see a schema inside someone's head, but using concepts like schemas help psychologists—and the rest of us—to understand and discuss what it would otherwise not be possible to do.

Cognitive schemas:
- organize information about the world with fixed and variable slots; if a slot is left out or unspecified, it is filled by a "default value"—that is, a best guess
- can be related to form systems
- are active recognition devices (pattern recognition)
- help to predict future events based on what happened before
- represent general knowledge rather than definitions.

Office schema

Schema theory suggests that what we already know will influence the outcome of information processing. This idea is based on the assumption that human are active processors of information. People do not passively respond to information. They interpret and integrate it to make sense of their experiences, but they are not always aware of it. If information is missing, the brain fills in the blanks based on existing schemas, or it simply invents something that seems to fit in. Obviously this can result in mistakes—called distortions.

Schema theory and memory processes

Schema theory has been used to explain memory processes. Cognitive psychologists divide memory processes into three main stages:

- **encoding:** transforming sensory information into a meaningful memory
- **storage:** creating a biological trace of the encoded information in memory, which is either consolidated or lost
- **retrieval:** using the stored information.

Memory processes

It is now believed that schema processing can affect memory at all stages. This is shown in the following research study on the next page.

A theory of a cognitive process: schema theory

When expert football players like Danish Michael Laudrup kick the ball directly into the goal during a penalty, it may look like any other goal to some of us. However, this particular kick is the result of many hours of practice, combined with an adjustment that is unique to him. All this is done based on his previous experience, which is stored in his memory as knowledge—but there is even more to it. Players like Laudrup have learned the behaviour to perfection, but need to modify it to fit the situation at hand. His kick must be manufactured out of the visual and postural information, and it is the movement and its possible consequences. A lot of this is based on recognition of patterns. This "how-to-score knowledge" will help him decide what aspects of the situation he needs to pay attention to in order to place the football accurately between the goalposts. Specialists in a certain field have expert knowledge that comes from hours of practice, which means that to some extent they can do the right things at the right time more or less automatically, but they always need to be able to analyse each individual situation.

Cognitive psychologists would call "how-to-score knowledge" a **schema**, and **schema theory** is a cognitive theory about information processing. A **cognitive schema** can be defined as networks of knowledge, beliefs, and expectations about particular aspects of the world.

Schemas can describe how specific knowledge is organized and stored in memory so that it can be accessed and used when it is needed—as in the example of Michael Laudrup. It is not possible to

referring to objects, ideas, and people in the real world. People use them when they think, make plans, imagine, or daydream. You have an idea of who you are and how you look somewhere in your mind—a self-representation. You also have ideas about how other people are. Mental representations are organized in categories, and the mind contains all sorts of mental representations stored in memory.

The human capacity to manipulate mental representations enables us to think about situations and imagine what might happen. People make plans, calculate risks, or create wonderful pieces of art. When authors write exciting stories, they rely on their imagination to construct imaginary universes and characters. The readers form mental images of the characters as they read the book, and sometimes they may even find that a book which has been made into a movie is not as good as their own "film". When reading books, people also imagine what will happen to the characters. Generally, the good guys and the bad guys do not fare the same. We have expectations as to what will happen to them because of pre-stored mental representations called **cognitive schemas**. "Mental representations" are how we store images and ideas in memory. Memory researchers believe that what we already know affects the way we interpret events and store knowledge in our memory.

![Chicken and representation of chicken](image)

**Be a thinker**

The way we represent objects in the world can be illustrated by this cartoon. The chicken may indeed be represented in different ways. Can you imagine a few other ways to represent the chicken?

Michael Laudrup

![Diagram of an office schema](image)
Research in psychology

Anderson and Pichert (1978)

The aim of the experiment was to investigate whether schema processing influenced encoding and retrieval. The participants were given one schema at the encoding stage, and another at the retrieval stage, to see if they were influenced by the last schema when they had to recall the information.

First, the participants heard a story about two boys who decided to stay away from school one day; instead, they went to the home of one of them because the house was always empty on Thursdays. The house was described as being isolated and located in an attractive neighborhood, but also having a leaky roof and a damp basement. The story also mentioned various objects in the house, such as a 10-speed bike, a colour TV, and a rare coin collection.

