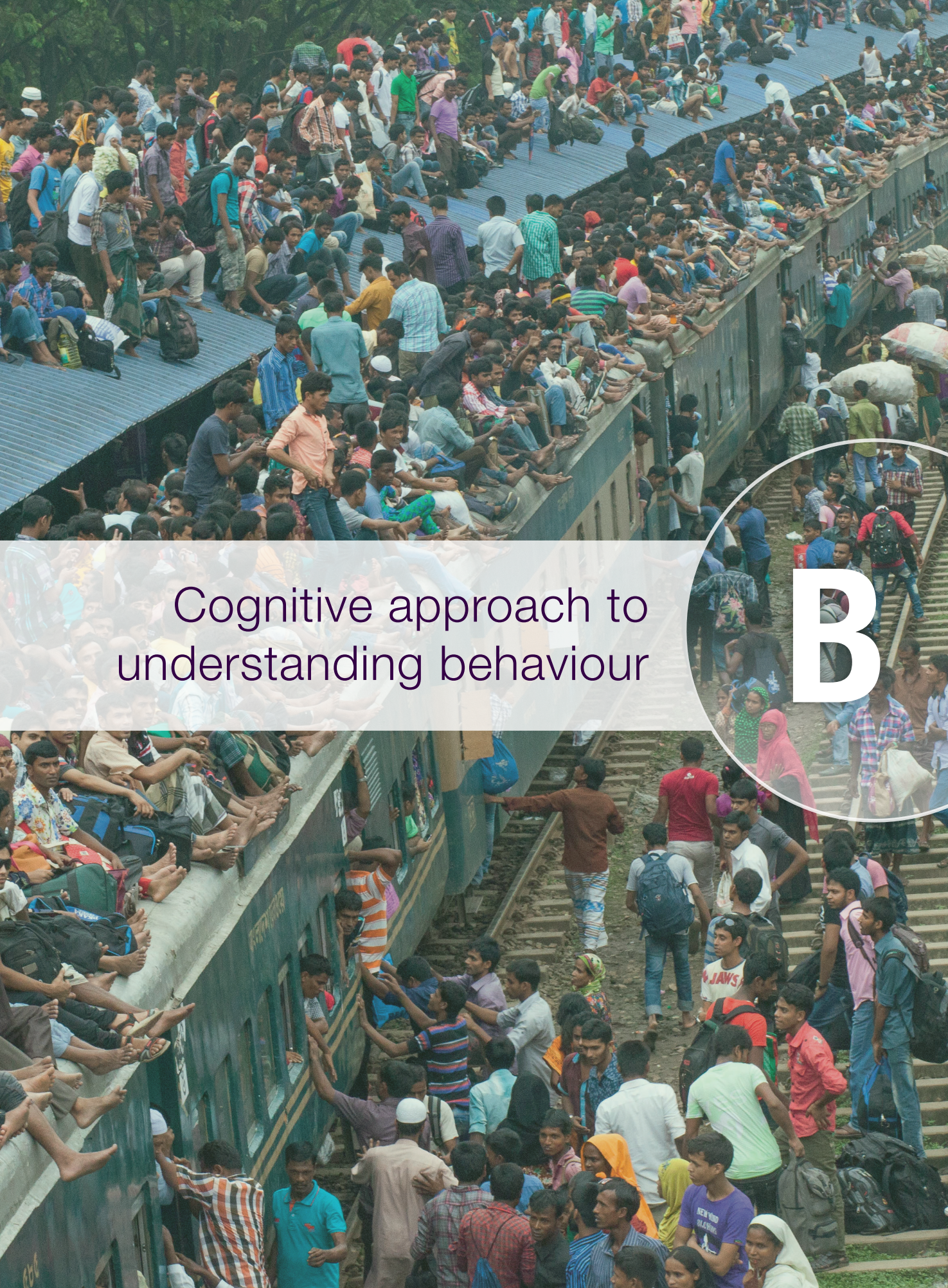


B

Cognitive approach to understanding behaviour

The cognitive approach to behaviour views human beings as processors of information in much the same way as a computer processes information. The cognitive approach to behaviour focuses on areas of research such as schema processing, memory processing, and thinking, and how cognition may influence behaviour. Researchers are also interested in the extent to which cognitive processes are reliable, for example, in relation to thinking and memory. How cognitive processes may be affected in the modern digitalized world is an emerging field within the cognitive approach to behaviour.

Cognitive processes are often influenced in complex ways by emotions. The influence of emotions on cognitive processes is studied not only by cognitive psychologists but is developing as an area of interest for cognitive neuroscientists as well as social psychologists.

Research methods in the cognitive approach to understanding of behaviour rely on experiments and brain imaging technologies as well as qualitative approaches to understanding everyday memory and thinking, making the cognitive approach an example of the holistic approach to understanding human behaviour.

The cognitive approach to understanding behaviour looks at:

- cognitive processing (SL and HL)
- reliability of cognitive processes (SL and HL)
- emotion and cognition (SL and HL)
- cognitive processing in the digital world (HL only).

7 Cognitive processing

Topic focus

To what extent can cognitive processes be used to explain behaviour?

7.1 Models of memory

Content focus

To what extent do the working memory model and the multi-store model represent human memory processes?

7.1.1 The multi-store model of memory

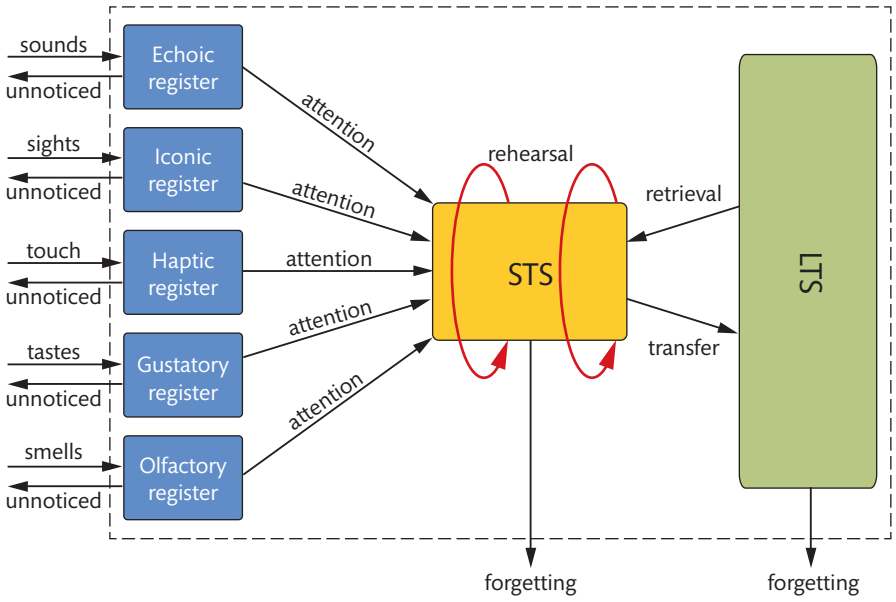
Atkinson and Shiffrin (1968) proposed a simple representation of human memory called the **multi-store model**. Their initial model comprised a group of sensory registers, each linked to the short-term store (STS), which is linked to the long-term store (LTS).

The multi-store model proposed a separate register for each of the senses.

The multi-store model proposed that when an environmental stimulus is detected, it is 'stored' very briefly in the appropriate sensory register (or buffer). If the information

in the sensory registers is given attention, it is passed to the STS where it may be rehearsed and then passed into the LTS. Once information has been transferred to the short-term memory, it can remain there for up to 30 seconds.

Information in the sensory registers that is not given attention, and information in the STS that is not rehearsed, quickly decays and is lost.



Use large, neat, and clearly labelled diagrams to support your written answers. Refer to the diagrams in your answers. Refer to at least one study to support your answer.

Figure 7.1 The multi-store model (Atkinson and Shiffrin, 1968)

According to the model, people detect many environmental stimuli (such as faces or sounds) during a day, and these stimuli are all captured in the sensory register. The model proposes a separate register for each of the senses: echoic register (sounds), iconic register (visual stimulus), haptic register (touch), gustatory register (taste), olfactory register (smell).

Redraw the multi-store model as a flow diagram highlighting the flow of information that gets stored in long-term memory and information that is lost or forgotten.

Atkinson and Shiffrin (1968) claimed that most information held in the sensory registers quickly decays and is lost, but information that receives attention is transferred to the STS. Attention, in the model's description, refers to 'noticing' in everyday language.

Only some of the environmental stimuli detected every day gets noticed; perhaps a face that looks unusual or familiar, the sound of the school principal's voice, or a catchy tune. If a stimulus is attended to (given attention) it is transferred from the appropriate sensory register to the STS. The rest, anything that does not get noticed, is not stored.

As you walk through the school corridor, try to pay attention to all of the material on the walls. When you get to the next classroom, immediately write down all of the things you saw on the walls. Do the walk again later and see what material you noticed and what you did not notice.

The model also proposed that information can be stored in a different mode to that in which it was first detected. For example, a sound (a spoken sentence) could be stored as a visual stimulus.

Information that is rehearsed sufficiently can be stored in the long-term or (relatively) permanent memory. The model proposes that the more the information is rehearsed, the stronger its position is in long-term memory. The model assumes that the long-term memory's capacity is limitless in both capacity and duration.

How reliable is memory as a way of knowing?

TOK

Evidence in support of the multi-store model

The Atkinson and Shiffrin (1968) model relied on hippocampal **lesion studies**, which showed that people with damaged hippocampal regions could create short-term memories, but not long-term memories. This showed that short- and long-term memory are distinctly different cognitive processes.

The hippocampus plays a significant role in the formation of long-term memories, i.e. the transfer of information from the short-term store to the long-term store.

Bekhterev (in Milner, 2005) showed that the medial temporal lobes have a role in memory formation. Bekhterev demonstrated that the brain of a patient who had shown severe memory impairment displayed significant 'softening in the regions of the uncus, hippocampus, and adjoining medial temporal cortex'. The strongest evidence supporting the hypothesis that the hippocampal region plays a role in memory formation came from studying patients who had developed **amnesia** after **ablation** surgery on the medial temporal lobe as a way of controlling certain types of epilepsy (Milner, 2005).

Most of Atkinson and Shiffrin's research focused on visual (seen) and aural (heard) stimuli, but the model also included a register for each of the senses including a gustatory (taste) store and a haptic (touch) store. Supporting this aspect of the model, D'Esposito et al. (2000) used fMRI images to show that the prefrontal cortex is involved in haptic memory.

Strengths of the multi-store model

Many memory-related studies, such as Glanzer and Cunitz's (1966) study relating to the **primacy and recency effect** and Scoville and Milner's (1957) studies relating to memory formation, are consistent with the multi-store model.

What are the implications of the multi-store model's process for remembering information presented during a lesson?

