from the research. This can help alleviate any anxiety before the test and any embarrassment caused by the test.

Design decisions taken in this experiment

Aim: to investigate the influence of acoustic similarity on short-term memory

Experimental hypothesis – directional: more acoustically dissimilar sounding words will be recalled than acoustically dissimilar sounding words.

Null hypothesis: there will be no difference in the number of acoustically similar and dissimilar sounding words recalled, and any difference found will be due to chance.

Experimental design: independent groups

Sampling method: volunteer

Independent variable: whether participants receive a list of ten monosyllabic rhyming words, or ten monosyllabic non-rhyming words.

Dependent variable: the total number of accurately recalled words from the list.

Ethical issues: parental/guardian consent gained, participant consent gained but this was not fully informed. No psychological harm was anticipated. A full debrief was given.

Analysing the results

Gather together the results from the participants and present them in a raw data table, like the one in Table 2.14.

Table 2.14 A raw data table to show the recall of acoustically similar and dissimilar sounding words.

Participant number	Total number of similar sounding words recalled	Participant number	Total number of dissimilar sounding words recalled
1	4	11	9
2	5	12	7
3	3	13	8
4	7	14	6
5	9	15	8
6	3	16	10
7	7	17	9
8	8	18	5
9	5	19	10
10	4	20	9

This raw data indicates that the highest number of words was recalled when the words presented were acoustically dissimilar and the lowest number recalled was from the acoustically similar list.

The raw data seems to support the experimental hypothesis. However, raw data can be difficult to interpret and represents individual scores. To help interpret the findings, descriptive statistics can be useful to present a summary of the average score achieved in a data set. Measures of central tendency, such as mean, median and mode, and measures of dispersion, such as range and standard deviation, should be presented in a summary table, as shown in Table 2.15.

Table 2.15 A summary table to show typical recall score and distribution of scores between acoustically similar and dissimilar sounding words.

	Acoustically similar sounding words	Acoustically dissimilar sounding words
Median of words recalled	5	8.5
Mode of words recalled	-	9
Mean number of words recalled	5.5	8.1
Range of words recalled	6	5
Standard deviation	2	1.6

The mode score for acoustically similar sounding words were 3, 4, 5 and 7, so is not a useful modal score to present. However, overall, the measures of central tendency suggest that more acoustically dissimilar words were recalled than similar sounding words. The measures of dispersion suggest that there was greater spread of results for the acoustically similar sounding words than the dissimilar sounding words, but this was only slightly greater. It perhaps suggests that some participants found it slightly easier or more difficult to recall the words than others within the acoustically similar word group.

Maths tip



All tables should be clearly labelled and titled to make it clear to the reader what the table represents and what the figures in the table mean.

The mean of words recalled seems to reflect the typical score achieved by participants in both conditions of the experiment, so this statistic can be graphically represented in a bar chart.

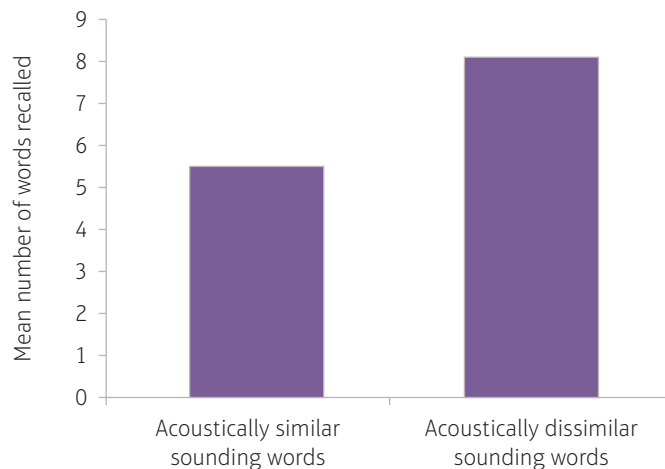


Figure 2.13 A bar graph to show the mean recall of acoustically similar and dissimilar sounding words.

Drawing conclusions

From the data gathered and presented, it is important that you can draw conclusions from your findings. This can involve going beyond the findings and relating your data to the concepts under investigation. This practical investigation found that participants recalled fewer acoustically similar sounding words compared to acoustically dissimilar sounding words. The typical recall score achieved by participants given acoustically similar sounding words was, on average, three words fewer than for dissimilar sounding words. However, the distribution of scores suggests that there was a large degree of individual variation in recall for both groups, which was marginally greater for the acoustically similar words group. This demonstrates that some individuals found word recall easier and some more difficult than others.

