Heriot-Watt University Study Guide

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Topic 1

Learning and Classical Conditioning

Contents

Learning Objectives

After studying this topic you should be able to:

- *Differentiate between generalisation and discrimination*
- *Understand the relationships between stimuli and responses*
- *Discuss ways of measuring the strength of conditioning*
- *Demonstrate awareness of the role of conditioning in the understanding and treatment of phobias.*

Prerequisites

There are no formal prerequisites for this topic, although a basic knowledge of psychology is desirable.

1.1 Introduction

This topic investigates learning and classical conditioning from a beginner's viewpoint. Specifically, the question "what is learning?" is answered, by recourse to various definitions and explanations, before a very simple form of learning, habituation, is discussed. The method of learning by associations that is the core tenet of learning theory is next briefly examined before the concept of conditioning is introduced. Classical conditioning is then looked at in some depth, taking in Pavlov's original experiments and such concepts as generalisation, discrimination and extinction. The main methods of measuring the strength of conditioning are also considered. Finally, the relationship between human phobias and conditioning is illustrated by presentation of some early studies in this area.

1.2 What is Learning?

1.2.1 The nature of learning

Without the ability to learn, humans, and indeed many other animals, would clearly be at a disadvantage. Humans, without ever having learned, would not be able to judge a situation by experience, read or write, or carry out many of the everyday behaviours that are taken for granted and that appear automatic. Basic cognitive processes, such as remembering facts and what had occurred the day before, would become impossible without the ability to learn. Learning is therefore clearly critical to the normal functioning of an organism.

Learning can be thought of as a relatively permanent change in an organism brought about by exposure to an external experience (Coon 1983). Learning cannot be observed directly and, therefore, it needs to be inferred from an organism's explicit behaviour. However, as Gross (2001) states, it is helpful to distinguish learning from behaviour, as behaviour suggests performance whereas learning can be seen as an individual organism's potential for performance. Actual behaviour, when reflecting learning, will fluctuate to a greater or lesser extent. For example, a student may perform badly in an examination if they feel unwell on the crucial day, but their potential for performance, related to what they have learned, has not been fully exercised. Their learning has not been accurately reflected in performance. Similarly, the skilled gymnast cannot fully demonstrate her abilities when exhausted or injured.

Learning then, can be viewed as a process that may only be inferred from observed behaviour. As it is relies upon previous experience and memories for a foundation on which to build and operate, learning can also be seen as a cumulative quality (Howe 1980). Furthermore, anything learned is influenced, at least to a certain degree, by past learning and memories.

1.2.2 Habituation

Learning in its most basic form can be observed in a simple process called **habituation**. Habituation refers to the process whereby a novel sensory input is gradually accepted as a normal part of the environment; it becomes familiar and is then largely ignored. For example, the roar of traffic might be initially quite annoying to a new resident on a busy street but in time habituation will occur and the traffic noise will become familiar and cease to be annoying. Note the implication that no information is really gathered about a given stimulus in this form of learning, other than it can be ignored as something that it is not useful to be constantly aware of. Note also that there is some type of memory mechanism implicated in habituation (Whitlow & Wagner 1984).

Habituation is useful from an evolutionary perspective in that it prevents animals becoming alarmed at every noise of whatever origin. Familiar sounds will therefore become habituated leaving the animal to go about undisturbed focussing upon important activities (Shalter 1984) Unfamiliar sounds will, however, still elicit alarm and evasive actions that are important for survival. Farmland birds, for example, are clearly habituated to the noise of a tractor, as they show no concern with them when collecting the exposed food in freshly ploughed land.

1.2.3 Conditioning and learning theory

Approaches to more complex forms of learning than habituation can be split into cognitive and behaviourist perspectives, with the latter being subdivided into **classical conditioning** and **operant conditioning**. It is the former approach with which the remainder of this topic will largely concern itself.

Classical conditioning is based upon the concept of **learning theory**. Adherents of learning theory hold that organisms are born with pre-programmed, hard-wired, reflexes and senses. Although these basic skills are limited, they are the foundation upon which learned behaviours are built and new connections between existing **reflex behaviours** are established. Learning that is concerned with the connections between events or relationships between events and behaviours is the learning of **associations** (see Figure 1.1). Gleitman, Fridlund & Reisberg (1999), for instance, offer the example of the sight of a mother's face becoming associated, in a neonate, with being fed. Some months later in life, the infant might learn to associate touching radiators with the unpleasant consequences of a burnt hand. In other words, for learning theorists a given stimulus elicits a particular response in an organism. Even complex examples of learned behaviour can be readily broken down into simpler sub-components. Indeed this was the approach taken by early learning theorists who, ultimately wanting unravel the enigmas of human learning, initially turned their attention to experimental research into simpler forms of learning in animals such as fish, rats, cats and pigeons.

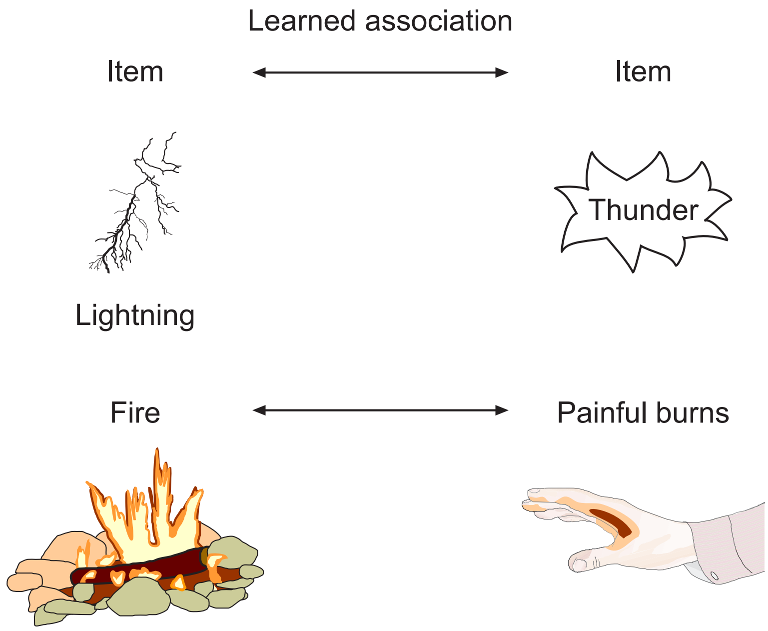


Figure 1.1: An example of association learning.

1.3 Learning and Conditioning

1.3.1 Classical conditioning

Learning through classical conditioning can be viewed as strengthening or weakening associations. Pavlov is credited with being the first scientist to experimentally investigate the conditioning of associations, although the importance of associations as a mechanism for learning goes back at least as far as the ancient Greeks. Pavlov's research grew out of his 1904 Nobel Prize winning investigations into the nature of digestion, specifically salivation in dogs.

Pavlov (1927) discovered that presentation of food elicited a salivation response in his dogs, but he additionally noticed that they also salivated on other occasions when food was not being offered to them. For example, the dogs were observed to salivate at the sight of their food bowl or the appearance of the person who usually brought their meals. On the strength of such observations Pavlov set about creating artificial associations in dogs by sounding a bell immediately before they were fed (see Figure 1.2).

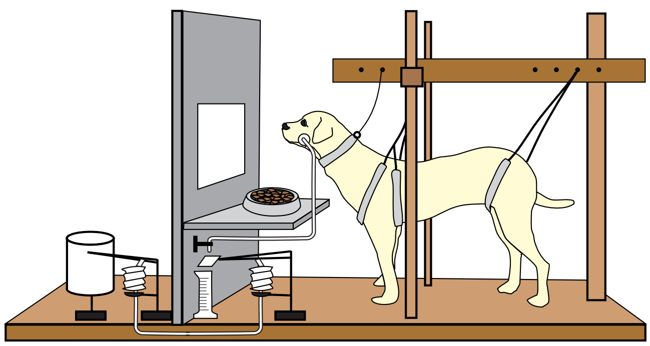


Figure 1.2: Classical Pavlovian conditioning of a dog's salivation to the sound of a bell.

When the bell was rang without the appearance of food it was noted that dogs still salivated. Pavlov (1927) called this type of learned response a **conditioned reflex** or **conditioned response**, differentiating it from what he termed unconditioned reflexes (or response), these being largely innate and independent of learning. An example of an unconditioned reflex is normally induced salivation, in other words salivation on presentation of food. Conditioned reflexes are characterised by a **conditioned stimulus** eliciting a conditioned response (e.g.: a bell eliciting salivation) and are an artificial behaviour programmed by pairing an unconditioned stimulus with an unconditioned response (see Figure 1.3). This type of learned stimulus-response relationship is called classical conditioning.