The participants heard a story that was based on 72 points. These had previously been rated by a group of people for their importance to either a potential house-buyer (e.g., leaking roof, attractive grounds) or a burglar (e.g., coin collection, nobody home on Thursdays). Half of the participants were asked to read the story from the point of view of a house-buyer (the buyer schema) and half from the point of view of a burglar (the burglar schema).

Once the participants had read the story, they performed a distracting task for 12 minutes before they recalled the story. Then there was another 5-minute delay in the experiment. Half of the participants were given a different schema, so that those who used the burglar schema in the first trial were switched to the buyer schema and vice versa. The other half of the participants were asked to retain their original schema, and their recall was tested once again.

The researchers found that participants in the changed schema group recalled 7 per cent more points on the second recall test compared to the first trial. Recall of points that were directly linked to the new schema increased by 10 per cent, whereas recall of points that were important to the previous schema declined. The researchers also found that the group which continued with the first schema actually remembered fewer ideas at the second trial.

The results of the experiment indicate that schema processing must have some effect at retrieval as well as at encoding, because the new schema could only have influenced recall at the retrieval stage. The research also showed that people encoded information which was irrelevant to their prevailing schema, since those who had the buyer schema at encoding were able to recall burglar information when the schema was changed, and vice versa.

This experiment was highly controlled and conducted in a laboratory, so there may be issues of ecological validity. However, a strength of this experiment was the variable control, which enabled the researchers to establish a cause-and-effect relationship on how schemas affect different memory processes.

Evaluation of schema theory

A lot of research has supported the idea that schemas affect cognitive processes such as memory. The theory seems quite useful for understanding how people categorize information, interpret stories, and make inferences, among other things. Schema theory has contributed to an understanding of memory distortions as well as social cognition. Social psychologists often refer to “social schemas,” when they are trying to explain stereotyping and prejudice.

Some of the limitations of schema theory are that it is not entirely clear how schemas are acquired in the first place and how they actually influence cognitive processes. Cohen (1993) has criticized schema theory, saying that the concept of schemas is too vague to be useful. However, many researchers use schema theory to explain cognitive processing. As US psychologist Daniel Gilbert has said that the brain processing the US psychologist Daniel Gilbert has said that the brain searches for a wonderful magician but a lousy scientist—the brain searches for meaningful patterns but does not check whether they are correct.

A model of memory: the working memory model

Atkinson and Shiffrin (1968) were among the first to suggest a basic structure (or architecture) of memory, with their multi-store model. Although this seems rather simplistic today, it certainly sparked research based on the idea of information processing, and it has been one of the most influential models to date. The working memory model, which is the focus here, builds on the multi-store model of memory. What is called short-term memory in the original model is changed to a more sophisticated version in the working memory model.

Models are attempts to describe complex phenomena: they are changed and developed based on research findings. Although models may clarify how memory might work, it is important to realize that even though evidence brings support to some of the ideas in a model, it can never be more than a model.

Multi-store model of memory

The multi-store model was suggested in the 1960s when the cognitive revolution began, and the model is clearly inspired by computer science, with the idea of humans as information processors. The model is based on two assumptions: first, that memory consists of a number of separate stores; and second, that memory processes are sequential. The memory stores are seen as components that operate in conjunctive with the permanent memory store through processes such as attention, coding, and rehearsal. You need to pay attention to something in order to remember it, and you need to give the material a format which enables you to remember it. Rehearsal simply means keeping material active in memory by repeating it until it can be stored.

The model contains several stores. Information from the world enters sensory memory, which is modality-specific—that is, related to different senses, such as hearing and vision. Information stays here for a few seconds, and only a very small part of the information attended to will continue into the short-term memory (STM) store. The capacity of STM is limited to around seven items and its duration is normally about 6–12 seconds. Material in STM is quickly lost if not given attention. Rehearsal plays a key role in determining what is stored in long-term memory.