Inferential test of significance

To determine whether the findings of the practical investigation are statistically significant, or just due to chance, you will have to run your data through an inferential test. For your practical investigation you will need to gather quantitative data that is at ordinal level or above, and therefore conduct either a Mann-Whitney U or Wilcoxon non-parametric test of difference. If you have used an independent groups design you will use a Mann-Whitney test, or if you have used a repeated measures design you will use a Wilcoxon test.

This practical investigation used an independent groups design, so a Mann-Whitney U test was run on the data:

Mann-Whitney U test formulae

$$U_a = n_a n_b + \frac{n_a(n_a + 1)}{2} - \sum R_a$$

$$U_b = n_a n_b + \frac{n_b(n_b + 1)}{2} - \sum R_b$$

(U is the smaller of U_a and U_b)

Maths tip



All graphs should be clearly titled and both axes fully labelled.

If the Y-axis scale is particularly large, it is possible to start the axis at a greater number than 0, however, if the Y-axis scale is not set at zero, it should be indicated with two intersecting diagonal lines at the lower end of the Y-axis scale. This should be done to alert the reader that differences between the bars may appear exaggerated.

Do not present individual scores/raw data in a chart.

Table 2.16 Scores for each group: words recalled.

Total number of similar sounding words recalled Group A	Rank	Total number of dissimilar sounding words recalled Group B	Rank
4	3.5	9	16.5
5	6	7	10
3	1.5	8	13
7	10	6	8
9	16.5	8	13
3	19.5	10	19.5
7	10	9	16.5
8	13	5	6
5	6	10	19.5
4	3.5	9	16.5
Sum total of points	89.5	Sum total of points	138.5

The sum of the ranks for group A and group B should be used in the following formulae:

$$U_a = N_a \times N_b + N_a \times (N_a + 1) / 2 - R_a$$

$$U_a = 10 \times 10 + 10 \times 11 / 2 - 89.5$$

$$U_a = 100 + 110 / 2 - 89.5$$

$$U_a = 65.5$$

$$U_b = N_a \times N_b + N_b \times (N_b + 1) / 2 - R_b$$

$$U_b = 10 \times 10 + 10 \times 11 / 2 - 138.5$$

$$U_b = 100 + 110 / 2 - 138.5$$

$$U_b = 16.5$$

This should be compared to a table of critical values for a Mann-Whitney U test.

Table 2.17 Critical values of U for a one-tailed test at 0.05; two-tailed test at 0.1 for a Mann-Whitney U test.

n	1	2	3	4	5	6	7	8	9	10
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	0	0	0	1	1	1
3	-	-	0	0	1	2	2	3	3	4
4	-	-	0	1	2	3	4	5	6	7
5	-	0	1	2	4	5	6	8	9	11
6	-	0	2	3	5	7	8	10	12	14
7	-	0	2	4	6	8	11	13	15	17
8	-	1	3	5	7	10	13	15	18	20
9	-	1	3	6	9	12	15	18	21	24
10	-	1	4	7	11	14	17	20	24	27

The observed value of U is significant at the given level of significance if it is equal to or less than the table (critical) value above.

The calculated (observed) Mann-Whitney U-value is 16.5. This is less than the table (critical) value at $p \leq 0.05$ of 27, with $N = 10, 10$. Therefore, the result is significant at $p \leq 0.05$ for a one-tailed test. Therefore the experimental hypothesis can be supported. In fact the calculated (observed) value is less than the critical value for a one-tailed test at $p \leq 0.01$, meaning that the result is highly significant and therefore the difference between the recall of the groups is unlikely to be due to chance. This means that the likelihood of making a type 1 error is reduced and the experimental hypothesis can be supported with confidence.

Maths tip



There is more than one table for the Mann-Whitney U test. You should use the title of each table to guide you to which one to use; consider whether you are using a one- or two-tailed test and what level of significance you are using.

Making a statistical statement

Following your statistical test, it is important to make a statistical statement and support or reject your hypotheses. Your statistical statement should include the following information:

- the statistical test used
- the observed/calculated value
- whether a one- or two-tailed test was used
- the level of probability
- the number of participants
- the critical value used
- whether the calculated value was greater than/equal to/less than the critical value
- whether the result is significant or not
- which hypothesis it supported.