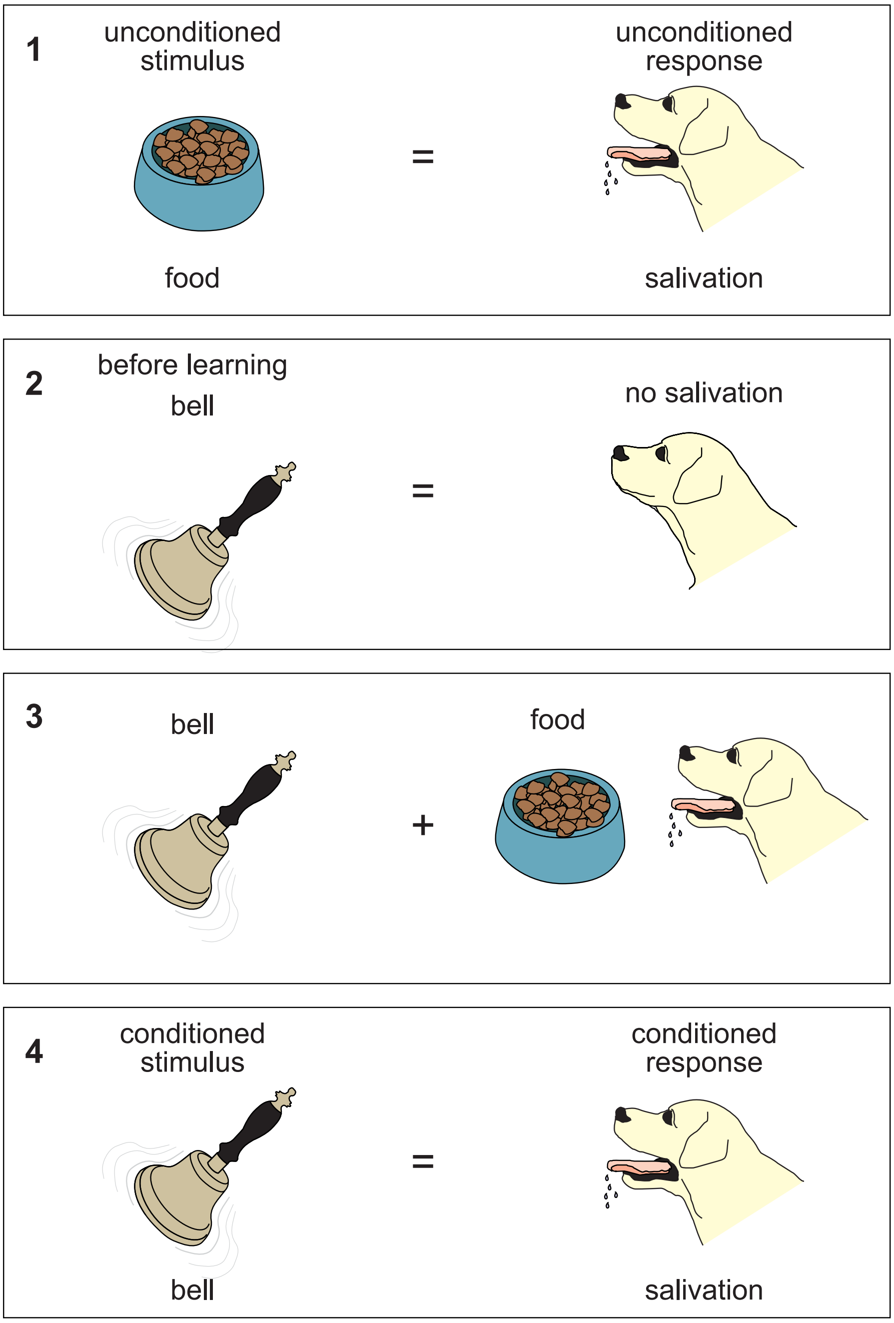


Figure 1.3: Classical conditioning table

As Gleitman et al (1999) state, classical conditioning has far wider implications than the pairing of conditioned stimuli with canine salivation. Indeed, classical conditioning has been observed in a variety of animals, from cockroaches and ants, through pigeons and cats to human beings. Basic human behaviours such as hunger and sexual arousal are typically subject to some form of classical conditioning. Hunger, for example, is conditioned in most individuals very much by time of day- we tend to feel hungry at allotted meal times. Sexual arousal can also be conditioned and as Gleitman et al (1999) point out, this need not be in reference to more outlandish sexual practices, certain words or gestures with erotic meaning can be a trigger to arousal in most individuals.

If conditioning is of sufficient strength it is also possible to produce another conditioned stimulus from the original one. Pavlov (1928) began pairing an original conditioned stimulus (a metronome click) with a different type of stimulus (a black square) when eliciting a conditioned response of salivation in his dogs. After several trials the dog began to salivate at the sight of the black square alone, which had become conditioned stimulus in this process of **second order conditioning**.

1.3.2 Generalisation and discrimination

It would be a mistake to think that the conditioned stimulus must be identical each time to elicit a conditioned response. Indeed, the evolutionary validity of conditioning would be questionable if this was the case. Instead the conditioned stimulus is open to **generalisation**, meaning that the subject of conditioning is open to a range of stimuli similar to the original stimulus. For example, a bird might be attracted (conditioned response) to bushes with a certain type of red flower (conditioned stimulus) because they harbour a certain kind of insect that the bird likes to eat (unconditioned stimulus). However, the bird might also be attracted to bushes with similar shaped orange or yellow flowers too. Specifically, the more similar to the original conditioned stimulus another stimulus is, the stronger the response. There must be a happy medium between useful generalisation and a lack of **discrimination**. Discrimination is another form of learning that finely "tunes" the conditioned response. For instance, to use the bird and flower analogy again, the bird might find a bush with very similar shaped pink flowers to that which contains its favourite meal. What will occur is that the bird will initially visit these similar bushes but eventually, due to lack of reinforcement in the form of its favourite food, will discriminate against these bushes.

Pavlov carried out various experiments to examine the relationship between generalisation and discrimination. Some of these studies were fairly innocuous, for example, training dogs to discriminate between bells of different pitches. The results of these experiments were that dogs were conditioned to respond to one type of bell pitch, but not to respond to another, so demonstrating discrimination. However another of his studies in this area produced severe disturbances in the behaviour of his canine subjects, an effect that Pavlov called **experimental neurosis**.

1.3.3 Experimental neurosis

Experimental neurosis clearly demonstrates that in certain conditions of ambiguity discrimination and generalisation can cease to neurotic behaviour (more accurately extreme confused distress) at least in dogs. Pavlov (1927) conditioned several dogs so that a circle elicited a conditioned response but an ellipse did not. He then manipulated presented ellipses until they were virtually circles. Unsure of how to respond the dogs shook with distress, losing both bowel and bladder control.

1.3.4 Classical conditioning regimes

It takes more than one pairing of a conditioned stimulus with an unconditioned stimulus in order to elicit a conditioned response. The learning regimes under which such pairing takes place have implications for the subsequent strength of the conditioning. When conditioned and unconditioned stimuli are both present on a learning trial (e.g. bell and food) this is termed a **reinforced trial**, whereas trials with the conditioned stimulus presented in isolation are called **unreinforced trials**. In general, the greater the number of reinforced trials to which an animal is exposed, the stronger the conditioning will be. However, not all trials increase the strength of the response to an equal degree, and there is a noticeable reduction of effect after a certain point. This effect can be shown in a simple idealised learning curve (see Figure 1.4).

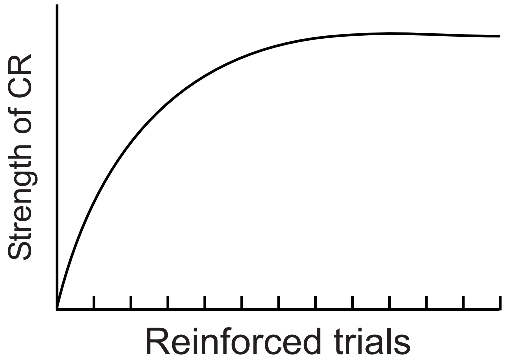


Figure 1.4: A graph showing a typical learning curve for classical conditioning reinforcement trials.

1.3.5 Extinction of conditioned responses

It is clear that a conditioned response will not continue to be produced at the same strength for a conditioned stimulus if the unconditioned stimulus does not appear again. Indeed a certain point is reached when the conditioned response, in the absence of the unconditioned stimulus it was originally paired with (e.g. the bell without the food), gradually decreases in strength until it no longer elicits a conditioned response. This process, called **extinction**, can be seen in the graph, which again refers to Pavlov's dog, shown in Figure 1.5. The graph shows that, as the unreinforced trials progress, the amount of saliva produced by the dog decreases as it gradually learns that the bell does not mean that food is guaranteed to appear. Note that if the same conditioning is again carried out with the same subject after extinction, a process called **reconditioning**, then conditioning will be occur far more rapidly than it did initially.

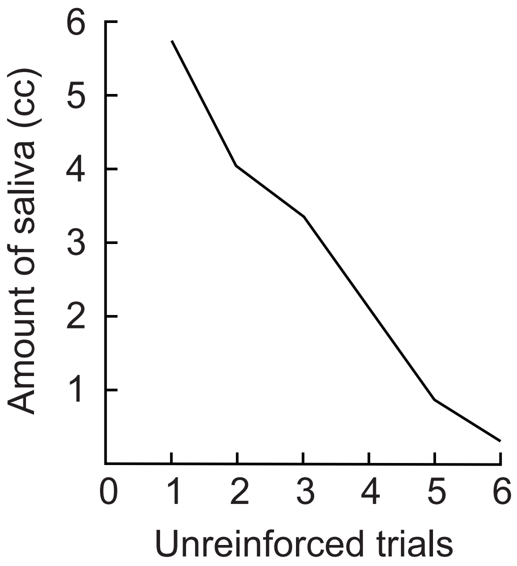


Figure 1.5: A graph showing an extinction curve of a conditioned response in the absence of the unconditioned stimulus.

1.3.6 Measurement of conditioned response

There are several different methods for measuring the strength of a conditioned response. A common method is to record the **response latency**. This involves examining the time it takes for a conditioned response to appear after presentation of the conditioned stimulus; the weaker the conditioning is, the greater the temporal duration between stimulus and response. A more obvious method of measuring the strength of conditioning is to simply measure the "product" of the conditioned response. In Pavlov's experiments this entailed examining the amount of saliva produced by the dogs. However, such **response amplitude** measurement may not always be as straightforward. One further method of measuring the strength of conditioning is by examining the **probability of response**. This is the number of trials in which presentation of the conditioned stimulus elicits a conditioned response.

1.3.7 Emotion and Conditioning

So far discussion of classical conditioning has concentrated very much on the mechanisms involved and a description of relatively simple conditioned responses such as the salivation of dogs or birds visiting a certain type of bush. However, conditioned responses can be far more complex than these behaviours and often the conditioned stimuli will elicit an emotionally based response producing heart rate change, hormonal release and so forth. One controversial type of conditioned emotional response, conditioning of phobias, is discussed in the next section.

1.4 Conditioning and Phobias

1.4.1 Classical conditioning in humans

Watson and Rayner (1920) employed conditioning in an ethically dubious manner when carrying out research into the nature of phobias. A nine month old male infant was selected by the researchers, due to him being healthy and "unemotional"- which presumably meant that the child wasn't prone to excessive crying. They then examined the child's reaction to various stimuli including flames, real rats and monkeys, cotton wool and strange masks. The baby displayed no signs of fear when presented with these items and could only be frightened by Watson creeping up behind him and striking a metal bar with a hammer behind his head.