The long-term memory (LTM) store is conceptualized as a vast storehouse of information. This storehouse is believed to be of indefinite duration and of potentially unlimited capacity, although psychologists do not know exactly how much information can be stored there. The material is not an exact replica of events or facts, but is stored in some outline form. Memories may be distorted when they are retrieved, because we fill in the gaps to create a meaningful memory as predicted by schema theory. This model is very simplistic and reflects the knowledge available in the 1960s.

Baddeley and Hitch (1974) suggested the working memory model, based on the multi-store model. However, they challenged the view that STM is a single store. Working memory is a model of
3.1 Outline principles that define the cognitive level of analysis and explain how these principles may be demonstrated in research

**Principle 1:** Human beings are information processors and mental processes guide behaviour. People are active information processors. They perceive and interpret what is going on around them. This is often based on what they already know. There is a relationship between people's mental representation and the way people perceive and think about the world.

**Principle 1 demonstrated in:** Schema theory defines cognitive schemas as mental representations of knowledge. Mental representations (schemas) are stored in categories (concepts) in memory. These schemas provide guidelines for interpretation of incoming information when people try to make sense of the world. Schemas influence cognition in that schemas create expectations about what will happen in specific situations (e.g., what a "teacher" is like or what to expect when you go to a rock concert). Schema theory can be of large extent, explaining memory and stereotyping.

Darley and Gross (1983) performed an experiment in which they showed participants videos of a girl playing in a poor environment, then in a wealthy environment. Then they saw a video of the girl in what could be an intelligence test. When the participants were asked to judge the future of the girl, they all said that the "poor" girl would do worse than the "wealthy" girl. The study demonstrated how human beings actively process information based on a few salient details to form an overall impression that may not necessarily be correct.

**Principle 2:** The mind can be studied scientifically. Cognitive research uses a number of scientific methods to study the mind (e.g., laboratory experiments, neuromaging, case studies, interviews, and archival research). The most used research method was, for a long time, the laboratory experiment, because it was considered to be the most scientific.

**Principle 2 demonstrated in:** Loftus and Palmer (1974) performed an experiment to test reconstructive memory in relation to eyewitness testimony. The aim was to see whether misleading questions could distort memory. Participants saw a picture of a car crash, and were asked to estimate the speed of the car based on questions such as "How fast was the car going when it smashes/hit/bumped into the other car?" Words such as "smashed" elicited higher speed estimates. Because the experimental method was used, it was possible to establish a cause-effect relationship between the use of specific words and estimation of speed. Experimental research on memory has been criticized for lacking ecological validity.

Corkin et al. (1999) used MRI scans to observe the exact damage to H.M.'s brain. H.M. suffered from amnesia due to a brain operation where the hippocampus and adjacent areas had been removed to eliminate his epilepsy. The scans confirmed damage to these areas. Although a small part of the hippocampus had been spared, it was not enough to support storage of new explicit memories.

**Principle 3:** Cognitive processes are influenced by social and cultural factors. Research has shown that cognitive processes such as perception, memory, and thinking are influenced by sociocultural factors. Bartlett (1932) introduced the concept of "cultural schema" in memory research. He suggested that schemas influence memory in that they lead to distortion or "reconstructive memory". Other researchers suggest that the environment in which people live leads to specific cultural and social demands that influence the way they process information.

**Principle 3 demonstrated in:** Bartlett (1932) suggested that memory is guided by schemas and that culture can influence schemas. Previous knowledge determines the way people interpret incoming information and memory (memory distortion). He asked British participants to read an unfamiliar Native American story and reproduce it. The participants changed details of the story to fit with their own cultural schemas.

Cole and Scribner (1974) investigated how memory strategies were influenced by culture. The study asked children from a rural area in Liberia and children from the USA to memorize items from four different categories: utensils, clothes, tools, and vegetables. Children from the US improved performance after practice but the Liberian children did not unless they had attended school. Learning memory strategies, like "chunking", appears to be dependent on schooling and the literate children in the study did not use these strategies. The researchers concluded that the way cognitive psychologists study memory processes does not always reflect the way people learn to remember in real life.