Discussion

A discussion section of a report will include a summary of the findings and how these relate to the wider concepts, theory and prior research related to the study. It will also include the strengths and weaknesses of the practical investigation and suggestions for possible improvements and new directions for the research.

In this practical investigation it can be concluded that there was a significant difference between recall of acoustically similar sounding and dissimilar sounding words; acoustically dissimilar sounding words were significantly less well recalled. This finding is consistent with theory which suggests that encoding in the short-term store is primarily acoustic, making similar sounding words difficult to sub-vocalise (rehearse) and maintain compared to dissimilar sounding material. This is also consistent with research conducted by Sperling (1963) who found that participants had difficulty remembering acoustically similar letters (B, D, T) compared to acoustically dissimilar sounding letters (F, L, M, X).

Critical evaluation

It is important to consider both the strengths and weaknesses of the practical investigation. For this, you will be better placed to judge the successes and failures with regard to your own procedure and outcomes. However, a number of general questions should be asked.

- Is the study ethical?
- Can you generalise the findings to others/different cultures/different eras?
- Is the study reliable?
- Is the study carried out in a natural or artificial environment?
- Is the task ordinary?
- Are the findings useful in real life?
- Is the research valid?
- Is there any conflicting evidence from other research?

Is the task ordinary?

This is a common question asked of much cognitive research conducted in laboratories using series of stimulus lists of words, letters and digits, seemingly unrelated to memory tasks that occur in ordinary everyday life. It is true that we are often required to draw on our memory for shopping

Maths tip



Use this statistical statement template to help structure your conclusion:

The calculated value of the _____ test was _____. This was equal to/greater/less than the critical value of _____ for a one/two tailed test at $p \leq 0.05$ with $N =$ _____. Therefore the result is/ is not significant and the experimental/ null hypothesis can be supported, which states that _____.

lists, telephone numbers or random sequences. However, this is not a typical activity for memory to undertake and often takes a degree of conscious processing and effort. For this reason, the task used in this practical investigation may be criticised for not reflecting an ordinary use of memory.

However, the task was intended to investigate encoding in the short-term store in a way that actually measured short-term memory in its most pure form, unaffected by the meaningfulness of everyday material. In order to study memory this practical investigation had to remove the social context in which memory normally operates in order to remove variables that could potentially confound the research. This can be more easily understood by comparing psychology to biology as a subject. No one would criticise a biologist for collecting blood in a test tube to determine its blood group, yet a test tube is not a natural state for blood to exist. In order for the blood to be tested, it needs to be collected from the body and isolated from contamination. This experiment performed the same function to test encoding in short-term memory.

Suggestions for improvement

In addition to considering the strengths and weaknesses of your practical investigation, you should also refer to how your study could be improved. To do this effectively you will need to consider the weaknesses of your research and how these weaknesses could be overcome. Suggestions for improvement can be ambitious, but should not be impractical or impossible to achieve.

In this practical investigation the nature of the word lists were withheld from participants, resulting in a lack of valid consent being gained. This is a potential ethical weakness of the study that could have been improved by fully informing participants of the aim of the research. A pilot study could have been conducted where participants were told that they would receive either a similar sounding word list or a dissimilar sounding word list, and participants could have been asked later whether this knowledge affected their performance. This is a useful suggestion to improve the ethical problem with the practical investigation that is not impractical and would not ruin the research.

Writing up the report

Psychological investigations are written following a set of conventions for report writing as shown below.

Conventions of report writing

Abstract: a summary of the background theory/research, aims, hypotheses, method, results and discussion. This is a short paragraph overview of the entire report.

Introduction: an overview of related theories and research in the topic area. The introduction provides a rationale for the current investigation that links prior research to the study aims and hypotheses.

Method: a detailed account of the participants, sampling method, apparatus, procedure, controls and ethical issues.

Results: a detailed account of the data gathered and its analysis using descriptive and inferential statistics.

Discussion: conclusions drawn from the results analysis, reference to prior research, strengths, weaknesses and possible improvements for future research.

To complete your practical investigation, it is necessary and useful to follow these conventions when writing up your report.