1.4.2 Conditioned phobia

At 11 months the infant was again presented with the rat, which he liked and attempted to stroke. However, every time the child did this Watson would strike the hammer onto the metal bar as before, frightening him. This conditioning continued over several weeks until eventually the unconditioned stimulus (the sound of the hammer striking the metal bar) became paired with the sight of the rat, which elicited a conditioned fear response. It was observed that the conditioned response soon generalised to other stimuli such as rabbits, dogs, fur coats and Watson's hair. Perhaps unsurprisingly, this generalised fear of hair was associated only with Watson (discrimination). It is unclear exactly when this repulsive demonstration of conditioning finally ended and if it caused long term adverse effects, but the initial effects were still being observed after a month.

As Gross (2001) points out, behaviour therapists hold that this is how all phobias are initiated in everyday life. Some individuals have a phobia of dentists and their tools- this can be understood because the fear and discomfort of a dentist visit (unconditioned stimulus) become paired with the dentist in his white coat and goggles, the sound of the drill and so on until these become conditioned stimuli to elicit conditioned responses of fear and discomfort.

Generally, with normal adult humans, other types of conditioning are easily overridden by verbal instructions. Davey (1983) found that merely telling volunteers that an unconditioned stimulus would no longer occur with the conditioned stimulus resulted in fully extinguishing the CR.

1.4.3 Removal of phobias by direct unconditioning

Happily, not all research into phobias and conditioning have been as unsavoury as those carried out by Watson and Rayner (1920). Jones (1924) described a two year old child who demonstrated phobias related to such stimuli as rats, rabbits, cotton wool and fur coats. The two year old was gradually introduced to the sources of his fear until the phobias disappeared. For instance, Jones introduced a caged rabbit into the room at times when the child ate his lunch and gradually moving the cage closer each successive lunchtime, eventually opening the cage door. The rabbit was soon being stroked, sitting on the child's knee, and was eventually allowed to sit on the food tray.

It seems clear that most phobias can be removed by such methods called **direct unconditioning** or, more commonly, **systematic desensitisation**. The reason these methods work is largely due to phobias being strengthened when the phobic avoids the object of fear rather than confronting it. Of course if an individual avoids an object of fear extinction cannot take place.

1.5 Summary

This topic has considered the themes of learning and classical conditioning. The nature of learning was initially considered before a simple for of learning, habituation was explained. Learning theory was then briefly outlined before a more in depth examination of classical conditioning was presented. Within this examination of classical conditioning Pavlov's original experiments with dogs, the concepts of generalisation, discrimination, second order conditioning and extinction were among the points discussed. Finally, the relationship between phobias and conditioning was explored with reference to early behaviourist experiments.

1.6 Further Reading

Gleitman, H, Fridlund, A.J., & Reisberg, D. (1999) *Psychology (5th Edition)*. London (Norton).

Gross, R. (2001) Psychology: *The Science of Mind and Behaviour (4th Edition)*. London (Hodder & Stoughton).

1.7 Assessment

Q1: Learning, according to Gross (2001) is best thought of in terms of an individual's-

a) Behaviour
b) Vocabulary
c) Potential for performance
d) Brain size

Q2: A simple form of learning that deals with stimuli that are often present is called-

a) Censoring
b) Organisation
c) Accommodation
d) Habituation

Q3: Conditioning can be split into two main types, operant and-

a) Abstract
b) Classical
c) Habitual
d) Remote

Q4: According to learning theory, the foundation for learned behaviours are-

a) Central nervous system condition
b) Innate reflexes and senses
c) A calm reflective personality
d) The length of nerves in the temporal lobe

Q5: Connections between events and behaviours are called-

a) Engagements
b) Synapses
c) Syntheses
d) Associations

Q6: Pavlov's 1904 Nobel Prize was won for studies into-

a) Conditioning
b) Canine behaviour
c) Psychology
d) Digestion

Q7: Dogs salivating at the sight of their food bowl are displaying a-

a) Conditioned stimulus
b) Unconditioned response
c) Unconditioned stimulus
d) Conditioned response

Q8: Classical conditioning has been observed in-

a) Sea shells
b) Ants
c) Roses
d) Bacteria

Q9: Hunger is conditioned in-

a) Most individuals
b) Few individuals
c) All individuals
d) No individuals

Q10: Producing a second conditioned stimulus from an existent conditioned stimulus is specifically called-

a) Pavlovian conditioning
b) Operant conditioning
c) Second order conditioning
d) Skinnerean conditioning

Q11: Conditioning being open to a range of similar stimuli is called-

a) Free range conditioning
b) Generalisation
c) Habituation
d) Closed range conditioning

Q12: "Fine tuning" of the conditioned response to a particular stimulus is called-

a) Pavlovian focusing
b) Discrimination
c) Optic fluctuation
d) Cognitive dissonance

Q13: Pavlov found ambiguity of stimuli when presented to dogs resulted in-

a) Reduced strength of conditioning
b) No effect
c) Experimental neurosis
d) Second order conditioning

Q14: An unreinforced trial is one in which the following is absent-

a) The unconditioned stimulus
b) The unconditioned response
c) The conditioned stimulus
d) The conditioned responsel

Q15: A large number of unreinforced trials usually result in-

a) Experimental neurosis
b) Habituation
c) Extinction
d) Associations

Q16: Examining the product of a conditioned response is called-

a) Probability of response
b) Response amplitude
c) Response latency
d) Habituation of response

Q17: Direct unconditioning is also called-

a) Systematic desensitisation
b) Brain washing
c) Habituation
d) Operant conditioning

Q18: If one of Pavlov's conditioned dogs was exposed to both bell and food, such a trial is termed-

a) Extinct
b) Generalised
c) Operant
d) Reinforced

Q19: Conditioning of the same subject with the same stimuli after extinction is called-

a) Reconditioning
b) Reverse conditioning
c) Second order conditioning
d) Generalised conditioning

Q20: After a large number of reinforced trials an organism will show-

a) A tendency to cease responding at all
b) A noticeable increase in generalisation
c) A marked reduction in strength of response
d) Experimental neurosis

Topic 2

Learning and Operant Conditioning

Contents

Learning Objectives

After studying this topic you should be able to:

- *Differentiate between puzzle boxes, shuttle boxes and Skinner boxes.*
- *Explain the differences between positive and negative reinforcement.*
- *Discuss the efficacy of the various reinforcement schedules.*
- *Understand how shaping can produce complex learned behaviour.*

Prerequisites

The student must have an understanding of the mechanisms underlying classical conditioning in order to comprehend the material discussed in this topic. A basic knowledge of psychology is also desirable.

2.1 Introduction

This topic examines several aspects of learning and operant conditioning. Firstly, the nature of operant conditioning is discussed with examples of Thorndike's law of effect and Skinner's modification of the theory illustrated by discussion of puzzle boxes and Skinner boxes. The ABC of operant conditioning and reinforcement is next considered, before an overview of the various reinforcement schedules and their merits, in terms of strength of effect and resistance to extinction, are discussed. Finally, negative reinforcement is examined in relation to rats before the learning of mental maps is discussed.

2.2 Foundations of Operant Conditioning

2.2.1 The Nature of Operant Conditioning

Operant conditioning or **instrumental conditioning**, as it is sometimes termed, along with habituation and classical conditioning, is one simple form of learning. The most popular examples of operant conditioning are those seen when animals, such as dolphins and dogs, are trained to do tricks for television or film. In such circumstances the animal has been trained to respond in a certain way (the behaviour) by use of operant conditioning. However, operant conditioning is far more profoundly implicated in the formation of behaviour than just as a form of animal training.

Skinner (1938) argued that most forms of behaviour in both humans and animals are not elicited passively by particular stimuli (**respondents**), but rather are voluntary determined in conjunction with the environment within which the organism operates. These latter examples of behaviour are called **operants** and it from these that the term operant conditioning is derived. It will therefore be clear that operant conditioning is an active rather than passive form of learning. Operant conditioning theory is based upon Thorndike's (1898) **law of effect** derived with his experiments with cats. Thorndike designed special experimental cages for cats that he called the **puzzle box**.

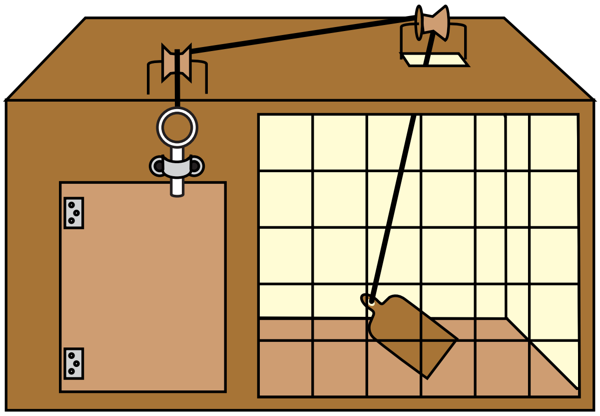


Figure 2.1: An example of Thorndike's (1898) puzzle box

2.2.2 Thorndike's Puzzle Box

Puzzle boxes were fitted with a special lever that, when pressed by a cat, would open the door to some favourite scrap of food such as fish. The cat would be able to see and smell the food from inside the puzzle box, but would not be able to reach it. The cats were unfed for some time before the experiment and so were extremely hungry. As soon as a cat managed to escape and ate the scrap of food it was caught and popped straight back into the puzzle box.

Thorndike noticed that, when initially put in the puzzle box, a cat would thrash about and attempt to escape in a totally random manner. Eventually the animated cat would accidentally depress the lever so allowing access to a scrap of fish. On average the initial escape occurred after about five minutes. However, after 10 or 20 trials the cat would typically escape in 5 seconds. The difference was due to learning in a trial and error style that led to a connection between the stimulus and response. In this case, the puzzle box's inner environment with which the cat could interact was the stimulus, while the response (operant) was pressing the lever allowing access to the fish. Thorndike's (1898) law of effect was formulated from these observations and states that the connection between a stimulus and the response is "stamped in" if the action results in pleasure, but "stamped out" if the reverse is true.

2.2.3 The Skinner box

Some four decades later Skinner designed a modified version of Thorndike's puzzle box, which in turn became know as the **Skinner box**. The Skinner box differed from Thorndike's box in that it was not designed so that animals escaped from it for food. Instead, the caged animal (Skinner favoured rats and pigeons over cats) was required to press a lever or peck a disc in a certain way in order to obtain a piece of food, the reward "stamping in" the appropriate behaviour. Skinner modified the wording of Thorndike's law of effect relating to "stamping in" and "stamping out" and replaced it with his own "strengthen" and "weaken" respectively, which he felt sounded more scientific.