Limitations of the multi-store model

- The multi-store model describes rather than explains. It does not tell us why information is stored.
- The model suggests memory formation processes are grouped and distinct, but lesion studies have shown that memories are spread out through the brain.
- Memory formation processes are more complex than the model implies. The model does not account for how memories are stored based on their importance, nor does it account for the effect of emotion on memory.
- The model does not account for the type of information taken into memory. Some information seems to pass into LTS more readily than other information. For example, information that is emotional or distinctive in some way is also stored and retrieved more readily.
- Rehearsal alone is too simple to account for the transfer of information from STS to LTS; the model ignores factors such as effort and the strategies that people may use when learning; elaborate rehearsal methods lead to better recall than simple rehearsal.
- The model does not account for the process of forgetting; forgetting is seen as a by-product, rather than an active process.

- The model does not account for the retrieval process. Information storage is only one part of the memory process; in order to be remembered, information must also be retrieved, and this retrieval process must be more complex than represented in the model.

7.1.2 The working memory model

Baddeley and Hitch (1974) expanded this short-term aspect of the Atkinson and Shiffrin model, proposing a three-part working memory model that separates primary memory into three components: the phonological loop; the visuo-spatial sketchpad; and the central executive. In 2000, the model was expanded again to include an episodic register.

The phonological loop

The phonological loop stores sound-based content. According to the model, the phonological loop is made up of a short-term phonological (sound) store from which information can decay very quickly, and an articulatory rehearsal component that can revive or recall sound-based memories. The phonological store is thought to detect and receive sounds and the articulatory loop process repeats or rehearses the sounds, preventing decay. This phonological loop, or repetition/rehearsal process, likely plays a significant role in language acquisition.

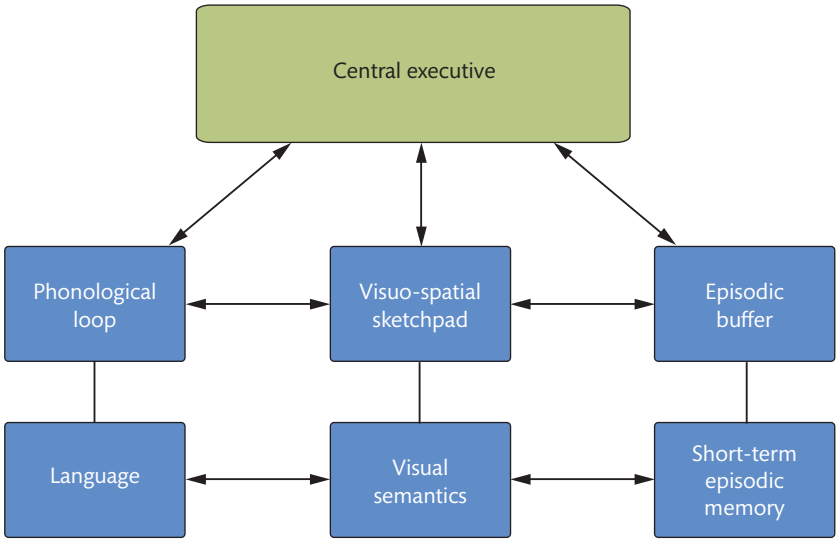


Figure 7.2 The three-part working memory model (Baddeley and Hitch, 1974)

The visuo-spatial sketchpad

The visuo-spatial sketchpad stores visual and spatial information. Mental images can be created, recalled, and manipulated as spatial tasks. The visuo-spatial sketchpad is made up of the spatial short-term memory, which remembers locations (i.e. where images are relative to each other); and the object memory, which stores objects' characteristics such as size, shape, surface texture, and colour (Logie, 1995).

The visuo-spatial sketchpad component of the model has been expanded to include a visual buffer (or cache) that stores information about objects' characteristics, and an inner scribe that rehearses information in the visuo-spatial sketchpad and passes it to the central executive for task processing.

The episodic buffer

The episodic buffer stores events or episodes made up of related information such as the sights, sounds, and chronologies associated with a particular event. This buffer is also assumed to link to the long-term memory. Baddeley (2000) found that patients who did not have the ability to form new long-term memories were able to recall stories, i.e. combinations of sights and sounds that would be too great to store together in the phonological loop.

The central executive

The central executive (CE) controls cognitive processes, including the flow of information. It combines information from different sources into episodes by coordinating the phonological loop, the visuo-spatial sketchpad and the episodic buffer. The CE also co-manages retrieval, attention, and inhibition.

Norman and Shallice (1986) proposed a model of the CE that split control of behaviour based on memories between two processes:

- the control of behaviour by habit patterns or schemas
- the control of behaviour by a supervisory activating system (SAS).

The split could be considered a way of applying minimal effort to controlling routine behaviours, leaving maximum energy for controlling non-routine behaviours.

Schemas are mental representations. They are practised or rehearsed, and so become memory by which future similar behaviour is controlled.

Schemas are mental representations. They are practised or rehearsed, and so become memory by which future similar behaviour is controlled. Evidence for some behaviour being controlled through the use of schemas and habits came from 'slips of action' such as getting out of bed on a Saturday morning and dressing for school rather than dressing for Saturday morning sports.

By contrast, the SAS monitors for unique or new stimuli and modifies general strategies to resolve new or unique situations. The SAS is relatively slow and deliberate and employs a range of strategies to solve unique or new problems.

Evidence supporting the existence of an SAS came from frontal lobe studies. Bayliss and Roodenrys (2000) studied the frontal lobes of children with **attention deficit hyperactivity disorder (ADHD)** who displayed many behaviours consistent with impaired CE functioning. The study applied Norman and Shallice's (1986) SAS as a model of the executive functioning that is impaired in ADHD. Fifteen children with ADHD were compared to a sample of non-ADHD learning disabled (LD) children and a group of children with neither ADHD nor LD. The groups were matched for age, gender, and IQ. The study used tasks that assessed inhibition or impulsive responding and found that the ADHD group was significantly impaired in comparison to the LD, non-LD, and non-ADHD groups. This study's findings supported the existence of the supervisory activating system and its role in controlling behaviour.

fMRIs of brain-damaged patients indicate that the phonological loop is associated with the brain's left temporal lobe while the visuo-spatial sketchpad is associated with the occipital lobe and the parietal lobe.

Location within the brain

fMRIs of brain-damaged patients indicate that the phonological loop is associated with the brain's left temporal lobe while the visuo-spatial sketchpad is associated with the occipital lobe and the parietal lobe. Research indicates the central executive is located

in the frontal lobes (Alvarez and Emroy, 2006). The episodic buffer is less isolated and associated with both of the brain's hemispheres, the frontal and temporal lobes, and the hippocampus.

7.1.3 Long-term memory

The multi-store model's long-term memory component has also been expanded upon by researchers proposing a split between explicit and implicit memories, each of which have subsequently been expanded.

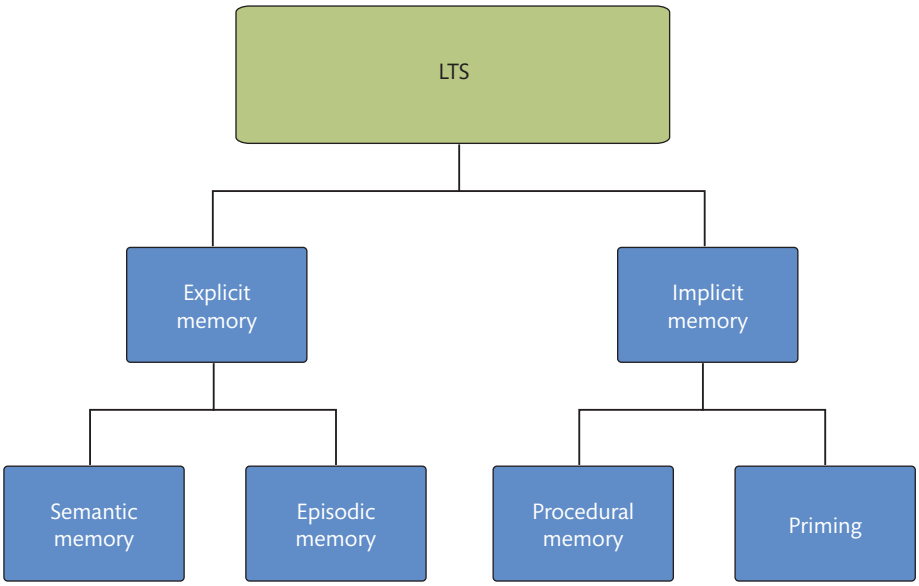


Figure 7.3 The expanded multi-store model of memory

Explicit memory

Explicit, or declarative, memories are memories that can be verbalized, such as a description of what happened while playing a game of cards or an account of driving through a city. Explicit memories tend to exist in a specific context. Tulving (1972) proposed two categories of explicit memory: **episodic memories**, which are events that happen to someone; and **semantic memories**, which are facts or details.

Episodic memories are actual and personal experiences from the past, such as a detailed description of what happened during a person's first day at school. They can also be called autobiographical memories. Tulving and others identified three key characteristics of episodic memory:

- a sense of time or mental time travel
- a connection to the self and the ability to create a personal narrative
- **autonoetic consciousness**, which means the ability to imagine ourselves in mentally-generated situations.

Semantic memories are non-specific information such as facts, ideas, meaning, and concepts, which are blended through personal experiences. For example, a semantic memory might be information about what a smartphone is, i.e. a screen, the physical design, weight, feel, and an operating system. Semantic memory is what allows people

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To what extent do models over-simplify reality and therefore become inaccurate?

to see a previously unseen smartphone and identify it as a smartphone. By contrast, episodic memory would be a memory of holding and using an actual smartphone.

Prince et al. (2007) used fMRIs and found: (1) the temporal lobes and the left hippocampus were associated with episodic memories, but not with semantic memories; (2) the lateral temporal cortex was associated with semantic memories, but not with episodic memories; (3) a more posterior region within the lateral intraparietal cortex was associated with semantic memories; (4) a mid-region was involved with both semantic and episodic memories; and (5) a more anterior region was associated with episodic memories, but only when semantic memories were also involved.

Create diagrams to show the approximate locations within the brain that seem to be associated with the different memory functions.

Implicit memory

Implicit, or non-declarative, memories are those that cannot be described. They tend to involve procedures such as how to eat a meal politely or how to write a job application letter. Similarly, an emotional response to a situation, such as reading a poem or listening to a song, cannot be accurately or objectively described and so is stored as an implicit memory.

Explicit, or declarative, memories are memories that can be verbalized or described. Implicit, or non-declarative, memories are those that cannot be described.

Two categories of implicit memory are proposed: procedural memory and priming (Tulving, 1972). Procedural memories inform or guide processes. They are automatically retrieved and used to execute cognitive and motor skills, such as reading and swimming. These memories are executed without conscious effort.

Priming is likely to happen after repeating or rehearsing perceptual, semantic, or conceptual stimuli. For example, if a person hears a list of words including 'computer' and is later asked to say a word starting with 'comp', they will be more likely to give the word 'computer'. Hearing the word 'computer' in the list has primed the brain for that response.