2.6 Issues and debates

Learning outcomes

In this section you will learn about issues and debates relevant to cognitive psychology. You should have already noticed that issues and debates have been mentioned throughout this topic. This section will draw together the main themes and ideas related to the cognitive approach as a whole. You will learn about:

- Ethical (including socially sensitive research), methodological and practical issues associated with cognitive research
- Reductionism as it applies to cognitive research and theory
- Different ways of explaining behaviour using alternative theories in cognitive psychology
- Whether or not cognitive psychology can be considered scientific
- The role of nature and nurture in cognitive systems and research
- How the cognitive approach and research has developed over time
- The use of cognitive psychological knowledge in society

Issues of social control

Psychology is largely concerned with how knowledge can be applied to the real world, and as such can have important applications in many areas of life, such as health, education and crime. However, we need to exercise care when applying knowledge in real life to ensure that it is not unwittingly directing the behaviour of others or encouraging social injustice. Using psychological knowledge can impact adversely on others, even if the application reflects dominant thinking at the time, this thinking may change practise or opinion. Memory research has been very influential in directing legal practise. Criminology is the application of memory research, used by police interviewers and the courts. One such theory has dominated legal practise for many years; that is the belief that eyewitnesses may not be reliable because their memory is reconstructive and prone to distortion. This has driven legal policy and police practise in an attempt to improve the reliability of testimony or ensure that eyewitnesses are not the only form of evidence used in court. This knowledge has effectively been used as a form of social control, dictating who can testify and under what conditions they can give accurate testimony.

Ethical issues associated with cognitive research

Experimental research

Cognitive psychology is largely based on experimental research into 'normal' participants with average memory ability. Although the full nature of experimental aims may be withheld from participants, to avoid the possibility of demand characteristics, most research gains participant consent and rarely involves deliberately violating the protection of participants by causing distress or anxiety. Some research may use deception by misguiding participants as to the true nature of the experiment, but will offer participants the right to withdraw from the research at any stage. In fact, most experimental research adheres very closely to the BPS ethical guidelines for research with human participants.

More recent experimental research into memory has adopted more naturalistic methodology, such as the field experiment. This research can involve staging realistic events for people to witness and

asking them to recall the event later on. These experiments may not ask participants for their initial consent to take part, but do gain consent after the staged incident and provide a full debrief after the memory test has concluded.

Case studies of brain-damaged patients

In case studies of brain-damaged patients, such as HM, participant confidentiality is maintained by ensuring that they are given pseudonyms to anonymise their identities. Research using individuals with brain damage is often criticised for violating a right to privacy; case studies of brain-damaged patients are rare and unique, which can result in them being over studied and their normal life impinged on by rigorous and intensive experimentation. This may be true of some cases where researchers may become overzealous in their research. However, Henry Molaison was reported to have enjoyed being tested and saw memory experiments as fun and challenging activities; this is perhaps because he had no recollection of any prior testing.

Socially sensitive research

Memory loss is a sensitive area for both the amnesia patient and the families concerned. Amnesia is a life-altering impairment that can cause an individual extreme distress because their intelligence remains virtually intact, leading to confusion and frustration about their loss of memory. However, this research is important for both psychological understanding and to benefit amnesia patient recovery.

Methodological and practical issues associated with cognitive research

Cognitive research often involves the use of laboratory experiments using tasks that lack mundane realism. The ecological validity of this research has often been debated, particularly when the findings are used to explain everyday memory or are applied to everyday contexts. However, laboratory experiments are often necessary to study memory in a vacuum that is devoid of variables that could affect the findings of the research, for example, the use of trigrams may not reflect ordinary information that we need to remember, but trigrams are necessary to study memory without the inference of meaning that we often associate with words or images. Ecological validity is often lost at the expense of internal validity.

Reductionism

Historically, the cognitive approach has tended to separate different cognitive functions, such as perception and memory, to make these cognitive processes easier to research and understand. Breaking up these areas of cognition into these separate parts can be considered to be reductionist as clearly what we remember is based on what we perceive in the first place, and to some extent perception is affected by previously stored knowledge. Bartlett recognised this in his theory of reconstructive memory, which can be considered as less reductionist than the other models of memory described in cognitive psychology. The multi-store model of memory can be considered as reductionist because it artificially fragments the short-term and long-term memory stores without discussing the interconnections between each store. Similarly, Baddeley and Hitch divided the short-term memory into slave systems for the purposes of studying working memory.