2.3 Operant Conditioning and Reinforcement

2.3.1 ABC of Operant Conditioning

When analysing operant behaviour Skinner (1938) formulated his **ABC** set of explanations as to which mechanisms are at work when operant conditioning occurs. The acronym ABC stands for **Antecedents**, **Behaviours** and **Consequences**. Skinner held that analysis of behaviour entails close observation of the contingencies or interactive relationships between these three qualities. Antecedents are the collective stimuli employed that trigger a given behaviour or operant. For example, if a bird has to peck a coloured disc in order to obtain food, then that disc and the sound it makes are antecedents. Behaviours are simply actions or operants in which the organism engages; the pigeon tapping its beak on a coloured disc for example. The consequences are the results of the behaviour, in the pigeon example this means the appearance of a food pellet.

2.3.2 Consequences and Reinforcement

Skinner's modified law of effect states that the behaviour of an organism is affected by the end product of that behaviour. In other words, the organism's behaviours are moulded and either strengthened or weakened by the consequences. These consequences are either **reinforcement** of a positive or negative variety, or punishment. Consider the rat in its Skinner box. If the rat presses a lever and food is presented as a consequence then the rat is likely to continue with this operant because of positive reinforcement.

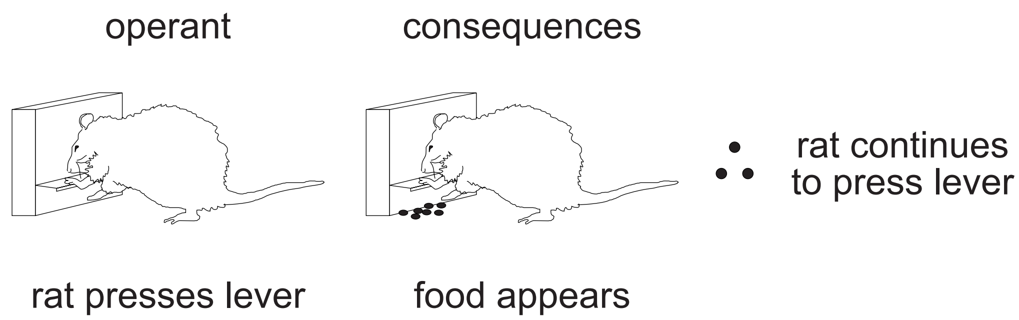


Figure 2.2: Positive and negative reinforcement of a rat in a Skinner box.

If the rat is being given a mild electric shock at regular intervals and pressing the lever switches off these shocks, then the operant is again reinforced. But in circumstances such as these the operant is negatively reinforced. Both these kinds of reinforcement therefore strengthen the performance of the operant. However, if an operant results in consequences of a negative nature, then that operant is weakened. For example if the rat pushes the lever and receives an electric shock for his troubles, the animal will be increasingly unlikely to engage in the operant the more often it occurs and will very rapidly avoid doing so altogether.

2.3.3 Reinforcers and Punishers

Reinforcers and punishers can only be defined as such in the light of the observed effects that they have upon the behaviour of an organism. This is because an effect that is intended by the consequences may not occur in reality. For instance, to use Skinner's example, a parent might chastise a misbehaving child in the belief that the child will stop "being naughty". However, smacking, that is viewed by the parent as a punisher designed to extinguish bad behaviour, may in fact act as a reinforcer if the child seeks attention from the parents, strengthening the bad behaviour operants.

2.3.4 Primary and secondary reinforcement

Just as in the case of unconditioned and conditioned stimuli in classical conditioning so there are primary and secondary reinforcers in operant conditioning. Primary reinforcers, such as sex and food, occur naturally and reinforce themselves. In contrast secondary reinforcers, like conditioned stimuli, achieve their reinforcing properties by dint of their association with primary reinforcers. In humans, Gross (2001) points out, a clear example of a secondary reinforcer is money, while the click of food appearing for a rat in a skinner box can become a secondary reinforcer.

2.3.5 Shaping

When seeing an animal performing amazing and complex tricks and routines, such as a budgie riding a bike, it is almost certain that such performances have been produced by use of shaping. Shaping works by reinforcing successively behaviours that approach ever nearer the goal behaviour until approximation finally becomes the desired behaviour. This is usually quite a prolonged process and is achieved by firstly breaking down the desired behaviour into steps. These steps are then reinforced in their normal sequence. Although Skinner employed shaping to train pigeons to play table tennis (see Figure 2.3) the technique has also been employed in less frivolous circumstances, such as in clinical behaviour modification. In this area especially shaping has been very fruitful and has been successfully employed, for example, in training the mentally handicapped to feed and dress without assistance.

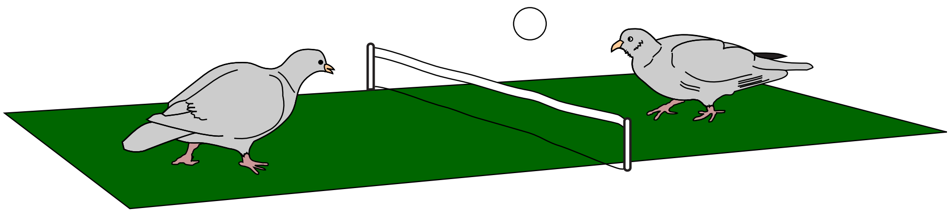


Figure 2.3: Skinner's table tennis playing pigeons.

2.3.6 Reinforcement Schedules

One of the most interesting, and indeed counterintuitive, aspects of Skinner's researches in the field of operant conditioning concerns the effects that different types of **reinforcement schedule** have on an organism's behaviour. Such schedules generally refer to how often reinforcement occurs and the temporal duration between reinforcements as a result of the appropriate operant. Ferster and Skinner (1957), who carried out an in depth study of various schedules of reinforcement using rats and pigeons, discovered five distinct types of schedule.

2.3.7 Types of Schedules

Reinforcement schedules are characterised by their individual patterns and rate of responding and their resistance to extinction. The five schedules of reinforcement that were identified by Ferster and Skinner are **continuous**, **fixed interval**, **variable interval**, **fixed ratio** and **variable ratio** (See Figure 2.4). The most obvious schedule is that of continuous reinforcement (CRF) where every appropriately performed operant is reinforced. In CRF the response rate in terms of, for example, lever pressing is steady but quite low. It is also the reinforcement schedule most susceptible to extinction. CRF is typically only employed when a novel operant is being learned, but Skinner (1938) found the change to one of the other four contingencies must be gradual or the response will be subject to extinction.

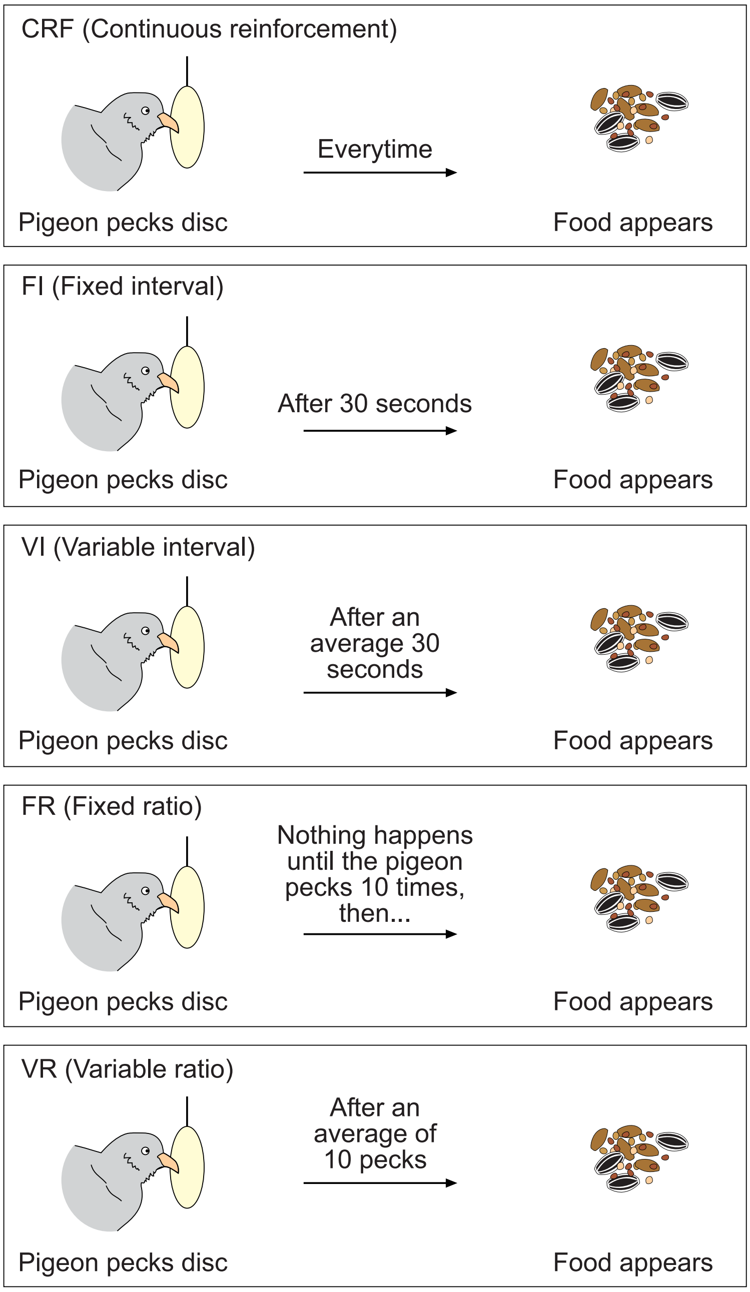


Figure 2.4: The five reinforcement schedules.

If reinforcement is presented, for instance, every 30 seconds, providing an operant has occurred at least once in the period since the last reinforcement, then this is a fixed interval (FI) reinforcement schedule. Ferster and Skinner noted that although frequency of operants increased as the fixed interval approached, after reinforcement the operant response stopped for a time. Response rate and extinction resistance were both little better than observed with CRF.