Initiate a discussion with friends or family about their significant memories and simply listen to their language – do they retell the event from their personal perspective, using 'I', 'my', and 'me' or do they retell the event from a social perspective using language such as 'we' and 'our'? Be careful not to make any cross-cultural conclusions about these responses because the people you interact with are most likely to be of your local culture and you will only consider a very small number of people.

7.1.4 Cross-cultural studies

Ismatullina et al. (2014) sought to determine whether there are cross-cultural differences in working memory. A spatial working memory task was given to 289 adolescents (aged 10–17 years old) from Russia and Kyrgyzstan. The study found no significant differences in working memory between the Russian and Kyrgyz participants, although working memory performance was greater in the older adolescent participants in each country.

Conway et al. (2005) conducted a content-analysis study on participants from Japan, China, Bangladesh, England, and the USA and found no cross-cultural differences in creating episodic (autobiographical) memories, although they did find that the content of memories was sensitive to the participants' different cultural influences. The Chinese participants' memories were of events that had a group or social basis, while the US participants' memories were of events oriented to the individual.

Studies have not shown significant cross-cultural differences in working memory or in creating episodic (autobiographical) memories.

7.2 Schema theory

Content focus

To what extent do schemas support our understanding of long-term memory?

Refer to studies to support your answers. Be cautious with **assertions** because, although schemas are well supported, they are not proven to exist, nor are they **universally defined**.

There are many theories of knowledge organization and schema theory is one of them. The way we process information or the way we act in specific settings is determined to a significant extent by relevant previous knowledge stored in our memories and organised as schemas. A schema is a cognitive structure that provides a framework for organizing information about the world, events, people and actions.

Schema theory assumes that people give meaning to new experiences by fitting them to mental representations (schemas) previously stored in long-term memory. Morton et al. (2017) proposed that schemas encapsulate the common features of events and so allow for predictions relating to new, similar situations.

There is little common agreement on a definition of schemas, (Sadoski et al., 1991). For this text though, schemas are defined as tools that allow information to be processed relatively quickly and with minimal cognitive effort. Alba and Hasher (1983) identified the following five processes incorporated into all schema theories.

- Selection – the process that selects information for storing and representing.
- Abstraction – the process that stores an event's meaning.
- Interpretation – the process through which background knowledge is used to help comprehension.
- Integration – the process by which a mental representation is formed.
- Reconstruction – the process that uses details from the event and general knowledge to refabricate the event.

A schema is a simplified mental representation of an event or situation. For example, many people have a mental image, or schema, of a typical office that includes typical office furniture and fittings. To demonstrate this, Brewer and Treyens (1981) asked participants to wait in a room that resembled a graduate student's office and later tested them for memory of the room's contents. Many participants said they had seen objects that would be expected in an academic's office, but were not there.

7.2.1 Effort after meaning

Bartlett (1932) referred to the 'effort after meaning' that people make to try to convert information that they cannot comprehend into a form that they can: '. . . it is fitting to speak of every human cognitive reaction—perceiving, imaging, remembering, thinking, and reasoning—as an effort after meaning' (Bartlett, 1932, cited in Roediger, 2003). The tendency to use metaphors and similes in language, such as describing someone as 'quiet as a mouse', is an example of 'effort after meaning'.

As people experience the world through their perceptions they store new events in long-term memory, but then apply past knowledge to try to make better sense of

these new events. This can mean that experiences are changed after they have been memorized so that they are more sensible to us.

For example, if a van arrives at a neighbour's house and a person wearing blue overalls walks from the van to the house, then ten minutes later returns to the van and leaves, this episode is likely to be stored by the neighbour who saw it. Soon afterwards though, 'effort after meaning' is likely to distort the event when it's retold. Perhaps the van becomes a service vehicle and the person who went into the house becomes a pest exterminator.

A schema is a mental representation of an event. Details that do not fit into the general mental representation may be deleted (forgotten) or adapted (changed) to match the schema.

Schema theory proposes that details that do not fit into the general mental representation may be deleted (forgotten) or adapted (changed) to match the schema. Bartlett (1932) found that when asked to retell the War of the Ghosts, a Native-American legend, some Cambridge University (UK) participants seemed to adapt it to fit the more culturally familiar fairy-tale schema, beginning their retelling with 'once upon a time' and ending it with a moral of the story.

Key study: Bartlett (1932)

Aim: To determine if recall from memory is affected by schema.

Procedure: An unstated number of Cambridge University students, male and female, were instructed to read a Native American story twice. The story included a number of cultural references. Fifteen minutes later, the participants were asked to recall and retell the story. The participants were asked to retell the story again some time later (for some participants this second delay was weeks, for others it was months or years).

Findings: The participants remembered the global idea of the story but changed unfamiliar elements, such as using the word kayak instead of canoe. The remembered story was shorter than the original and tended to have the supernatural elements removed.

Conclusion: Recollections or memories are not accurate copies, but reconstructions of the original stimuli. These reconstructions can be influenced by people's schemas.

Evaluation: The procedure was conducted in relatively uncontrolled conditions and so lacks ecological validity. The rehearsal phase was not overseen by the researchers so there is no way to be sure that rehearsal happened as per the instructions. The participants did not receive standardized instructions. The study was conducted with Cambridge University (UK) students in about 1915 (the study was published in 1932 in a book rather than a peer-reviewed journal), so its conclusion may not generalize/transfer to the general population today.

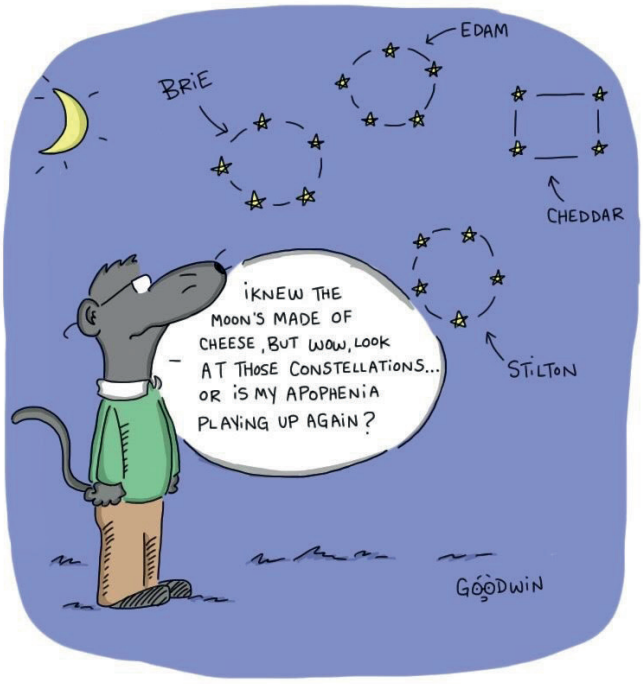
Identify the research method employed in Bartlett's (1932) War of the Ghosts study. Explain your answer.

To what extent has research such as Bartlett (1932) been influential, despite being based on weak methodology? Is Bartlett (1932) a case of 'Argument from False Authority'?

7.2.2 Pattern recognition

Pattern recognition is an example of schema theory in action. A pattern can be any recognizable set of external stimuli, such as a short piece of music associated with a television advertisement, a person's facial features, components of language, or the grimacing mouse character in this book's cartoons. Any newly detected external stimuli are recognised against previously stored information.

Gestalt psychology is largely based on the concept of forming global wholes from collections of separate elements, such as interpreting a simple stick figure as a person. **Apophenia** is the irrational tendency to recognise patterns that do not exist, such as faces in burnt toast, the man in the moon, and the ancient Greeks' constellations.



7.2.3 Stereotyping

Stereotyping is an example of a schema based on a mental representation of a group of people. Stereotypes are simplified generalizations about identifiable groups. Examples of gender, nationality, race, and sexuality stereotypes abound. Stereotyping of groups of people is the basis of racism, homophobia, xenophobia, age and gender discrimination, and profiling.

Tao et al. (2016) used a self-report questionnaire and found that 'middle-class' Chinese had formed stereotypes about the rich and poor that focused on competence, sociability, and morality. Rich people were seen as highly competent, having low sociability and bad morals, while poor people were seen as being incompetent, with 'average' sociability and good morals.

Key study: Tao et al. (2016)

Aim: To investigate stereotypes about rich and poor Chinese people.

Procedure: One hundred and fifty-two participants (69 males, 83 females, aged 20–47) were selected from 28 professions and from 24 cities and provinces including Beijing, Shanghai, Tianjin, Guangxi, Heilongjiang, Jiangxi and Hunan, with annual household income 80 000–350 000 RMB. The researchers considered this sample to comprise 'ordinary people in China, not belonging to the rich or the poor'. The participants were instructed to write ten adjectives to describe poor and rich people. The sequence was balanced: half the participants were asked to write about rich people first and the other half wrote about poor people first.

Ask people to draw a simple but actual object, for example the cup they are using or the book they are looking at. Observe whether they draw 'the' object or a mental representation of the object, i.e. 'a' cup or 'a' book. To what extent is this an application of schemas?

Stereotyping is an example of a schema based on a mental representation of a group of people. Stereotypes are simplified generalizations about identifiable groups of people.

Findings: The researchers filtered out non-adjectives to yield 1317 adjectives for rich people and 1399 for poor people. Rich people were commonly described as 'intelligent, self-confident, motivated, hard-working, active, knowledgeable, flexible, and innovative'. Adjectives associated with poor people were 'uneducated, conservative, pessimistic, lazy, low-capacity, hard-working, and strong'. The researchers separated the adjectives for sociability and in this respect the rich were described as arrogant, supercilious, hypocritical, indifferent, and showing off. They were said to have good communication skills, but they developed relationships calculatingly, for material gain. On the sociability dimension, the poor were described as 'warm, kind, tolerant and displaying affinity, willing to help others, but vain and impulsive'.

Conclusion: The study concluded that stereotypes about rich and poor people can be viewed on three dimensions: competence, sociability, and morality. Rich people were considered highly competent, having low sociability and bad morality. Poor people were seen as incompetent, with average sociability and good morality.

Evaluation: The participants were selected and balanced for gender and socioeconomic status. The method was a free-report questionnaire and so the researchers did not affect the participants' choice of adjectives by giving a list of their own. The study is very recent and so has not lost validity over time. The study focused on Chinese people only, so the findings may not transfer to wider populations. The inherent weakness of questionnaires is participant unreliability, e.g. **demand characteristics**.

7.2.4 Evaluation of schema theory

Strengths

Schema theory helps to understand stereotyping, prejudice, discrimination, and inaccurate or unreliable memory.

Limitations

Schemas have not been universally defined and so schema theory is based on a fundamental concept, the meaning of which has not been universally agreed upon by researchers.

Schema theory describes but does not explain how and why schemas are formed. The theory does not explain why information that does not match a person's schemas can be forgotten or distorted to match schemas.

If you watch television or movies, identify stereotypes associated with nationality, sexuality, gender, or age.

Do not mistake several weaknesses but only one strength as meaning a theory is weak. One strength may outweigh several weaknesses. Cautious and conditional conclusions that use language such as, 'it seems that...' are more appropriate than definitive statements.