It has become increasingly acknowledged that in order to better understand memory and other cognitive processes we need to acknowledge the interplay between systems and stores. Research using brain imaging has helped us to appreciate the interrelatedness of different parts of the brain when we perform cognitive functions, and amnesia patients have helped us understand that loss of functionality may not be a direct consequence of damage to a particular region of the brain, but an interaction between different regions.

Comparing explanations

Comparing explanations of memory can be done on many levels; such as the type of research used to support the explanation, whether it has practical application, the role of nature or nurture within the explanation, or whether its emphasis is on structure or function. As an example, the explanations of memory described in this section can be compared in terms of whether they emphasise the nature of memory as a series of structures or the way that memory is processed. The multi-store model views memory as a series of stores; the sensory store, the short-term store and the long-term store, so can be considered a structural model of memory because the focus of the explanation is on the architecture of the memory system. Similarly, Baddeley and Hitch also focus their explanation of working memory on what components of short-term memory exist. Although both theories of memory acknowledge the type of processes involved in the transfer and manipulation of information, this is second to describing how memory is represented as a structural system.

In direct contrast to these structural models is Bartlett's reconstructive memory. This explanation of memory does not attempt to describe the structure of memory, instead focusing on memory as a process or function. Reconstructive memory is a functional model of memory because it explains how stored knowledge affects perception and remembering as an active process of construction.

Psychology as a science

The cognitive approach is one of the most scientific perspectives in psychology because it largely adopts the scientific method. The dominant research method used is the laboratory experiment, which means that controls are used to establish causality between the independent and dependent variables, and research has replicability. Studies within this approach employ the hypothetico-deductive experimental method, which investigates predictions in an objective way and, unlike the inductive method, ensures that hypotheses can be refuted or supported.

The use of case studies of brain-damaged patients can be very scientific because they use highly controlled experiments and brain-imaging techniques, however, these cases are rare and often the damage is unique to the individual, resulting in a lack of generalisability.

However, the cognitive approach can study concepts that are largely theoretical with no empirical evidence to support them, such as the working memory's central executive.

Nature–nurture

The cognitive approach emphasises the role of both nature and nurture within its explanations of cognitive functioning. Using the computer metaphor, the cognitive approach assumes that we are born with the hardware to have the capacity to perform certain functions, such as remembering. The approach also assumes that the experiences we have during our lives change what we remember and how we process information in the same way that a programmer alters the software of a computer. How our experiences affect cognition represents the role of nurture.

Reconstructive memory describes how we all represent knowledge as schema; these are universal mental constructs (nature) hardwired into our memory, but the contents of which are affected by how we are raised and what we experience as we develop (nurture).

The case of HM is a useful example when considering the nature–nurture debate because his unique characteristics make it unclear which elements of his impairment are due to the surgery that caused his brain damage and which to the lack of schooling and seizures he experienced when growing up. Clearly the loss of his hippocampus (nature) resulted in severe amnesia, but perhaps his underperformance on certain tests could be a result of nurture.

Taking it further

Research Gary Wells online. Gary Wells has researched eyewitness identification extensively and suggests how memory research can be used to improve eyewitness identification procedures.

How psychological knowledge has developed over time

The study of memory can be traced back many years, and each time that a new explanation is put forward, psychology develops a new understanding. The multi-store model was one of the first coherent theories of memory, and although now largely regarded as simplistic, it has been useful in understanding what memory might look like and has contributed to a better understanding of memory today. The multi-store model directly informed the development of Baddeley and Hitch's working memory and Tulving's semantic and episodic long-term memory. Similarly, within the working memory theory, a reformulation was done to fine-tune the explanation by adding the episodic buffer to explain the interrelationship between short-term and long-term memory.

More recently there has been a resurgence of interest in reconstructive memory that has led to a wealth of studies conducted into eyewitness memory which continues to debate whether we can rely on such testimony in our courts.

The use of psychological knowledge within society

The most important use of cognitive psychology is its application of explanations and research in society. A general understanding of how memory works can be used in everyday contexts, such as using mnemonics to aid revision or chunking bits of information together to remember a telephone number. Understanding how memory works can also help in the treatment of learning impairments such as dyslexia; teachers can simplify and shorten instructions and information so that working memory is not overloaded. As there is no cure for memory loss, cognitive therapies, such as cognitive stimulation, have been used with dementia patients to practise memory tasks (remembering the date, people in a group) and reduce their confusion.