Variable interval (VI) reinforcement is given on average every 30 seconds but, as the name suggests, reinforcement intervals vary on each trial. This results in a stable response rate, but with some operant increase as time elapses since the last reinforcement. This schedule has high resistance to extinction. Fixed ratio (FR) reinforcement occurs only after a certain number of operant responses. This results in a very long pause in operant response after reinforcement, followed by a very high operant response afterwards until reinforced again. This produces the same extinction pattern as VI- high resistance. Variable ratio (VR) reinforcement is given on average every 10 responses, but varies on each trial. This produces very high and steady response rates and a very high resistance to extinction.

It can be seen from the research carried out by Skinner and Ferster (1957) that the less an organism is reinforced the stronger the operant becomes. Infrequent reinforcement produces more "work activity" in terms of operant behaviours such as lever pushing than does continual reinforcement.

2.4 Negative Reinforcement and Mental Maps

2.4.1 Avoidance Learning

The nature of negative reinforcement has been examined via the techniques of **avoidance learning**. Avoidance learning should not be confused with escape learning, in which an operant is performed to remove an undesired stimulus, a budgie tapping a disc to stop electric shocks for example. Avoidance learning has been examined by employing **shuttle boxes**. Shuttle boxes are split into two halves and typically have a dividing door in the centre. Electric shocks can be delivered to either side, but the captive rat is warned of impending shock by a signal such as a light coming on. When this signal is observed the rat can relocate to the safe side of the shuttle box.

Miller (1948) similarly trained rats to run through an open door between a white and black room by administering shocks when the rat ventured into the white room. They were then placed in the white room with the door to the black room shut but no further shocks were administered. However, the rats were so anxious while in the white room that they quickly learned to open the door by moving a wheel, so allowing them to run into the black room to "safety". Rats will typically continue escaping indefinitely despite the shock never being administered again, as negative reinforcement is far more resistant to extinction than positive reinforcement. Such avoidance learning works, according to Gray's (1975) two-process theory, by the rat initially pairing the signal with fear of pain through classical conditioning. Following this, the rat's avoidance response (changing to the opposite side of the shuttle box when the light appears for example) is negatively reinforced.

2.4.2 Classical and Operant Conditioning

It can be seen that in some circumstances, such as the two process theory of avoidance learning outlined above, that classical and operant condition can work in close association to produce a pattern of behaviour. However, it is often not entirely clear what the main differences and similarities are between the two types. Gross (2001) offers several points on which the two kinds of conditioning differ. For example, whereas both types of conditioning are forms of associative learning, featuring generalisation, discrimination, extinction and spontaneous recovery, classical conditioning guarantees a response on presentation of the stimulus but operant conditioning offers no such certainty, only a likelihood of a response. Furthermore, classical conditioning involves formation of novel stimulus response connections whereas operant conditioning effects are based upon employment of an organism's pre-existing behavioural tendencies, modifying these by either strengthening or weakening them. In classical conditioning response is measured in latency or response magnitude, in operant conditioning the main measurement is response rate.

2.4.3 Mental Maps

Tolman explained the behaviour of rats learning a route around mazes in terms of cognitive processing, calling the product of such learning mental maps. Tolman and Honzic (1930) split rats into three distinct groups then allowed them to find their way though a specially constructed maze. The groups differed according to their reinforcement schedules with group A gaining reinforcement each time they found their way through the maze. Group B however received no reinforcement at all, while group C only began to receive reinforcement after 10 days of maze solving. The performance of group C rats was comparable with those belonging to group B that never increased the speed of maze solving, until day 11 when they began to be reinforced. Thereafter, group C performed as well as group A. This is an especially surprising outcome as it took group A 10 days of progressive learning to reach this level (see Figure 2.5)

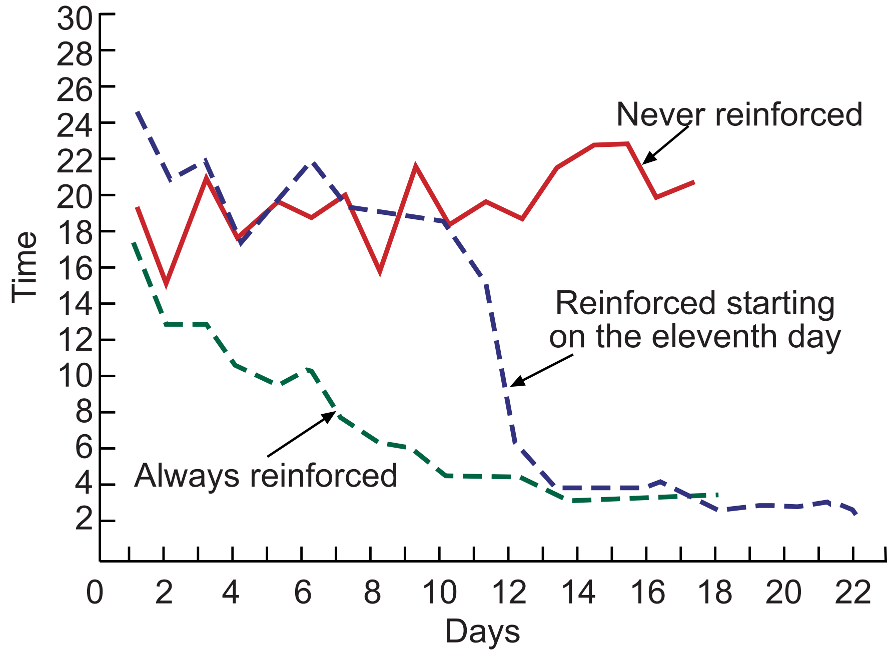


Figure 2.5: Latent learning in three groups of rats.

Tolman and Honzik (1930) reasoned that the performance of group C indicated **latent learning**. According to the theory of latent learning the group C rats had indeed learned the intricacies of the maze as well as those rats from group A. Group C rats however did not display this learning as explicit behaviour until they were reinforced. It seems then that reinforcement is not always crucial in terms of learning, but may be required to elicit performance of behaviours related to that learning.

Further research into the abilities of rats to solve mazes led to Tolman formulating the **sign learning theory** (Tolman 1948). According to sign learning theory, rats learn **expectations** when solving mazes. Expectations can be thought of as indications as to what section of a maze follows on from a previous section. It seems reasonable to suppose that expectations are utilised by a rat for negotiating it's natural environment as well as when solving mazes in laboratory experiments. It soon became clear to Tolman that expectations are based upon a visuo-spatial plan of a given environment that is termed a **mental map**.

Mental maps would seem to be accurately formed in terms of spatial expectations and their relative locations based upon the evidence of experimental studies. For example, Tolman, Ritchie and Kalish (1946) found that when they blocked a crucial path in a maze that rats had previously learned, the rats would take short cuts that indicated they knew the direction of the maze exit and the routes leading to it. Furthermore, Restle (1957) found that rats were just as proficient in swimming to food through a previously learned maze that had been flooded. This result shows that the rats were not just relying upon the learned repetitive motor actions of walking to solve the maze. Such findings suggest that learning is not just dependant upon physical conditioning, but that a cognitive aspect is also implicated.

2.5 Summary

This topic has examined learning and operant conditioning in terms of several core issues. Operant conditioning was initially discussed in relation to Thorndike's law of effect and Skinner's modification of the theory. This discussion was illustrated by reference to animal studies carried out with both puzzle boxes and Skinner boxes. The ABC of operant conditioning and reinforcement was then examined before the various reinforcement schedules and their effects were considered. Next, negative reinforcement was examined before finally, the mental maps of rats were briefly discussed.

2.6 Further Reading

Gleitman, H, Fridlund, A.J., & Reisberg, D. (1999) *Psychology (5th Edition)*. London (Norton).

Gross, R. (2001) Psychology: *The Science of Mind and Behaviour (4th Edition)*. London (Hodder & Stoughton).

2.7 Assessment

Q1: Another name for Operant conditioning is-

a) Gestalt conditioning
b) Classical conditioning
c) Pavlovian conditioning
d) Instrumental conditioning

Q2: Voluntary behaviours encouraged by the environment are called-

a) Respondents
b) Consequents
c) Operants
d) Tangents

Q3: Operant condition should be viewed as-

a) Active learning
b) Indifferent learning
c) Passive learning
d) Faulty learning

Q4: Thorndike's Law of Effect was formulated after experiments with-

a) Apes
b) Rats
c) Cats
d) Mice

Q5: The main difference between a puzzle box and Skinner box is that-

a) The puzzle box is only suitable for pigeons
b) The Skinner box has one half electrified
c) Animals don't need to leave the Skinner box for reinforcement
d) A central door divides the puzzle box

Q6: After 20 trials a cat could typically escape Thorndike's cage in-

a) 90 seconds
b) 5 seconds
c) 120 seconds
d) 45 seconds

Q7: Skinner's term "weaken" replaced Thorndike's original term-

a) Exhausted
b) Wilted over
c) Tuned down
d) Stamped out

Q8: In the ABC of operant conditioning, the B stands for-

a) Barriers
b) Bias degrees
c) Biological conditioning
d) Behaviours

Q9: Collective stimuli that trigger an operant are termed-

a) Subscribers
b) Animators
c) Reactioners
d) Antecedents

Q10: An example of a secondary reinforcer is-

a) Money
b) Sex
c) Food
d) Shelter

Q11: An organism's behaviours are strengthened or weakened by-

a) Mental maps
b) Consequences
c) Operants
d) Reflexes

Q12: Handicapped individuals have learned to dress themselves by-

a) Classical conditioning
b) Pavlovian techniques
c) Mental maps
d) Shaping

Q13: Which of the following is not a reinforcement schedule-

a) Continuous reinforcement
b) Delayed reinforcement
c) Fixed interval reinforcement
d) Variable ratio reinforcement

Q14: CRF refers to the correct operant being reinforced-

a) Never
b) Every time
c) Only occasionally
d) Every 5th time

Q15: Resistance to extinction following VI reinforcement is-

a) Extremely high
b) Extremely low
c) Non-existent
d) Average

Q16: Generally, the less the reinforcement, the more an operant is-

a) Reversed
b) Confused
c) Strengthened
d) Weakened

Q17: Miller's rats ran into the black room due to-

a) Positive reinforcement
b) Avoidance learning
c) Escape learning
d) Presence of food

Q18: Gray's (1975) theory that involves classical conditioning is called-

a) Fixed ratio theory
b) Three process theory
c) Two process theory
d) Multiple ratio theory

Q19: Tolman and Honzic's group C rats performed badly at first because of-

a) Latent learning
b) Negative conditioning
c) Spontaneous recovery
d) Generalisation

Topic 3

Memory Models and Long Term Memory

Contents

Learning Objectives

After studying this topic you should be able to:

- *Differentiate between encoding, storage and retrieval.*
- *Understand the relationship between meaning and processing.*
- *Discuss ways in which the major models of memory differ.*
- *Demonstrate awareness of the aspects and organisation of long term memory.*

Prerequisites

The student is expected to have some prior knowledge of cognitive psychology and the information processing approach to human cognition as regards concepts such as sensation, perception, attention, schema theory and so forth.