7.3 Thinking and decision making

Content focus

Evaluate one model of thinking and decision making.

7.3.1 Systems of thinking

Thinking and decision making research frequently refers to two distinct types of thinking and decision making: rational (logical, careful, controlled) and intuitive

(automatic, impulsive, emotion-driven). It is widely believed that rational thinkers give the time and effort needed to make correct decisions, while intuitive thinkers tend to make impulsive and emotion-driven decisions and are therefore less likely to make correct decisions.

Phillips et al. (2016) conducted a **meta-analysis** to determine whether intuitive or rational thinking is more likely to result in accurate decision making. With a combined sample of 17 704 participants from 89 studies, their meta-analysis found no significant difference in the accuracy of decisions made using either intuitive or rational thinking, suggesting that people apply the most appropriate thinking style to decision making situations.

Thinking, fast and slow

Kahneman (2011) proposed a model of thinking made up of two types of thinking: System 1 thinking and System 2 thinking.

System 1 thinking	System 2 thinking
relatively fast	relatively slow
intuitive	rational/logical and therefore calculated
emotional	purposeful
seemingly automatic	requiring more cognitive effort and therefore time
requiring minimal cognitive effort	less influenced by prejudice, bias, and schemas
influenced by bias and perhaps schemas	uses reasoned beliefs and choices to slowly reach a less simple representation of reality
uses associations and metaphors to quickly reach a simple representation of reality	

System 1 thinking can manage these relatively simple cognitive tasks:

- compare and contrast objects
- identify the source of a sound
- complete a common phrase such as 'as quiet as a . . .'
- display an emotion in response to a stimulus, such as smile at a funny cartoon
- solve simple maths problems such as 'the square root of 16'
- read text on signs.

System 2 thinking can manage these more demanding cognitive tasks:

- prepare to dive into a swimming pool
- direct attention to one actor on a stage of many actors
- look for a person who has been described in an airport arrivals area
- recognize a familiar voice
- determine appropriate behaviour in a social setting
- evaluate several similar products, such as smartphones
- interpret a logical conundrum.

Initiate a discussion with friends and list ten decisions that were taken by prominent world figures such as heads of very large companies, religious leaders, or government leaders. Suggest whether the decisions were made spontaneously by the person or by a consultative process, i.e. with other people.

Key study: Tversky and Kahneman (1983)

Aim: To test whether people mistake representativeness for similarity.

Procedure: Eighty-eight US statistically naive (undergraduates), informed (graduates) and sophisticated (PhD candidates) participants completed a questionnaire. They were asked the following question: Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Which is more probable?

- Linda is a bank teller.
- Linda is a bank teller and is active in the feminist movement.

Findings: A significant percentage (almost 90 per cent) of the participants answered the questionnaire incorrectly by stating that Linda was more likely to be a bank teller and active in the feminist movement.

Conclusion: Naive, informed, and even sophisticated users of statistics were inclined to make incorrect decisions, indicating System 1 thinking overrode System 2 thinking. Quick, intuitive, perhaps emotion-driven thinking made the respondents answer that it is more likely that Linda is both a bank teller and a feminist than just a bank teller. This is an example of the conjunction fallacy: that specific conditions have a higher probability than a single general condition.

Evaluation: The study has a number of weaknesses. The participants were not a representative sample of the general population. The study was conducted on students from the US in two US universities. If the study was carried out in cultures where statistics and probability are more prominent in the school curriculum the results could be different. For example, one of the participants, when shown the statistical error responded with, 'I thought you just asked for my opinion' (Kahneman, 2011). The study's main strength is that it has been replicated many times with similar results.

Use the internet to investigate Nobel Laurete Richard Thaler and his work relating to apparently irrational decision making. To what extent are these seemingly irrational decisions likely to be culture-bound or culture-affected? Would the findings of these studies apply in all cultures?

7.3.2 Irrational thinking and decision making

The large body of work by Kahneman and Tversky on flawed, illogical decision making is supported by other researchers. For example, Kivetz and Simonson (2002) asked 85 Americans aged 18 to 80 whether they would prefer a lottery prize of $55 in cash or a $50 bottle of wine. They found that 24 participants (i.e. 28 per cent) chose the wine rather than the cash. The study concluded that people made the seemingly irrational decision of choosing the wine, even though if they had chosen the cash they could buy the wine and have $5 extra, because if they won the $50, they would spend it on a necessity rather than a luxury.

Framing

Tversky and Kahneman (1981) explored how the phrasing of a choice affected decision making outcomes. Framing refers to the way a statement is presented, for example whether the focus is on loss or gain.

In their study, participants were asked to choose between two health programmes for 600 people with a potentially fatal disease. Treatment A was expected to result in 400 deaths; Treatment B had a 33 per cent probability of no deaths and a 66 per cent probability of 100 per cent deaths. This choice was presented to participants framed either positively (focusing on how many patients would live) or negatively (how many would die).

Seventy-two per cent of participants chose Treatment A when it was framed positively (it saves 200 lives) but only 22 per cent chose the same treatment when it was negatively framed (400 people will die).

Loss aversion

Kahneman and Tversky (1984) demonstrated people's tendency to choose to avoid losses rather than make equivalent gains. For example, most people seemed to prefer not to lose $10 over finding $10, even though logically they amount to the same thing and so there should be no significant preference shown either way. Critics of this study have suggested it is the way the problem is stated, i.e. simply framing with a money focus.

Peters et al. (2006) showed that highly numerate people make more accurate decisions than those with poor numeracy skills. This suggests that the poor (i.e. inaccurate) decision making demonstrated in some studies and attributed to decision making biases may simply be the result of a poor understanding of statistics and probability.

7.3.3 Cultural considerations

Strohschneider (2002) considered the effect of cultural factors on decision making by using the results of two empirical studies that investigated complex decision making by participants in India and Germany. According to Strohschneider (2002), thinking

Initiate an informal discussion, perhaps at lunchtime, asking whether people think different cultures have different decision making styles or strategies. You may have to explain that 'culture' is not the same as race or nationality.

toward decision making is not an innate skill, i.e. we are not born with this ability; it must be learnt through value systems, family practices, socialization practices, and patterns of schooling.

Strohschneider (2002) found that there are culture-specific decision making processes, developed according to the environment's functional requirements. Differences in predictability and certainty lead to differences in the 'strength' of decisions, or decisiveness. The cost of incorrect decisions, attitude toward risk and assertiveness are all likely to differ across cultures and lead to different decision making styles.

7.3.4 The influence of emotions on thinking and decision making

The relationship between emotions and decision making is bi-directional: emotions affect decision making and decision making affects emotions.

There is a tendency for people to associate their current mood or the emotions they are feeling when a decision is being made with the decision's outcome (Clore and Huntsinger, 2007). Johnson and Tversky (1983) found that happy people tend to overestimate the probability of positive results, and the opposite tendency for sad people. Happy people tend to adopt a top-down, or heuristic, processing strategy with a heavy dependency on pre-existing knowledge and schema, and little reliance on the current situation's details – consistent with Kahneman's System 1 thinking style. Lerner and Keltner (2000) found that fear resulted in pessimistic decisions and anger resulted in optimistic decisions.

Does fear help or hinder decision making effectiveness?

If the hormones associated with being in love are similar to those associated with OCD, does love help or hinder thinking and decision making?

To what extent are thinking and decision making theories culture-bound?

The relationship between emotions and decision making is bi-directional: emotions affect decision making and decision making affects emotions.

Fenton-O'Creevy et al. (2012) used heart rate variability data to investigate the influence of emotions on the decision making of investment bank traders in London and Copenhagen. The study focused on thinking and decision making in a real-world situation. With the large sums of money and high risk involved, financial trading is a job that most would expect relies on rational thinking, but many of the participants' (traders') decisions had to be made relatively quickly. Fenton-O'Creevy et al. (2012) used interviews with the traders and their managers, and concluded that antecedent-focused, emotional strategies (Kahneman's System 1 thinking) achieved better decision making outcomes than strategies that were response-focused (Kahneman's System 2 thinking).

8 Reliability of cognitive processes

The process of encoding, storage and retrieval is still not well understood. Be cautious in how you use terms such as short-term and long-term memory. Be similarly cautious when referring to schemas because there is not a universally agreed definition of schemas.

Topic focus

To what extent are cognitive processes reliable?

8.1 Reconstructive memory

Content focus

Discuss the reconstruction of memories.

8.1.1 Constructing and deconstructing memories

The construction of memories is a complex process. Memories are not simply bundles of recordings that can be replayed like a file on a smartphone. They are not constructed of just images and sounds, but also traces of semantics and emotions. The memory construction process works by encoding sense perceptions such as sound, touch, and sight, with emotion and semantics.

The concept of **engrams**, or memory traces, was first proposed by Richard Semon (1859–1918) and subsequent research showed there is not one single brain location where complete engrams are stored. Instead, memories are deconstructed into several engrams, each possibly stored in different locations in the brain, which together make up a memory. These traces are rebundled or reconstructed when the memory is recalled.

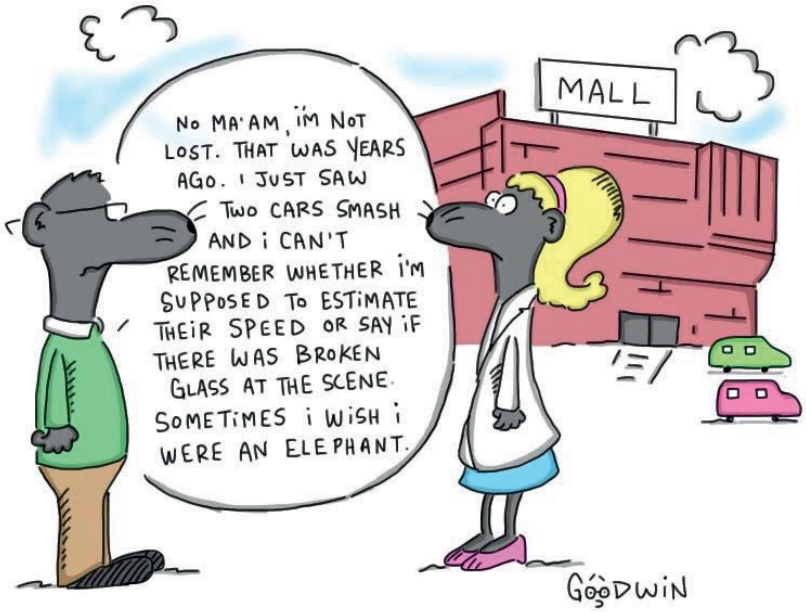
Stark et al. (2010) used fMRIs to show that memories are reconstructed from fragments of information previously encoded into memory (Semon's engrams) and that these are reactivated at retrieval. The study showed that the auditory cortex was active during the retrieval of auditory information and the visual cortex was activated when visual information was retrieved.

It is during the reconstruction process that errors such as false memories, **confabulation** and schemas can occur. In general, true information and false memories showed similar brain activation in the fMRI studies of Stark et al. (2010).