One of the most significant contributions of memory has been to our understanding whether eyewitness testimony can be relied on. There has been considerable research examining the factors affecting reliability of memory, such as whether age, anxiety or post-event information can affect our ability to accurately recall an incident and identify a perpetrator. This academic research led to the Devlin Report (1976) which called into question eyewitness reliability following a number of cases of false imprisonment based on witness identification. This has led to recent changes in the Police and Criminal Evidence Act Codes of Practice in the way eyewitnesses are asked to identify a perpetrator from a line-up.

Summary

Knowledge check

Content

In the content section you are required to describe, evaluate and apply your knowledge of four theories of memory.

To check your evaluation skills, refer to the introduction section of this book and review 'how to evaluate a theory'. Remember that you may be asked to consider issues of validity, reliability, credibility, generalisability, objectivity and subjectivity in your evaluation of theories.

Can you describe Atkinson and Shiffrin's (1968) multi-store model of memory and understand the difference between each store in terms of their capacity, duration, encoding and forgetting?

Are you able to apply the concepts used in the multi-store model of memory to explain how we remember and why we forget?

Can you evaluate the multi-store model of memory in terms of strengths and weaknesses?

Are you confident that you can describe the components of the working memory model (Baddeley and Hitch, 1974)?

Are you able to apply working memory concepts to explain dual task performance?

Can you evaluate the working memory model in terms of strengths and weaknesses?

Can you identify and distinguish between the episodic and semantic long-term memory stores?

Are you able to evaluate Tulving's (1972) distinction between the types of long-term memory in terms of strengths and weaknesses?

Can you describe Bartlett's (1932) theory of reconstructive memory?

Are you confident that you can apply your knowledge of schemas to understanding everyday memory and how memory can be affected by stored knowledge?

Can you evaluate reconstructive memory in terms of strengths and weaknesses?

Can you explain individual differences in memory in terms of processing speed, autobiographical memory and schemas?

Can you describe at least one developmental difference in memory by age (see studies section for Sebastián and Hernández-Gil, 2012), dyslexia and Alzheimer's.

Methods

Are you able to describe how laboratory and field experiments are designed and conducted?

Can you identify and write independent and dependent variables and fully operationalise each?

Can you identify and write operationalised experimental (directional and non-directional) and null hypotheses?

Are you able to identify, describe and evaluate experimental designs (repeated measures, independent groups and matched pairs), explain order effects and how problems with each design could be controlled (counterbalancing and randomisation)?

Are you able to identify and explain extraneous variables (situational and participant) and understand the impact of confounding variables?

Can you identify and explain experimenter effects and demand characteristics and consider how these could be controlled?

Can you explain what is meant by the concepts of objectivity, reliability and validity, and understand the impact and control of these concepts within the scientific process?

For quantitative data, can you identify, calculate and understand the analysis and interpretation of measures of central tendency (mean, median and mode), measures of dispersion (range and standard deviation), and percentages? Can you draw, interpret and select appropriate table and graphical representations of quantitative data (frequency table, bar graph and histogram)?

Do you understand the purpose of inferential tests, and the concept of probability?

Can you select an appropriate non-parametric test of difference (Mann-Whitney and Wilcoxon)?

Do you understand levels of significance ($p \leq 10$ $p \leq 05$ $p \leq 01$) and are you able to use these to interpret the results of an inferential test?

Can you compare observed and critical values on a critical values table to check whether results are significant?

Are you able to select an appropriate one- or two-tailed test according to the hypothesis and use this to interpret significance using a critical values table?

Can you explain what is meant by type I and type II errors and how the results of a statistical test may be vulnerable to these errors according to the level of significance adopted?

Can you describe, identify, draw and interpret normal and skewed distribution?

Are you able to describe the case of Henry Molaison (HM) as a case study of a brain-damaged patient, including how this case demonstrates individual differences in memory and the evaluations done of this case?

Do you understand what is meant by qualitative data, how qualitative data is conducted and interpreted and its strengths and weaknesses?

Studies

In the studies section you are required to describe, evaluate and apply your knowledge of one classic and one contemporary study of memory.

To check your evaluation skills, refer to the introduction section of this book and review 'how to evaluate a study. Remember that you may be asked to consider issues of validity, reliability, credibility, generalisability, objectivity and subjectivity in your evaluation of studies.

Can you describe the classic study by Baddeley (1966b): The influence of acoustic and semantic similarity on long-term memory for word sequences, in terms of its aim(s), method, procedure, results and conclusions?