3.1 Introduction

This topic is a basic introduction to some of the models and concepts associated with memory. Specifically, after outlining the three processes of memory, three key models are investigated. The models discussed are the two component model, the modal model, and the levels of processing model. The relative merits of each of these models are discussed in terms of encoding, storage, and processes involved. A brief overview of long term memory is finally presented, discussing its various subtypes and the brain areas implicated.

3.2 The Theories of Memory

3.2.1 Three Processes of Memory

Memory underlies most of conscious human functioning recall of faces, language and so on (Stirling 2002). Memory can be more readily understood as a series of processes and stores. The three main memory processes are **encoding**, **storage** and **retrieval** (see Figure 3.1). Encoding entails the registering of incoming sensory information from the environment in a form suitable for manipulation by the human memory system. Storage involves just what it suggests, the storage of some or all of the information that been encoded within the cognitive system and available to memory. Retrieval involves extraction of stored information from memory. In simpler terms, any act of remembering, such as recalling what you had for lunch two days ago is an act of retrieval. These processes should become clearer and more defined as memory processes are discussed in Figure 3.1.

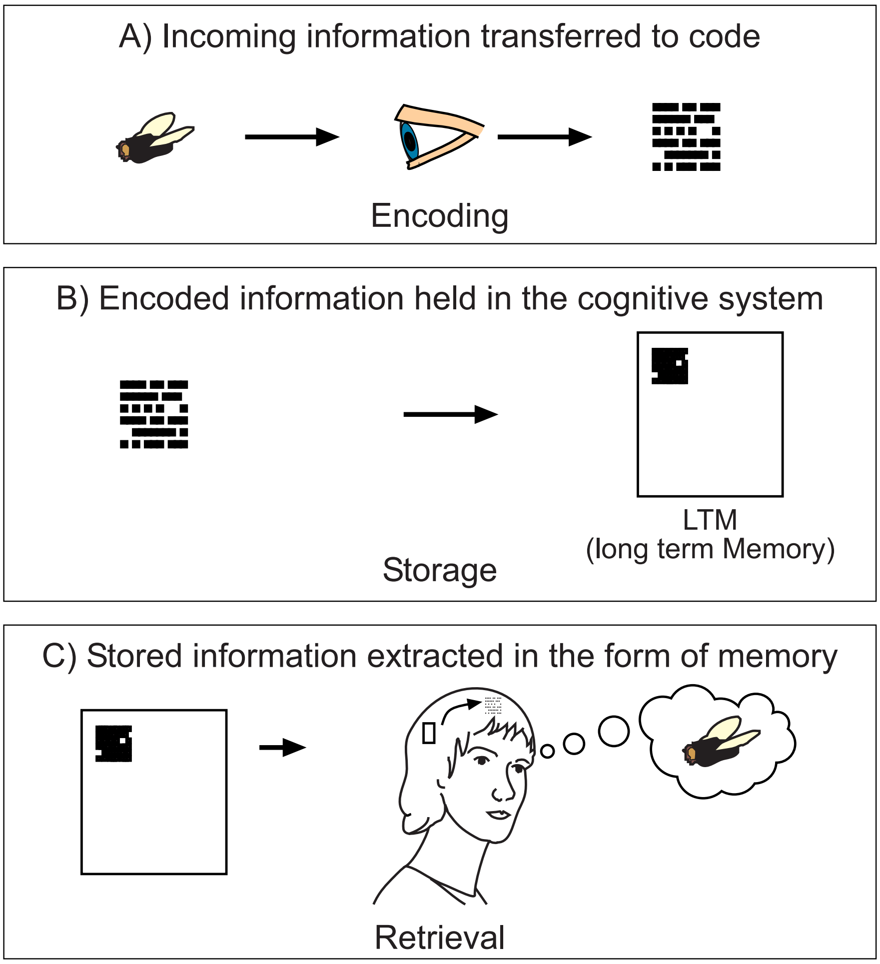


Figure 3.1: The Three Processes of Memory: Encoding, Storage and activation.

3.2.2 Past Influences on Memory Theory

Half a century ago, in the 1950s, models of memory were generally taken to refer to a **unitary** concept, or single system, although several great thinkers of the remote past, such as Locke, Bain and James, had at least toyed with the idea of memory being more than a single entity (Logie 1996). Indeed James in particular has informed much modern thinking on the subject of memory. James (1890) proposed that human memory is characterised by two distinct stores. He distinguished between a **primary memory**, that contains the present contents of conscious attention, and a **secondary memory**, which he saw as containing past experiences.

3.2.3 Waugh and Norman's (1965) Model

The advantages of viewing memory as having more than one component became clear by the mid 20th century. Information must be retained for short periods in order to perform everyday tasks like remembering a new phone number and this would seem to employ a different system to that of general knowledge or past experiences. The first lucid modern model of memory to offer a non-unitary system of memory was that of Waugh and Norman (1965) that became known as the **two component model**. Their model, informed by James (1890), and adopting his terminology, postulated a **short term memory** store (primary memory) and a **long term memory** store (secondary memory). Primary memory was viewed as a mechanism that stores information for only a short time before being replaced with new material. The primary memory store was therefore seen as having **limited capacity**. This replacement was thought to occur unless the initial information held was **rehearsed**, or repeated to oneself mentally, for a sufficient duration in order that it is transferred to secondary memory. This latter component was thought of as a long term storehouse of past memories without the limitations of capacity and transience of storage duration proposed for primary memory.

3.2.4 Evidence For The Two Component Model

The evidence for the two component memory of Waugh and Norman at first appeared convincing. Glanzer and Cunitz (1966), for example, found that if an individual is presented with a list of words and then attempts to recall them in no particular order (**free recall**), an effect termed the **serial position curve** is observed. The serial position curve refers to the graphic representation of the pattern in which an individual typically recalls the words. Initially the last few words on the list are recalled (**the recency effect**) followed by the first few items on the list (**the primacy effect**) and then lastly, some words from the middle of the list are recalled. This produces the characteristic curve when plotted graphically (see Figure 3.2). Any interfering incident, such as asking the learner to count backwards following presentation of the words, results in loss of the recency effect.

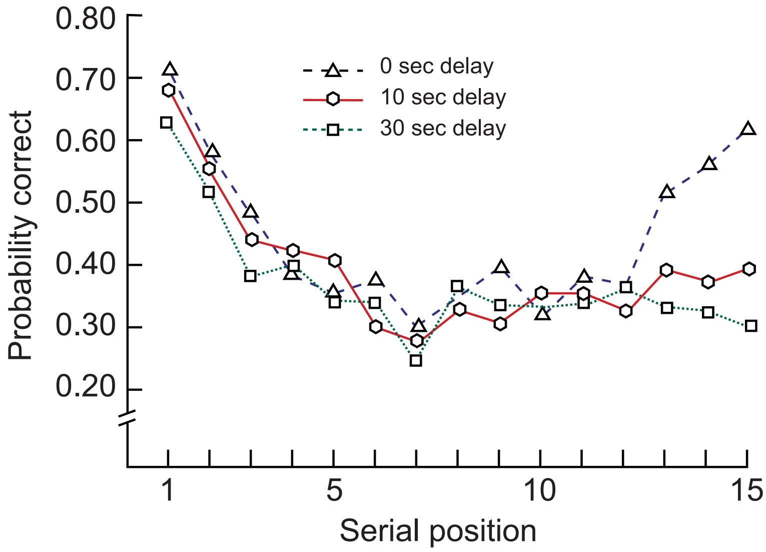


Figure 3.2: An example of the serial position curve generated in free recall tasks.

This phenomenon was taken to indicate that the recency effect was the result of those items stored in primary memory and that the interference resulted in these items being dislodged and unable to be retained by rehearsal. Although doubts later arose about this interpretation of the serial position curve, at the time it was accepted as being a elegant demonstration of the existence of two memory systems and, as such, served the useful purpose of encouraging researchers to look beyond a simple unitary model of memory.

3.2.5 Evaluation of the Two Component Model

Although Waugh and Norman's (1965) model was a step forward in terms of memory models, suggesting interactions between two distinct cognitive components, it did lack details of how these postulated perceptual processes occurred. Most obviously the model was of a passive nature and did not presuppose an active role in the processing of incoming information. In addition, the postulated primary store was only described as handling verbal information with the result that the processes involved in dealing with incoming information of, for example, a visual nature were not addressed unless it was taken that all non-verbal information is transformed into linguistic codes in order that it be processed. Such a procedure is clearly not an adequate explanation of how the rich variety of non-linguistic information is handled by the cognitive system. However, few years afterwards a model of memory was proposed by Atkinson and Shiffrin (1968) that went some way towards addressing these problems.

3.2.6 The Modal Model of Memory

Atkinson and Shiffrin (1968, 1971), in their modal model of memory (see Figure 3.3), viewed short term memory as a unitary concept, with limited storage and capacity, within which disparate control processes deal with retention of incoming information and transference and storage of this information to long term memory. They also viewed short term memory as a short term **buffer**: a temporary store responsible for storing and processing incoming sensory information. These two functions of storage and processing were not mutually exclusive and this meant that the greater the processing task, the less capacity for storage, with the reverse also being true. These control processes, such as verbal rehearsal and the manipulation of visual imagery, inferred an active participation for the individual, being dynamic and subject to conscious influence unlike the passive, automatic model previously offered by Waugh and Norman (1965). Additionally, unlike Waugh and Norman's model, the modal model did allow for the processing of information from modalities other than that derived verbally. Nevertheless, there were still problems associated with the modal model that required attention.