8.1.2 False memories

A false memory occurs when a person 'remembers' something that simply did not happen, although they believe it did. False memories must not be confused with repressed memories, which were proposed by Freud and thought to be associated with childhood trauma and are described as memories that an individual refuses to recall. There is no evidence to support the existence of repressed memories.

False memories are believed by the person to be true accounts.



Ramirez et al. (2013) showed that it is possible to create an inaccurate memory of a fearful event in mice. The researchers created a false memory in mice by **optogenetically** manipulating memory cells in the hippocampus. Optogenetics is a technique that uses light to control living cells, in this case neurons. In the study, neurons were activated and later optically reactivated. Mice were deceived into recalling and therefore reacting to an electric shock that did not occur. The results showed that recall of a false memory was context-specific and could also initiate a fear response. The study showed that it is possible to generate an internally represented and behaviourally expressed fear memory artificially.

Loftus (1996) used the 'lost in the mall' technique to determine if false memories can be created in participants. Over the course of several days, one participant was told a convincing story by several family members of being lost in a shopping mall and found by an elderly man. Not only did the participant 'remember' the event when later questioned about it, he added new details to it. Loftus (1996) found that about 25 per cent of participants can be made to create a false memory of an event during their childhood.

Pezdek and Hodge (1999) used the same 'lost in the mall' technique with 19 5–7-year-old children and 20 9–12-year-old children to determine whether children can have false memories planted or created. The children were read descriptions of two events: (1) a plausible event (being lost in a shopping mall); and (2) an implausible event (receiving a rectal enema), each said to have occurred when the children were 4 years old. Neither event actually happened. Fifty-four per cent of the 39 children did not remember either event. Twenty-four per cent of the children remembered the plausible event, but not the implausible event. One of the 39 children remembered the implausible event, but not the plausible event. Three of the children, all in the 5–7-year-old group, remembered both being lost in a shopping mall and receiving a rectal enema.

Key study: Loftus (1975)

Aim: To test whether a false presupposition can affect a witness's answer to a later question about that presupposition.

Procedure: Forty undergraduate University of Washington students were shown a short video recording, showing a group of eight students disrupting a lesson. After watching the video recording, the participants were given one of two questionnaires, each containing 19 filler questions and one key question. Half of the participants were asked, 'Was the leader of the four demonstrators who entered the classroom a male?' The other 20 participants were asked, 'Was the leader of the 12 demonstrators who entered the classroom a male?' One week later the participants answered another questionnaire. The key question was, 'How many demonstrators did you see entering the classroom?' They were asked to answer from memory rather than inference.

Findings: Ten per cent of those participants who were prompted with 12, answered '12' and 10 per cent who were prompted with four answered 'four'. The mean response for the group prompted with four was 6.4 while the mean response from the group prompted with 12 was 8.85.

Conclusion: A question that contains false numerical data can affect an eyewitness's answer to a question about that data.

Evaluation: The study was conducted under controlled conditions, meaning many environmental variables were controlled, and therefore shows that information that has been stored in the memory can be changed in the reconstruction process. The participants are representative of a narrow socioeconomic slice of the population. No information was given about the participants' gender, sociocultural background, or age, which means we must be cautious about generalizing the study's results to wider populations. It is difficult to be sure whether participants' responses were manipulated, perhaps through demand characteristics, or whether memory reconstruction was affected.

8.1.3 Confabulation

Confabulation is an error of memory reconstruction because it involves fabricated or distorted narratives, especially about the individual. People who confabulate are not deliberately or consciously dishonest. Inaccurate memories can be subtle or grandiose and the individuals are usually very confident about their memories.

Benson and Ardila (1996) reported a patient who recounted detailed accounts of conversations with physicians who she had never met, and accounts of trips she had made that had not happened. Confabulation seems to be associated with under-development or degeneration, or with brain damage, and is symptomatic of Alzheimer's disease, brain damage, dementia, and Korsakoff's syndrome (Johnson and Raye, 1998).

8.1.4 Schema processing and errors in memory

Schema processing, described earlier in this chapter, can also be a source of errors in memory, both in the construction of memories and their retrieval. Schemas are simplified mental representations. Jean Piaget proposed that information is **assimilated** or moulded with previously learned information to make sense of it. Piaget also proposed the concept of accommodation, a cognitive process in which pre-existing information is altered to accommodate new information. Piaget and Cook (1952) proposed that accommodation and assimilation work simultaneously, altering new and existing memories to assist memory construction.

For example, if a person has childhood memories of an enjoyable family holiday in Fiji, he or she is likely to assimilate new information, perhaps a television documentary about Fiji, to fit this generally positive schema or mental representation of Fiji. It is likely that subsequent memories of that television documentary will be generally positive. The existing schema is also likely to accommodate new information from the documentary, perhaps details of dangerous hurricanes or military coups, so that the schema is slightly altered, slightly less 'cheerful' perhaps. Schemas and schema processing, accommodation and assimilation result in errors of both memory construction and retrieval.

8.1.5 Implications of the unreliability of memory

There is little doubt that human memory is unreliable, and this can have significant implications.

People being interviewed for jobs are often asked to recall details about their previous work or their studies. It is clear from research that memory is unreliable, and interviewers should be aware that inaccuracy in memory recollection is not the same as deception or dishonesty.

Eyewitness accounts of historical events, such as the Yugoslav War, the Fukushima earthquake, or the 2004 tsunami around the Indian Ocean, are often vivid, emotional, and compelling, but research shows that they may not be very accurate and other evidence should also be used to verify people's accounts of events.

Eyewitness testimony is often thought to be accurate, but numerous studies and an increasing number of legal cases that use CCTV evidence or DNA testing have shown the opposite. In 1984, in Maryland USA, Kirk Bloodsworth was convicted of rape and murder and was sentenced to death. Five eyewitnesses testified that they had seen Mr Bloodsworth with the victim, at or near the crime scene at the time of the murder. After almost nine years in prison, DNA testing established Mr Bloodsworth's innocence, showing that the five eyewitnesses' testimonies were inaccurate.

If false memories can be created, can memory be a reliable way of knowing?

TOK

While not being able to remember what we ate for dinner three days ago may seem trivial, inaccurate eyewitness accounts can have significant consequences for many people.

8.2 Biases in thinking and decision making

Content focus

To what extent do biases in thinking affect the accuracy of decision making?

Kahneman and Tversky are clearly experts in thinking and decision making research but be aware that their work is mono-cultural and so it may not be possible to transfer their conclusions to wider populations. Be cautious when describing all studies' results and generalizing their conclusions.

Biases are normal human tendencies to think in certain ways, often contrary to, or without considering, evidence. Humans are irrational thinkers, relying on intuition or inaccurate cognitive processes that result in biases. Factors involved in biased thinking and decision making include the use of inappropriate thinking styles such as was discussed with Kahneman's System 1 and System 2 thinking, heuristics, algorithms, framing and representativeness, as well as cognitive biases.

8.2.1 Heuristics

Heuristics are simple decision making rules that people use to make decisions efficiently, i.e. with minimal cognitive effort. They usually focus on one of many aspects of a decision making situation, ignoring the rest. For example, given the complexity of technical specifications, pricing structures, and the opinions of friends, some people choose to just buy the latest model of a popular brand of smartphone rather than conducting their own research into the best option. Normally this works well enough, which is why people tend to use heuristics in complex decision making situations.

Heuristics are simple decision making rules that people use to make decisions efficiently.

Tversky and Kahneman (1974) demonstrated three heuristics that hinder effective thinking and decision making: anchoring and adjustment, representativeness, and availability.

Anchoring and adjustment

Anchoring and adjustment is a heuristic that begins with a statement or suggestion to influence a person's subsequent decision. For example, if a person is asked whether Te Rauparaha (a Māori chief) was more than 100 years old when he died, they are more likely to estimate his age at death as higher than if the same question were asked with the age 35 instead of 100. The anchoring and adjustment heuristic has been used in promotional activities such as signs stating, 'limit 12 per customer', which tends to result in people buying more than if the signs state, 'limit six per customer'.

Caverni and Péris (1990) conducted an experiment in which 48 teachers (participants) were given sets of students' essays to be graded along with a list of the students' fictional grades. The higher the mean of the fictional grades, the higher the grade given by the teachers for the essays they graded. The fictional grades were the teachers' 'anchors'. They affected the teachers' judgement and the distorted grade given was the 'adjustment' or the changed behaviour.

Representativeness

Tversky and Kahneman (1974) identified the 'representativeness heuristic': when people mistake representativeness with likelihood or probability. For example, John lives in a medium-sized city with a university and is described as logical, unemotional, and interested in patterns. If research participants are asked whether John is more likely to be a doctor, a police officer, or a mathematics professor, most predict that he is a mathematics professor even though the percentage of mathematics professors in the population is less than 1 per cent while the percentage who are police officers is closer to 5 per cent.

Like all heuristics, the representativeness heuristic is used because it is simple and so demands less cognitive effort than logically thinking through calculations.

Availability

The availability heuristic is the error of mistaking readily available examples as the typical sample. Tversky and Kahneman (1974) explained the heuristic as the ease with which examples come to one's mind. For example, if several close friends and family members suffer from heart disease in their mid-fifties, the availability heuristic would lead to the conclusion that many or most people in their mid-fifties suffer heart disease.

This has been tested by researchers asking participants if there are more words starting with an 'm' than words with 'm' as their third letter. It is easier, i.e. it requires less cognitive effort to think of words beginning with an 'm' than thinking of words with 'm' as the third letter (Gilovich and Griffin, 2002). As a result, people tend to say there are more words that start with an 'm' than have 'm' as their third letter.

8.2.2 Confirmation bias

Confirmation bias is a broad term to describe what occurs when people select or interpret information to confirm their existing knowledge, including the tendency to interpret ambiguous information so that it supports their existing ideas or beliefs. Confirmation biases contribute to the formation and strengthening of schemas and stereotypes.

Think of a recent decision you made. With the advantage of hindsight, would you describe the decision as accurate? How did you make the decision? Slowly and carefully, using a lot of cognitive effort? Or quickly?

To what extent is confirmation bias a cross-cultural or a culture-bound behaviour?

Confirmation bias tends to result in overconfidence in personal beliefs, even when contrary evidence is presented. People tend not to search for, and even avoid or deny, information that would contradict a belief and therefore show decisions based on these beliefs to be incorrect (Koriat et al., 1980). Confirmation biases are often present in poor decision making.

Snyder and Swann (1978) provided participants with information about another person that strongly suggested the other person was either an **extrovert** or an **introvert**. Participants were instructed to select questions to ask the person to test the hypothesis that the person was extroverted or introverted. Participants tended to seek information that supported the hypothesis. The study also found that when interviewees were asked questions that confirmed the hypothesis, they tended to behave in ways that also confirmed the hypothesis.

8.2.3 The illusory correlation

The illusory correlation describes the conclusion people reach when they decide that events occurring at the same time are related, sometimes going as far as stating that one event causes the other. For example, a student who did well in a test when writing with a pencil may conclude that writing with a pencil caused the success.