Are you able to evaluate Baddeley's (1966b) study in terms of strengths and weaknesses?

Are you able to identify and describe the aims, method, procedure, results and conclusions of a contemporary study from the following list and evaluate the study in terms of strengths and weaknesses?

- Schmolck et al. (2002) Semantic knowledge in patient HM and other patients with bilateral medial and lateral temporal lobe lesions.
- Steyvers and Hemmer (2012) Reconstruction from memory in naturalistic environments.
- Sebastián and Hernández-Gil (2012) Developmental pattern of digit span in Spanish population.

Key question

Are you able to identify and describe a key question in cognitive psychology that is relevant to today's society?

Can you explain this key question using concepts, theories and research that you have studied in cognitive psychology?

Practical investigation

Have you designed and conducted a laboratory experiment to investigate an area of cognitive psychology?

Can you explain how you went about planning and designing your laboratory experiment, justifying your decision making for your choice of design, sampling, operationalisation and hypothesis construction?

Can you explain your control issues for experimenter effects and demand characteristics, and ethical considerations you had?

Can you describe and analyse (using measures of central tendency and dispersion) the quantitative data that you gathered for your laboratory experiment and how you presented your data (table and graphical representation)?

Are you able to explain, justify and interpret the non-parametric test of difference that you used on your data?

Are you able to draw conclusions from your descriptive data and inferential test (including critical and observed values, and level of significance)?

Remember that you may be asked to consider issues of validity, reliability, credibility, generalisability, objectivity and subjectivity in your evaluation of your practical investigation.

Can you explain the strengths and weaknesses of your laboratory experiment and suggest possible improvements that could have been made?

Are you able to write up the procedure, results and discussion sections of your laboratory experiment in a report style?

Issues and debates (A level only)

Remember that issues and debates are synoptic. This means you may be asked to make connections by comparing issues and debates across topics in psychology or comment on issues and debates within unseen material.

Can you identify ethical issues associated with theory and research within the cognitive approach?

Can you comment on the practical and methodological issues in the design and implementation of research within the cognitive approach?

Can you explain how theories, research and concepts within the cognitive approach might be considered reductionist?

Can you compare theories and research within cognitive psychology to show different ways of explaining and understanding memory?

Are you able to discuss whether theories, concepts, research and methodology within cognitive psychology are scientific?

Are you able to discuss the nature-nurture debate in the context of cognitive psychology, in terms of which parts emphasise the role of nature and nurture or the interaction between them?

Do you understand how cognitive psychology has developed over time?

Do you understand what is meant by social control and how research within cognitive psychology may be used to control behaviour?

Can you show how the theories, concepts and research within cognitive psychology can be used in a practical way in society?

Are you able to understand what is meant by socially sensitive research and explain how research in cognitive psychology might be considered to be socially sensitive?

References

Atkinson, R. and Shiffrin, R. (1968) 'Human memory: A proposed system and its control processes', in K. W. Spence and J. T. Spence (eds) *The Psychology of Learning and Motivation: Advances in Research and Theory*, Vol 2, pp 89–195, New York Academic Press.

Baddeley, A.D., and Hitch, G. (1974) 'Working memory' in G.H. Bower (ed.) *The psychology of learning and motivation: Advances in research and theory*, Vol. 8, pp. 47–89, New York: Academic Press.

Bartlett, F. C. (1932). *Remembering: A Study in Experimental and Social Psychology*, Cambridge, UK: Cambridge University Press.

Sebastián, M.V., and Hernández-Gil, L. (2012) 'Developmental pattern of digit span in Spanish population. *Psicothema*', Vol 24 (2), pp 183–187.

Steyvers, M. and Hemmer, P (2012) 'Reconstruction from Memory in Naturalistic Environments' In Brian H. Ross (ed.) *The Psychology of Learning and Motivation*, Vol 56, pp. 126–144, Elsevier Publishing.

Schmolck, H., Kensinger, E. A., Corkin, S. and Squire, L. R. (2002) 'Semantic knowledge in patient H.M. and other patients with bilateral medial and lateral temporal lobe lesions', *Hippocampus*, Vol 12, pp. 520–533.

Tulving, E. (1972) 'Episodic and semantic memory', in E. Tulving and W. Donaldson (eds), *Organization of Memory*, pp. 381–402. New York: Academic Press.