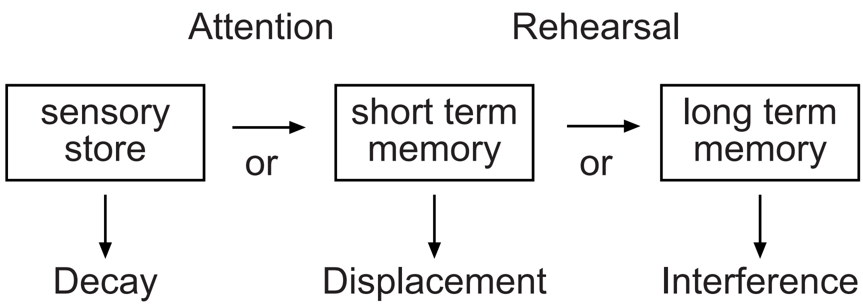


Figure 3.3: The modal model of memory (Atkinson & Shiffrin 1968)

3.2.7 Evaluation of the Modal Model

The modal model was still vague in several areas, notably the exact nature of the hypothesised control processes. Atkinson and Shiffrin (1968) failed to elaborate upon why certain processes dealing with the transfer of information into long term memory were superior to others (Logie 1995). In contrast, the "level of processing" model proposed by Craik and Lockhart (1972), which is described below, concentrated in detail upon such processes. The important point to bear in mind here though is that the modal model employed the same "gateway" theory of short term memory, as did its predecessor. That is, before entering into long term memory, information must firstly be processed by short term memory. However, the basic mechanism inherent in Atkinson and Shiffrin's (1968) two component model were supported by data from the above mentioned serial position curve and also from the inability of some patients with amnesia to store or retrieve information from long term memory, despite being able to repeat back a string of digits presented to them at a near normal rate. Milner and Vaughan 1968 had previously reported this dichotomy between long term memory functioning and performance on **digit span** tasks when testing patients with amnesia. Digit span refers to the amount of numbers a person can be told and repeat back without making a mistake, about seven being the normal span.

3.2.8 Levels of Processing Model

Craik and Lockhart's (1972) **levels of processing** model dealt more fully with the manner in which information is processed via perceptual and attentional mechanisms than did previous attempts to delineate the mechanisms and processes underlying memory. They postulated that physical, purely perceptual, features of perceived stimuli, for example shape, are subject to **shallow processing** via rehearsal, while meaningful or **semantic** features are deeply processed. Such **deep processing** is thought to produce a stronger **memory trace** in long term memory and, therefore, improved subsequent recall of such information. A memory trace can be viewed as the physical basis of a given memory, established through whatever physical processes, stored in the brain.

Deep processing was held to occur due to stimuli being semantically associated to other stored material and/ or being elaborated through use of imagery. According to Craik and Tulving (1975) an example of shallow processing would involve classifying words as either uppercase or lower case while deep processing would entail judging whether a word could meaningfully fit into an incomplete sentence. A separate short term memory component was viewed by Craik and Lockhart as responsible for rehearsal and also for the basic judgements regarding the semantic and lexical content of the material being processed.

3.2.9 Evaluation of the Levels of Processing Model

There are some drawbacks with the levels of processing model. The model dealt more with the differences of information coding than with the architecture and functions of short term memory. More importantly, although Craik and Lockhart's (1972) model appears to be valid intuitively, Baddeley (1978) pointed out that the theoretical model lacked an objective measure of processing depth independent of the results derived from their experiments. However, the model does, in general, contain valid theories regarding the relationship between methods of encoding information and the strength of the subsequent memory traces produced by such methods.

3.3 Long Term Memory

3.3.1 Varieties of Long Term Memory

It should have become clear at this stage that knowledge and experiences are stored in the form of long-term memories. The nature of these long term memories are not immediately apparent and several theories and models of memory systems have been offered to account for the way in which knowledge is stored in long term memory. Note that the different varieties of long term memory need not suggest different cognitive systems at work; rather they might refer to different aspects of one system. One theory concerns a dichotomy between **declarative** and **procedural** memory. Simply stated, declarative memory is concerned with explicit, factual knowledge, whereas procedural memory is largely unconscious and often a "body memory" concerned with patterns of motor learning, largely or entirely devoid of factual knowledge. A good example of procedural memory is remembering how to ride a bike. However, further detailed investigation of the dichotomy between declarative and procedural memory would be too complex a task within this topic and therefore a second dichotomy, between episodic and semantic memory, will be investigated. It is useful to note though that both of these forms of memory can be classified as being declarative rather than procedural.

3.3.2 Episodic and Semantic Memory

Tulving (1972) distinguished between two main forms of long term memory that he termed episodic and semantic. Episodic memory can be viewed as the storage and retrieval of personal experiences that can be specified as occurring at a definite place and time. Memory for what you bought in a shop the other day is therefore classed as episodic. Tulving and colleagues later gave a more specific description of episodic memory as being dependent upon an awareness of specific moments in one's personal past (Wheeler, Stuss, & Tulving 1997). Semantic memory, on the other hand, is knowledge about the world in general, an amassed store of impersonal information unrelated to a time and place of a specific learning episode. So words and symbols, mathematical formulae, the ability to read music, what was learned for school exams, these are all classed as semantic knowledge.

Wheeler et al (1997) state that the cognitive system, in all probability, has very similar methods of registering episodic and semantic memories, mainly because they are inextricably linked. Specifically, they state that there is not a known method of encoding information into semantic memory without encoding corresponding information into episodic memory and vice versa.

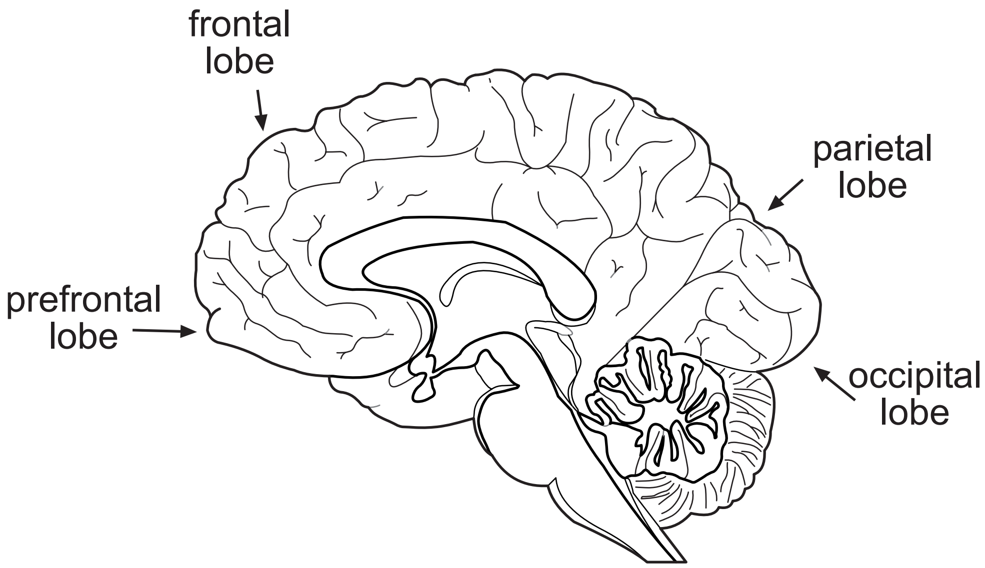


Figure 3.4: The Prefrontal Cortex implicated in both episodic and semantic memory processing.

3.3.3 Mediating Brain Areas

As Eysenck (2001) states, this statement by Wheeler et al (1997) crucially depends upon episodic memory being encoded by cortical networks mediated by the **prefrontal cortex** of the brain (see Figure 3.4). There is neurological evidence to support this. Some patients with frontal lobe damage cannot recall when specific pieces of information were learned. The right prefrontal cortex has also been found to be more active in brain scans when episodic memories were being retrieved than for semantic memory retrieval. Conversely, the left prefrontal lobe has been observed as being more active during episodic encoding. According to Wheeler et al (1997) this supports the theory that the two main points of distinction between semantic and episodic memory are that episodic involves awareness of a subjective experience connected to the recollection whereas semantic memory recall features no personal awareness. Note that the prefrontal cortex is implicated in episodic memory processing to a far higher degree than observed during semantic memory processing.

3.4 Summary

This topic has discussed some basic aspects of human memory and the explanatory models offered to account for its processes. Specifically, the theories of memory in terms of cognitive models were examined in terms of the two component, modal, and level of processing models. The relative merits of these three key models were investigated in terms of both storage and processing capabilities. Long term memory was then briefly discussed in terms of different dichotomies such as declarative and procedural, and episodic and semantic. Finally, brain areas mediating aspects of long term memory were considered.

3.5 Further Reading

Baddeley, A.D. (1997) *Human Memory: Theory and Practise (revised edition)*. Hove: Psychology Press.

Eysenck, M.W. & Keane, M.T. (2000) *Cognitive Psychology: A Student's Handbook (4th Edition)*. Hove: Psychology Press.

Gleitman, H, Fridlund, A.J., & Reisberg, D. (1999) *Psychology (5th Edition)*. London (Norton).

Gross, R. (2001) *Psychology: The Science of Mind and Behaviour (4th Edition)*. London (Hodder & Stoughton).