The illusory correlation likely plays a role in stereotype formation (Peeters, 1983). Often, when behaviour is negative (such as crime) and the group is of a clearly identifiable minority (such as immigrants), negative stereotypes are formed and strengthened. This is because the two factors (the crime and the minority) both seem significant and the casual observer assumes they are related.

8.2.4 Implicit personality theories

Implicit personality theories relate to people's understandings about which personality characteristics they think co-occur in others. For example, if a person observes someone else acting in a quiet, reserved way and considers reserved behaviour to be related to intelligence, then the observer will probably conclude that the shy person is intelligent.

Implicit personality theories relate to people's understandings about which personality characteristics they think co-occur in others.

The halo effect is the false correlation of positive characteristics, i.e. the assumption that someone who has a few positive characteristics has many. A halo effect is sometimes associated with physical attractiveness: people tend to assume that physically attractive people have other positive characteristics. Verhulst et al. (2010) found attractiveness and familiarity to be strong predictors for selecting people for leadership roles. Palmer and Peterson (2012) found that even after factual knowledge is considered, candidates that voters rated as more attractive were still considered more knowledgeable. The halo effect, then, is thought to have an effect on how political candidates are elected.

Key study: Zebrowitz and McDonald (1991)

Aim: To investigate the effect of plaintiffs' and defendants' facial appearance on decisions made in a small claims court.

Procedure: Twenty-five decisions relating to 506 cases were observed in a Massachusetts small claims court. Fifty-one per cent of the cases were presided over

by three judges and the rest by 22 judges. Two observers independently rated the plaintiffs' and defendants' appearance. Seventy-two per cent of the plaintiffs and 78 per cent of the defendants were male. Ninety-six per cent were white and 81 per cent were between 21 and 50 years old.
Results of cases were obtained from court records by a different researcher. The appearance ratings were compared with the case outcomes.

Findings: The greater a plaintiff's physical attractiveness, the more likely defendants were to lose the case.
As a defendant's rating of baby-facedness increased, the more likely they were to win cases involving intentional behaviour, and more likely to lose cases involving negligence.
As the rating of a defendant's facial maturity increased, the greater the monetary awards were to baby-faced plaintiffs.

Conclusion: The study concluded that the outcome of a small claims court case is correlated with the plaintiff's and defendant's facial attractiveness and a halo effect is evident.
The study also measured for a possible correlation between nine other variables such as height, weight, clothes, and whether the defendant/plaintiff wore glasses, and no correlation was found.

Evaluation: The study's conclusion is reasonably robust: a halo effect, i.e. a positive correlation between attractiveness and innocence is apparent.
No information about the judges, i.e. gender, age, or experience, is included in the study. The study's participants are the judges because it is the relationship between the litigants' appearance and the judges' decision making that the study investigated, so the omission of the participants' characteristics is a serious limitation of the study.
The study was limited to Massachusetts and the subjects within the study were a fairly homogeneous group – predominantly white, male, and middle-aged – and so the conclusion cannot be widely generalized. The study did not conclude a cause-effect relationship, simply a correlation.

Zebrowitz and McDonald (2012) investigated whether the halo effect is a cross-cultural phenomenon by comparing judgements made by US judges and decision making by Tsimané people living in the Bolivian rainforest. The study found that a within-culture halo effect was present in decision making by Tsimané people, i.e. the attractiveness rating was culture-bound, but the correlation of attractiveness and favourable decision making is cross-cultural.

8.2.5 Algorithms

An algorithm is a step-by-step approach to reaching a conclusion. Algorithms are often associated with mathematics and computer coding. The same methodical approach can be applied to problem solving or decision making. Algorithms are often described graphically with squares representing each step in the path to an accurate decision. Sometimes there is a simple one-path set of steps, and in other situations there are alternatives to be considered when coming to a decision.

Draw a flow diagram that represents the algorithm used to calculate the mean of a set of people's heights rounded to the nearest centimetre.

Draw a flow diagram that represents the algorithm used by a doctor to determine an unwell patient's diagnosis.

Algorithmic thinking has been applied to medical diagnostic decision making and to procedures for aircraft pilots, so that the most accurate and efficient decision making process can be applied in critical situations to reach the best outcome every time. Algorithms are often contrasted with heuristics, which involve cognitive shortcuts and do not always achieve accurate outcomes.

9 Emotion and cognition

Topic focus

To what extent are emotion and cognition related?

9.1 The influence of emotion on cognitive processes

Content focus

Discuss the role of emotion in one cognitive process.

Be cautious when you write about causes and effects, because emotion and cognition are intertwined: emotions affect cognitive processes and cognitive processes affect emotions.

There was a time when science considered emotion and cognition to be separate, but there is now evidence showing brain areas and psychological processes that are commonly associated with cognition. For example, the dorsolateral prefrontal cortex and working memory are strongly associated with emotion. This research shows that emotion and cognition are interwoven.

Emotions such as stress and anxiety influence cognitive activities such as selective attention, working memory, and cognitive control (Pessoa, 2013). Other research, for example Ochsner and Gross (2007), has shown that the neural activity associated with cognitive activities is involved in the regulation of emotions.

9.1.1 Valence theory

Valence refers to the inherent positiveness or negativeness of an event, object, situation, or emotion. Emotions with a negative valence include disgust and fear, while emotions with a positive valence include happiness and love. Emotions that are positively valenced are produced by events or situations that are similarly valenced. The valence approach proposes that emotions with the same valence have a similar effect on decision making.

Emotional reactions help people manage and respond to difficult situations, often when that person is experiencing stress. Emotions perform an adaptive function by motivating people to act quickly and take action that maximises the likelihood of survival.

Darwin (1872) proposed that emotional states are adaptive, and only those who can express certain emotions can pass on their characteristics to their offspring. When the human body creates a state of fear, anger, disgust, or happiness, it produces withdrawal or approach behaviours that have been perpetuated through evolution because they

have been advantageous to survival (Damasio et al., 2000). Positive emotions such as joy, interest, and love are also thought to be adaptive. They broaden the range of people's thoughts and actions, 'to play and create when experiencing joy, to explore when experiencing interest, to savour and integrate when experiencing contentment, and to combine play, exploration and savouring when experiencing love,' (Fredrickson, 1998).

Tugade and Frederickson (2002) showed that the adaptive benefits of positive emotions are more significant when people are experiencing stress. Resilient people use positive emotions to recover from stressful situations.

EE

To what extent are emotions an adaptive behaviour?

Are positive emotions as valuable to humans as negative emotions?

Do emotions hinder or help cognitive processes?

9.1.2 Arousal theory

The arousal theory of emotion and memory proposes that emotionally arousing information is encoded to a higher standard, resulting in better retention and more accurate retrieval of the information.

Significant autobiographical memories tend to be accompanied by strong emotions. Our memories of happy family gatherings, deaths of close friends, traumatic incidents such as car accidents, or bullying incidents in school, all involve intense emotions. These memories are likely to be recalled more often and more vividly than neutral memories such as brushing your teeth, researching your extended essay, or eating lunch.

Arousal theory is likely explained by, or at least associated with, greater attention during the initial stage of memory formation. Arousal theory proposes that retention is strengthened when the information is associated with arousing events or information, and the information is also remembered more vividly and more accurately (Sharot and Phelps, 2004). Schachter and Singer (1962) found that participants remembered arousing words better one week after learning them, compared to just two minutes after learning the words. This is probably because during the later time the memories were recalled and rehearsed.

Memories that are supported or strengthened by intense emotions are likely to be adaptive, i.e. evolutionary. Survival often relies on behaviour that has been repeated, rehearsed, and reinforced. The 'fight or flight' instinct is an example of such an adaptive behaviour. A physically or emotionally traumatic event creates a physiological response which excites neurochemical activity affecting brain areas associated with encoding and recalling memories. Intense emotion, however, does not always enhance memory.

9.1.3 The two-factor theory of emotion

Schachter and Singer (1962) proposed the two-factor theory of emotion: that emotion is based on a physiological arousal and a cognitive label. When a person experiences an emotion, a physiological arousal follows. The person then searches the immediate environment to identify the physiological arousal. For example, a person on a high suspension bridge would experience stress or anxiety and, based on the immediate environment, label the emotion as a fear of height or a fear of falling.

Lesion studies and **neuroimaging** studies have shown that the amygdala is a critical structure for the development of memory by emotion (Adolphs et al., 1997). The right

Lesion studies and neuroimaging studies have shown that the amygdala is a critical structure for the development of memory by emotion.

amygdala is more significantly associated with the formation of emotional memories and the left amygdala with the retrieval of those memories (Sergerie et al., 2007). The amygdala is also associated with classifying information as new rather than old (Sergerie et al., 2007).

9.1.4 Flashbulb memory

First proposed by Brown and Kulik (1977), the flashbulb memory model proposes that unexpected, personally significant episodes may be stored unchanged in people's memories for years. While some research has found people reporting remarkably accurate and stable memories (Neisser et al., 1996), others have shown that memories that would qualify as flashbulb are just as inaccurate as other kinds of memories (Neisser, 1982).

Most studies into the existence of flashbulb memory have focused on negative public events such as ferry sinkings, assassinations, or large-scale disasters in which the studies' participants have been personally involved, rather than private or personal events such as car accidents or home invasions, or positive personal events such as weddings or the birth of a child.

Key study: Er (2003)

Aim: To test flashbulb memory models by sampling subjects who experienced the Marmara earthquake on 17 August 1999 directly, or who learned about it in the news.

Procedure: Six hundred and fifty-five Turkish volunteers, of whom 335 (140 female, 195 male) experienced the Marmara earthquake directly (age range 18–48, mean age 34.4) and 320 (150 female, 170 male) were not directly affected, but lived nearby (age range 18–53, mean age 30.22), completed self-report questionnaires. Questionnaires were distributed by the experimenter to small groups of participants asking about their experiences of the earthquake. Data collection occurred six to nine months after the earthquake. A subsample from both the victim and the comparison groups was tested again after another six months.

Findings: The findings indicated participants from both groups had been significantly affected by the earthquake, that the earthquake was consequential (important), and that it generated high levels of surprise and emotional reaction. Two important similarities were found for both groups: firstly, importance or consequentiality determined the intensity of the participants' emotional states; and secondly, rehearsal (retelling and reliving the event) had a direct effect on flashbulb memory.

Conclusion: This study concludes that the Marmara earthquake is a flashbulb event, especially for the victim group, and had consequences for all participants. The study also concludes that the greater the event's importance and the more intense the emotional reactions to it, the more vivid and detailed the memory.

Evaluation: The study is recent and was conducted with a large number of volunteer participants with a reasonable age and gender balance. The participants were all either personally involved in, or well informed about, the earthquake and

so the study has strong ecological validity. Most flashbulb memory studies involve memory of public events in which the studies' participants were not directly involved and this may explain why the memories 'fade'.
The study could not isolate the cause of the flashbulb memory effect – the personal significance, the consequentiality, and the rehearsal may each be responsible for the flashbulb memory effect. Although the study's method was largely **quantitative**, the findings and conclusion are qualitative, so the study ought to have included a reflexivity statement from the researcher to expose any possible researcher biases.

Ask your parents and teachers where they were and what they were doing when they first learnt about the Indian Ocean tsunami on 26 December 2004. To what extent are their responses flashbulb memories?

10 Research methods: cognitive approach

Learning focus

Discuss the contribution of research methods used in the cognitive approach to understanding human behaviour.

Most research methods have weaknesses as well as strengths. Adopt a critical but balanced attitude when evaluating the contribution of different methods.

10.1 Field experiments

Field experiments are experiments conducted in real-life settings rather than in laboratory settings. Hippocampal lesion studies, i.e. research that studies the effects of damage to the hippocampus, are an example of a field experiment because they occur outside a laboratory in real-life settings.

The Atkinson and Shiffrin (1968) model of memory (the multi-store model) relied on hippocampal lesion studies that showed people with damaged hippocampal regions could create short-term memories, but not long-term memories. The independent variable (IV) in this study is the state of the hippocampus and this takes two conditions. IV1 is the undamaged hippocampus and IV2 is the damaged hippocampus. The dependent variable (DV) in the experiment is the function of the hippocampus, i.e. the formation of long-term memories.

Milner (2005) also conducted a field experiment that used hippocampal lesion studies to support the hypothesis that the hippocampal region plays a role in memory formation. Milner (2005) studied the development of amnesia after ablation surgery on the medial temporal lobe as a way of controlling certain types of epilepsy.

In a laboratory experiment all the variables other than the IV are controlled so that any change in the DV can only be attributed to the change in the IV. In a field experiment, all other variables may not necessarily be controlled because the study is conducted in a real-life setting. This means that there is less certainty that any change in the DV can be attributed to the change in the IV.

In a laboratory experiment all the variables other than the IV are controlled so that any change in the DV can only be attributed to the change in the IV. In a field experiment, other variables are not able to be controlled because the study is conducted in a real-life setting.

Moreover, participants in laboratory experiments are usually representative of a wider population, while in a field experiment the participants are usually purposively selected and are unlikely to be representative of wider populations. This reduces the extent to which the field experiment's conclusions can be generalized.

10.2 Interviews and questionnaires

Interviews are a qualitative research method and may be used in conjunction with a questionnaire, which is a quantitative method, to collect data from a representative sample so that the findings can be transferred to a larger population.

Tao et al. (2016) used a questionnaire to investigate stereotypes about rich and poor Chinese people (see page 61). The researchers considered their sample to be 'ordinary people in China, not belonging to the rich or the poor'.

The study concluded that stereotypes about rich and poor people existed. Rich people were considered highly competent, having low sociability and bad morality. Poor people were seen as incompetent, with average sociability, and good morality. The research method was a free-report questionnaire and so the researchers did not affect the participants' choice of adjectives by giving a list of their own.

The inherent weakness of questionnaires is participant unreliability, e.g. demand characteristics. This occurs when the participant responses are distorted, perhaps because the participants want to please the researcher or perhaps because the participants simply do not want to give a truthful response.

Conduct a simple questionnaire with your friends using three or four questions to determine how much time they spend using their smartphones. Knowing your friends, do you think they gave accurate responses to your questions? Why might their responses be inaccurate?

11 Ethical considerations: cognitive approach

Learning focus

To what extent are ethical considerations significant in the cognitive approach to understanding human behaviour?

Incorrectly or poorly designed research is not necessarily unethical research. As researchers have become more aware of their actions, studies that were once considered ethical would not be now.

Ethics are the rules imposed on researchers by their professions, their cultures, and themselves. The simplest two ethics are 'do the right thing' and 'do no harm'.

Loftus (1996) used the 'lost in the mall' technique to determine if false memories can be created. Over time, a participant was told a convincing story by several family members of being lost in a shopping mall and found by an elderly man. Not only did the participant just 'remember' the event, but when later questioned about it for the study, new details were added.

This study involved deception and so if the participant consented to the study, their consent was not given from a position of full information. The study, therefore, would be considered by most to be unethical.

Pezdek and Hodge (1999) used the same 'lost in the mall' technique with 19 5–7-year-old children and 20 9–12-year-old children to determine whether children can have false memories planted or created. The children were read descriptions of two events – a plausible event (being lost in a shopping mall) and an implausible event (receiving a rectal enema). Both events were said to have occurred when the children were 4 years old. The study concluded that some children can have memories planted or created.

Children cannot give 'fully informed consent' because they cannot understand the implications of their involvement in such research. A child cannot understand how having a false memory planted would affect him or her. Creating false memories, whether these are memories of positive or negative events, is unethical because the participant believes the event occurred, when it did not. Pezdek and Hodge (1999) would, in most cultural situations, be considered unethical because it harms the participant and because children cannot give fully informed consent.

One might reasonably ask, 'Is a little harm to some participants an acceptable cost to pay for the benefit accrued to many as a result of this research?' This is the type of question an ethics committee might discuss before giving a researcher its approval to proceed.

Children cannot give 'fully informed consent' because they cannot understand the implications of their involvement in such research.

TOK

Is it ethical to use the results of unethical research?

12 Cognitive processing in the digital world (HL)

General focus

To what extent is cognitive processing affected by the digital world?

Research has shown that technology affects cognitive processes such as attention, memory formation, and thinking. Just as printed pages, numbers, clocks, abacuses, and typewriters levered human intellectual performance, the internet and other digital technologies are shaping, possibly even reshaping, how people think. Some neuroscientists are concerned that digital technology not only has positive neurological impacts, but also significant negative effects. China's psychological body has made internet addiction a clinical disorder and the Chinese government has established more than 400 rehabilitation camps for the condition.

Digital technology includes many aspects that simultaneously compete for people's attention, some of which may be useful but some of which may be better described as a distraction. Some argue that we cannot process vast quantities of information from numerous sources and therefore the internet may be degrading the way that we think, learn, and make decisions. Others argue that the information overload through technology is no different to the information overload of everyday life.

Hebb (1947) looked at information overload by comparing the problem-solving capabilities of rats kept in a confined space with rats that had been reared in a stimulating environment. The 'free-range' rats outperformed the rats kept in captivity in problem-solving activities later in the rats' lives. The study concluded that exposure to more information may lead to increased brain weight, greater neuron cell size, and greater cortex thickness.

Take care when using the broad and ill-defined term 'technology', which has been used in research to mean television, computers, video games, and mobile phones. It is more likely that the technology that actually affects behaviour is the software or content, rather than the hardware.

Use the internet to determine statistics of daily internet use.

TOK

To what extent did the invention of the clock affect the way humans behave?

To what extent does a lack of clarity regarding the term 'digital technology' hinder research into the effects of using technology?

12.1 The influence of digital technology on cognitive processes

There is a worldwide shortage of research determining cause-effect relationships between modern technology and effects on cognitive processes, so claims should be considered cautiously, using critical-thinking skills.

Learning focus

To what extent does digital technology affect one cognitive process?

The technology in question includes television, calculators, the internet, and smartphones. Perhaps because the peer-reviewed research process is relatively slow compared to the rate of technology development, there is a shortage of research examining a possible cause-effect relationship between technology and cognitive processes.

While current research focuses on smartphones and the internet, older technology has also affected cognitive processes. Murzyn (2008) found that people who had lived in a home with a black and white television were more likely to dream in black and white than those who had lived with colour televisions, who almost always dream in colour. Before the introduction of black and white television, dreams were in colour. King and Robinson (2012) indicated that some students' use of calculators means they do not understand what the calculator is doing in mathematics, although the evidence for this seems more **anecdotal** than the result of empirical research.

12.1.1 Attention

Stothart et al. (2015) showed that exposure to notifications from smartphones decreased participants' performance on a concurrent attention-based task. Simply hearing or feeling the alert distracted the participants and affected their attention to the primary task. This result is not very surprising as the purpose of a smartphone's alerts is to draw the user's attention to the incoming message or call. However, when Drouin et al. (2012) surveyed 290 undergraduates, 89 per cent reported that they had felt their phone was vibrating when it was not. They reported that this distraction occurred at least once every two weeks. Rothberg et al. (2010) found 68 per cent of 176 medical workers reported feeling similar phantom vibrations and therefore distractions from their primary task. Thornton et al. (2014) found that just being in possession of a smartphone is sufficiently distracting to affect cognitive functioning, although only during demanding tasks.

Numerous studies (for example, Caird et al., 2014) have found that texting while driving consistently decreased attention to the road and traffic conditions and correlated with slower response times to hazards and, not surprisingly, more crashes. In 2011, 31 per cent of adults in the US, and in 2015, 42 per cent of teen drivers in the US, said they had read or sent text messages while driving within the past 30 days.

Design and conduct a simple survey of 20 classmates to determine whether a correlation exists between hours of smartphone use and one cognitive process such as attention or memory.

Loh and Kanai (2015) found less than expected grey matter in the anterior cingulate cortex of heavy users of multimedia, suggesting that multi-tasking with technology may affect the structure of a region in the brain known to be associated with attentional control. It is therefore clear that smartphones have an effect on attention, but of course this is a deliberate feature of smartphones.

12.1.2 Memory

Studies show that the effects of technology on memory and knowledge acquisition are limited. For example, Sparrow et al. (2011) had participants type a series of newly learned, but trivial pieces of information into a computer. Half were told the computer would save their information and the others were told the information would not be saved. All were told to remember the information.

Those who thought their information would be saved did less well on a recall task. This suggests that knowing we will be able to read the information later leads to poor encoding and storing of information in long-term memory.

Sparrow et al. (2011) also proposed that technology users remember less information, but they are better at remembering where and how information can be found. To investigate this, Sparrow et al. (2011) conducted an experiment similar to the one described above, but with three conditions: for one third of the questions, participants were simply told that the information they entered was saved; for another third of the questions the participants were told that the information was saved into one of six named folders (Facts, Data, Info, Names, Items, and Points) and the remaining third of the questions were followed by a prompt that informed the participants that the information they typed was immediately deleted. The results showed that participants recalled the name of the folder in which the information was located more readily than the information itself and the researchers concluded that, 'the processes of human memory are adapting to the advent of new computing and communication technology' (Sparrow et al., 2011).

Henkel (2013) investigated the impact of cameras on autobiographical memory formation. Participants took their smartphones on a tour of an art museum and were told to (1) photograph specific objects, and (2) observe other objects, but not photograph them. The next day the participants were tested on their recall of the objects. The results showed that the photographed objects were recalled less than those not photographed. The effect was less pronounced if the participants were instructed to zoom the camera in on the object, supporting Atkinson and Shiffrin's (1968) conclusion that memory formation is more effective when stimuli are given more attention.

Memory formation is more effective when stimuli are given more attention.

12.1.3 Thinking

Barr et al. (2015) assessed participants with a set of cognitively demanding questions, including numeracy and verbal intelligence tests, and then asked participants to estimate how much time they spent using their smartphones and how much of that time they spent using internet search engines. The results showed that participants who reported using their smartphones the most had weaker analytical thinking skills and lower knowledge measures. Tempting as it is to conclude that smartphones cause diminished cognition, it may simply be that those with poor cognitive ability are more likely to make use of their smartphone's internet search capabilities.

12.2 The positive and negative effects of modern technology on cognitive processes

Learning focus

Discuss the effects of modern technology on one cognitive process.

Be careful not to be too simplistic – it is reductionist to state that modern technology has either a negative or a positive effect on any cognitive process because the technology is varied, and the cognitive processes are complex.

Modern technology appears to have both negative and positive effects on cognitive processes. In most cases, it is reductionist to state that modern technology has a negative or a positive effect on any cognitive process. For example, smartphones appear to have both positive and negative effects on attention and on different aspects of memory, such as encoding and recall. Further, in some instances, what some consider to be a negative effect, others may consider a positive effect. For example, as people switch from encoding and storing memories to using technology-based information storage mechanisms such as digital contact lists and reminder apps, they conserve cognitive energy that they can then use for more sophisticated mental tasks.

12.2.1 Positive effects of technology on memory, attention, and emotion

Memory

Humans are cognitive misers: they tend to use cognitive shortcuts that require little effort, such as schemas and heuristics.

Kahneman (2011) described humans as 'cognitive misers'. This means that humans tend to use cognitive shortcuts that require little effort, such as schemas and heuristics. It is likely that this cognitive 'miserliness' is what motivates people to use memory-assistive technology. This suggests that any effects of technology on memory that are perceived to be negative are in fact positive, and given the well-documented unreliability of memory, people are probably better served using technology to store and retrieve information than to rely on human memory.

Attention

Most of the time, when people believe they are multi-tasking they are actually switching between two tasks.

Some people, some of the time, experience greater attention to a primary task if they complete it while also listening to music. This is one of the few exceptions to the idea of true multi-tasking. Most of the time, when people believe they are multi-tasking they are actually switching between two tasks. Switching attention between tasks requires significant and fast cognitive effort, which is challenging, but it appears that we can learn to do it with rehearsal or practice. Lui and Wong (2012) had participants perform a task that required integrating information of multiple sensory **modalities** (i.e. sights and sounds) and found that those who reported greater multi-tasking significantly outperformed those who were light multi-taskers. This suggests a positive effect on people's attention of exposure to multimedia.

Design and conduct a survey of students in your school to investigate whether smartphone use helps or hinders students' attention. Do any students use apps that help focus attention?

Emotion

While technology has been shown to have a negative effect on emotions such as exacerbating depression and anxiety, it has also been shown to have a positive effect. Computer software, often in the form of smartphone apps, has been developed to improve the mood of people suffering from depression by showing them photos, video, and audio of, for example, their friends and families. Similarly, apps have been

developed to treat phobias, and computer games have been developed to provide therapy for people who are, for some reason, reluctant to interact with a human therapist. For example, a fantasy role-playing game called SPARX was found to be at least as effective as human face-to-face therapy (Horne-Moyer et al., 2014).

12.2.2 Negative effects of technology on memory, attention, and emotion

Memory

Sparrow et al. (2011) showed what they called the 'Google effect' or 'digital amnesia' – that knowing or expecting to have later access to information tends to make people less inclined to encode and store information in long-term memory. Other studies have shown some technology has a negative effect on spatial memory. Heavy users of GPS technology drew significantly simpler and more disjointed (and therefore inaccurate) maps of commonly used routes than non-GPS users, who could recall maps with significantly greater accuracy.

Other research has shown that technology such as digital cameras may have a negative effect on the formation of autobiographical memories.

Attention

There is evidence suggesting that when it comes to distractions, the richer the information in the distraction, the more significant a negative effect it will have on the successful completion of a primary task (Levy, 2016). Information that includes text, graphics, sound, and perhaps even movement, is more distracting than information that has fewer elements. This of course should not come as a surprise, because distraction is usually the designed purpose of technology's disruptive features.

The extent of the effect of disruption may be less about technology and more about the person's susceptibility to distractions, i.e. the person's pre-existing lack of cognitive ability to self-regulate attention and control over behaviour.

Emotion

Both depression and anxiety are known to have negative effects on cognitive functioning. Mark et al. (2016) found that restricting email access reduced people's anxiety and improved their focus on work-related tasks. However, research indicates that separation from smart devices also causes anxiety. Cheever et al. (2014) found that people who did not have their phones with them experienced increasing levels of anxiety as time without their phone passed.

Some research, for example Chiu (2014), suggests general stress (life-stress) is a strong predictor of smartphone use, i.e. generally more stressed people tend to use smartphones for social support and other stress-mitigating uses.

Discuss with others in your class how researchers might design research to determine a cause-effect relationship between high smartphone–internet use and diminished cognitive skills. The challenge, to establish effective cause-effect results, is in controlling all variables except the independent variable. How could researchers do this?

EE

To what extent is research into the effects of modern technology on cognitive processes likely to be distorted by socioeconomic and cross-cultural factors? How could researchers strengthen their research to account for cross-cultural factors?

12.3 Methods to study interactions between digital technology and cognitive processes

Learning focus

Discuss methods used to study the interaction between digital technology and cognitive processes.

Be clear not to confuse data-collection methods with research methods. For example, brain scans and questionnaires usually are data-collection techniques that contribute toward research methods such as correlational studies or experiments.

A range of data-collection techniques, such as fMRI scans and self-report questionnaires, have been used as elements of research methods that include observations, correlational studies, and experiments to study the interaction between digital technology and cognitive processes. There appears to be a need for longitudinal studies, although there are inherent problems with this type of research for studying the effects of technology on cognition because new technology is being developed faster than longitudinal research can be conducted, peer-reviewed, and published.

It should be noted that many studies use the term 'technology' to describe television, video games, the internet, smartphones, and social media, when in fact these are all very different. Many studies also fail to control socioeconomic or environmental factors that correlate with technology use. For example, while students who use smartphones in lessons may achieve better results, they may also be the students who can afford to employ private tutors. Despite this, it seems reasonable to assume that the internet, smartphone use, and video games will change brain structure and cognitive processes, but then so has playing sports, reading books, and driving taxis in inner London.

12.3.1 Animal research and fMRI scans

Animal research could be used to observe the effects of technology on cognition. Dombeck et al. (2010) used a virtual reality system with mice to study decision making and learning in fast-paced 'mice-enticing' environments. The mice interacted with a spherical treadmill to navigate a virtual maze while researchers used fMRI scanning to study the effect on the CA1 region of the hippocampus.

Animal research incorporating fMRIs is useful because the ethical limitations of animal research are less restrictive than those for human research. fMRIs are non-invasive and do not require the mice to be killed. Conclusions from animal behaviour research, however, usually cannot be generalized to human behaviour.

12.3.2 Meta-analysis

A meta-analysis is a research method in which researchers consider the results of many previous studies, effectively combining the number of participants and factoring in cross-cultural and inter-temporal effects by including studies done in different countries and in different time periods. A meta-analysis is useful because it involves very large numbers of participants. Meta-studies are relatively low cost as they do not involve the cost of new studies being conducted.

Caird et al. (2014) performed a meta-analysis to examine 28 experimental studies involving 977 participants and reached a conclusion regarding the effect on attention of sending and receiving text messages while driving. The meta-analysis found that texting while driving produces cognitive distraction.

12.3.3 Self-report questionnaires

Self-report questionnaires are often used as a data-collection technique in many studies to identify variables such as how many hours per week participants use their smartphone or access the internet. Self-report questionnaires are useful because they are relatively low cost and they are direct, i.e. the respondents provide the information, so the responses are not prone to errors of interpretation.

However, self-report estimates are of limited reliability, and because technology is being developed rapidly and usage rates are increasing even more rapidly, many of the studies based on self-report questionnaires are obsolete before they can be applied to studies.

Self-report estimates of behaviour are of limited reliability.

12.3.4 Longitudinal studies

A longitudinal study involves repeated observations, or repeated experiments, over long periods of time (often years or even decades) to determine long-term effects. There is almost no long-term data relating to the effect of modern technology on cognitive processes, partly because the technology itself changes fundamentally across short periods of time. For example, the technology that children were using in schools just ten years ago is significantly different to that used now.

Longitudinal studies that investigate the effects of technology should take this into account at the design stage, or the conclusions should be clearly stated to show that the study relates to technology in general rather than a particular technology such as a tablet or a smartphone.

There is almost no long-term data relating to the effect of modern technology on cognitive processes.

12.3.5 Experiments

Experiments are designed and conducted to determine (or rule out) a cause-effect relationship.

They are useful because by showing whether a cause-effect relationship exists, they can usually give a definitive answer to a research question such as, 'Do students who make class notes with a tablet achieve better exam results than students who do not use tablets?'

To confidently show that modern technology has a negative effect on memory, an experiment would have to show that all variables other than 'modern technology' have been controlled so that the only factor that could have produced a change in a dependent variable (in this case memory) is the modern technology.

One issue faced by researchers is finding participants who match in age and socioeconomic status who make little or no use of modern technology to contrast with those with high exposure to technology.

Finally, the few experimental studies conducted on technology's effect on cognition have almost all investigated momentary, or very short-term, effects rather than long-term effects.

Design and conduct an interview or self-report questionnaire to use with people of different ages in your school community, aiming to find out the approximate usage level of technology during their school-age years. Use the results to create a wall chart that shows a longitudinal trend. Describe the flaws in this data-collection method.

Experiments are designed and conducted to determine (or rule out) a cause-effect relationship.

Key study: Sparrow et al. (2011)

Aim: To determine whether people recall where to find information more than they recall the actual information.

Procedure: Thirty-two undergraduate students at Columbia University (USA) read standardized instructions from a computer screen. Participants had to write trivial facts into the computer and then read that the information was saved into a folder called Facts (or Data, Info, Names, Items, Points). Participants were led to believe that they could access what had been saved. The order of the statements was randomised. Participants were allowed ten minutes to write down the statements they had written. Participants were then asked a general question about each piece of information they had written (e.g. In which folder is the statement about ostriches saved?) Participants were not reminded of the folder names.

Findings: Participants recalled the names of the folders where the information was stored more accurately than the information itself.

Conclusion: These results suggest that processes of human memory are adapting to the advent of new computing and communication technology.

Evaluation: Strengths include being conducted in laboratory conditions with most variables controlled. This leads to low ecological validity. The participant group was relatively small in number and relatively homogeneous (although the group was approximately gender-balanced), so the conclusions cannot be generalized to the wider population.
A weakness in this study's procedure is that remembering a full statement is likely to require more cognitive effort than recalling one relatively odd (because it is unrelated) word associated with the informational statement.

Activity

Find all of the new words or expressions from this chapter and write them into a document with their definitions and explanations next to them. Be creative and use diagrams or boxes to help make your personal glossary unique and effective.