3.6 Assessment

Q1: One of the three main processes of memory is-

a) Encoding
b) Forgetting
c) Manipulation
d) Cell growth

Q2: The extraction of stored material in memory is called-

a) Recovery
b) Requisition
c) Recombination
d) Retrieval

Q3: James's term for short term memory was-

a) Fragmentary memory
b) Primary memory
c) Transient memory
d) Miniscule memory

Q4: One feature of the short term store in two component model is-

a) Manipulation of rich visual imagery
b) Verbal rehearsal
c) An unlimited capacity
d) An integral supervisory attentional system

Q5: Attempts to remember a list of items in no particular order is called-

a) Disordered remembering
b) Non-serial memory
c) Free recall
d) Digit span

Q6: The graphic representation of recall of a list in no particular order is called-

a) A serial position curve
b) A scree plot
c) A stem and leaf plot
d) A normal distribution curve

Q7: The "buffer" of the modal model was viewed as responsible for information processing and-

a) Storage
b) Metamorphosis
c) Consolidation
d) Combination

Q8: The idea that short term memory is the only route that information can take into long term memory is called the-

a) Limited capacity theory
b) Processing corridor theory
c) Vestibule theory
d) Gateway theory

Q9: The modal model was partially supported by near normal digit span observed in-

a) Prosopagnosia patients
b) New born babies
c) Patients with amnesia
d) Patients with Alzheimer's dementia

Q10: The modal model differed from the two component model largely because it was-

a) Solely concerned with verbal processing
b) More with dynamic processes
c) An altogether more passive model
d) Unitary

Q11: Craik and Lockhart's (1972) model of memory suggested purely perceptual features were only subject to-

a) Procedural processing
b) Semantic processing
c) Focussed processing
d) Shallow processing

Q12: Deep processing is thought to produce a-

a) Weak memory trace
b) Confused memory trace
c) Irretrievable memory trace
d) Strong memory trace

Q13: One suggested method of deep processing involves elaboration by-

a) Consolidation
b) Rehearsal
c) Use of imagery
d) Reversing the order of a sentence

Q14: The levels of processing model has been criticized for not utilising-

a) An objective measure of processing depth
b) A subjective measure of visual imagery
c) An objective measure of verbal information
d) An objective means of testing rehearsal

Q15: A variety of long term memory that is largely unconscious is:

a) Autobiographical memory
b) Procedural memory
c) Working memory
d) Primary memory

Q16: Declarative memory is concerned with remembering of information such as:

a) How to ride a bike
b) What to do when walking up stairs
c) The answers to biology exam questions
d) The way to play a tune on the guitar

Q17: Episodic and Semantic memory were first distinguished between by-

a) Atkinson & Shiffrin
b) Baddeley & Hitch
c) Tulving
d) James

Q18: Recollection of personal events and the time and place they occurred is mediated by-

a) Procedural memory
b) Semantic memory
c) Sensory memory
d) Episodic memory

Q19: The area of the brain most implicated in episodic memory encoding is the-

a) Right prefrontal cortex
b) Right temporal cortex
c) Left prefrontal cortex
d) Left temporal cortex

Q20: Episodic memory and Semantic memory can both be viewed as forms of-

a) Declarative memory
b) Short term memory
c) Procedural memory
d) Working memory

Topic 4

Working Memory

Contents

Learning Objectives

After studying this topic you should be able to:

- *Differentiate between the sub-components of working memory and their functions.*
- *Understand the relationship between working memory and long term memory.*
- *Discuss ways in which the use of interference elucidates the functioning of the slave systems.*
- *Demonstrate awareness of the role of consciousness and attention in working memory.*

Prerequisites

The student is expected to have some prior knowledge of cognitive psychology and the information processing approach to human cognition as regards concepts such as sensation, perception, attention, schema theory and so forth. A sound knowledge of the main models of memory is also crucial to ease of understanding in this topic.

4.1 Introduction

This topic investigates the model of working memory from several perspectives. Initially the main components of working memory, the central executive, phonological loop and visuo-spatial sketch pad are introduced before examining each of these components in greater detail. Specifically, the central executive is first discussed in relation to attention and coordination of the slave systems and its similarities with the supervisory attentional system. Next, the phonological loop is examined in relation to its temporal interval and capacity as well as in terms of the roles of its sub-components. Thirdly, the visuo-spatial sketch pad is discussed in relation to its sub-components and experimental evidence employing visual noise and mnemonics examined. Finally, the relationship between working memory and long term memory is discussed in some detail in relationship to the route into working memory, attention and conscious awareness.

4.2 The Nature of Working Memory

4.2.1 Working memory and long term memory

The basic model of working memory (see Figure 4.1) was informed by, and partially based upon, earlier less fully stated and conceptualised models of memory such as those formulated by Atkinson and Shiffrin (1968), Tulving (1972), and Waugh and Norman (1965). Since its initial conception working memory has been partially modified to explain new research findings (e.g.: Baddeley 1986, 1990, 1996). It is important to note though that working memory should be viewed as only a part of an individual's memory system and that it depends upon and utilises information stored in long term memory. Perhaps the best way to view working memory is as a greatly modified and improved version of short term memory as envisioned by the modal model, with subcomponents and an overall control system, but still having the ability to store and manipulate material for a limited duration. Long term memory can be viewed as containing stored memories and knowledge for a more or less permanent duration. Although unlikely to be of infinite capacity, the storage capabilities of long term memory are undoubtedly massive (Baddeley 1998), especially in comparison to working memory. The nature of the relationship between these two aspects of human memory is a crucial theoretical consideration and is discussed further later in this topic.

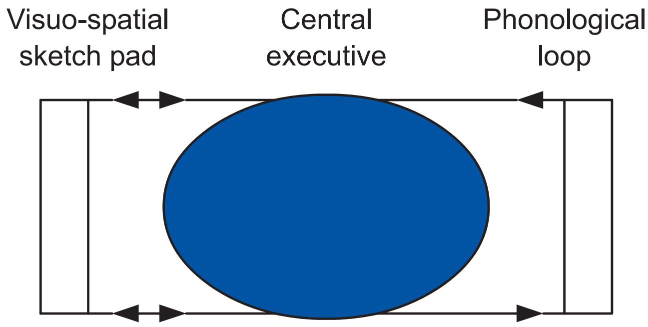


Figure 4.1: The model of working memory showing the central executive and slave systems (Baddeley & Hitch 1974).

4.2.2 The components of working memory

Working memory is an active, dynamic system; as Baddeley (1986) points out, short term memory is not just a passive store but also a workspace within which information is manipulated. This is an important consideration that is raised again presently. The model encompasses three major functional components: **the central executive**, controlling attention and resource allocation, and two "slave" systems, **the phonological loop** (or **articulatory loop**), dealing with auditory information, and the visuo-spatial sketch pad, that deals with visual imagery.

4.2.3 The central executive

The central executive is generally responsible for reasoning, decision making and co-ordination of the slaves systems. In addition to these tasks the central executive has been allocated many roles such as planning, retrieval of information and control of attention. Indeed, so numerous are the functions ascribed to this component that Baddeley has been prompted to refer to it as a "rag bag" of concepts that do not appear to fit elsewhere in the working memory model (1996). However, it is clear that the central executive was allocated an attentional role at the inception of working memory and parallels can be drawn with existing cognitive models of attention.

4.2.4 The central executive and attention

Baddeley (1996) has equated the central executive, or at least its major functions, with the **Supervisory Activating System** (SAS) of Norman and Shallice (1980). The SAS, informed by capacity models of attention, can be viewed as a hypothetical attentional device that selects and activates schemas (mental "menus" of behaviour appropriate to a given situation). Even as early as the first half of the 20th century Bartlett (1932) reflected that memory could be viewed as consisting of schemas. These schemas, if activated frequently, become relatively automatic (Shiffrin & Schneider 1977). In other words, conscious awareness and attentional mediation of these patterns of behaviour is not required to any great extent. This suggests that long term memory representations, when not directly monitored by working memory, are not necessarily available to an individual's subjective conscious awareness. Baddeley takes the view that one function of the central executive must be temporary activation of long term memory representations, but avoids the hypothesis that the contents of short term memory reflect the information that is currently activated in long term memory, as suggested in studies by Hasher and Zacks (1988) and Cowan (1993).

4.2.5 The phonological loop

The phonological loop is implicated in the encoding and manipulation of speech, verbal information, verbal reasoning and speech related processes. The phonological loop is also implicated in arithmetic manipulation (Logie, Gilhooly & Wynn 1994). Baddeley (1986) specifies two sub-components one of which, **the phonological store**, is passive and acoustically based. Storage is said to last around 2 seconds at which point it decays unless the information is **refreshed** (maintained) by **sub-vocal rehearsal** (Baddeley 1990). Sub-vocal rehearsal is a term for silent mental repetition of a word or phrase and is carried out by the other sub-component within the phonological loop that is termed the **articulatory control system**. The articulatory control system can be viewed as an automatic processor that can transform written speech into a phonological state suitable for manipulation by the cognitive system. This code is also employed for conversion of incoming semantic information into a form suitable for handling by the phonological store, a process that is a prerequisite to speech production. The phenomenon of **word length effect** supports the two seconds duration of the phonological store. Baddeley Thomson and Buchanan (1975) found that shorter words were remembered more readily than longer words, and indeed Ellis and Hennelly (1980) found that native Welsh speakers perform badly on English word recall tasks as the words tend to be longer and involve a more protracted and deliberative pronunciation than do Welsh words.

4.2.6 Interference in the phonological loop

One aspect of the phonological code is that it is subject to interference from both other stored words and intrusive speech from the environment. For example, Baddeley (1966) found that similar sounding words were less likely to be recalled on a serial recall task due to the difficulty in discriminating between two similar traces held in the phonological store. Furthermore, during a dichotic listening task, when asked to repeat a back sequence of numbers volunteer recall was impaired when an unattended German voice was heard during recall (Colle & Welsh 1976). Similar disruptive effects were observed by Salome and Baddeley (1989) for both real and nonsense words, however, synthetic non-verbal words, even when pulsed to resemble speech, do not appear to have a similar disruptive effect (Baddeley 1990).

4.2.7 The visuo-spatial sketch pad

In normal healthy subjects the conscious visual representation of any given scene is temporarily held within the visuo spatial sketch pad. This can be either a real visual scene or one imagined or brought back into memory. Recent research has suggested that there are two distinct sub-components of the visuo-spatial sketch pad.

4.2.8 Visual cache and inner scribe

Logie (1996), for example, holds that visual memory and spatial memory are separate functions and have separate but related components in the visuo-spatial sketch pad (see Figure 4.2). Visual working memory is seen as a passive store of visual patterns termed **the visual cache**. The visual cache can be readily equated with the conscious visual representation of a given scene as mentioned above. Such a representation would need to be constantly updated on line, in accordance with environmental fluctuations, if it were to have any useful purpose. This is the function of the second, spatial, sub-component which Reisberg and Logie (1993) have called the **inner scribe**. This holds dynamic information related to movement and it "redraws" the information in the visual cache to allow updating necessitated by movement of configurations of images in the environment. The inner scribe is also involved in rehearsing, transforming and manipulating visual and spatial information (Baddeley & Logie 1999).

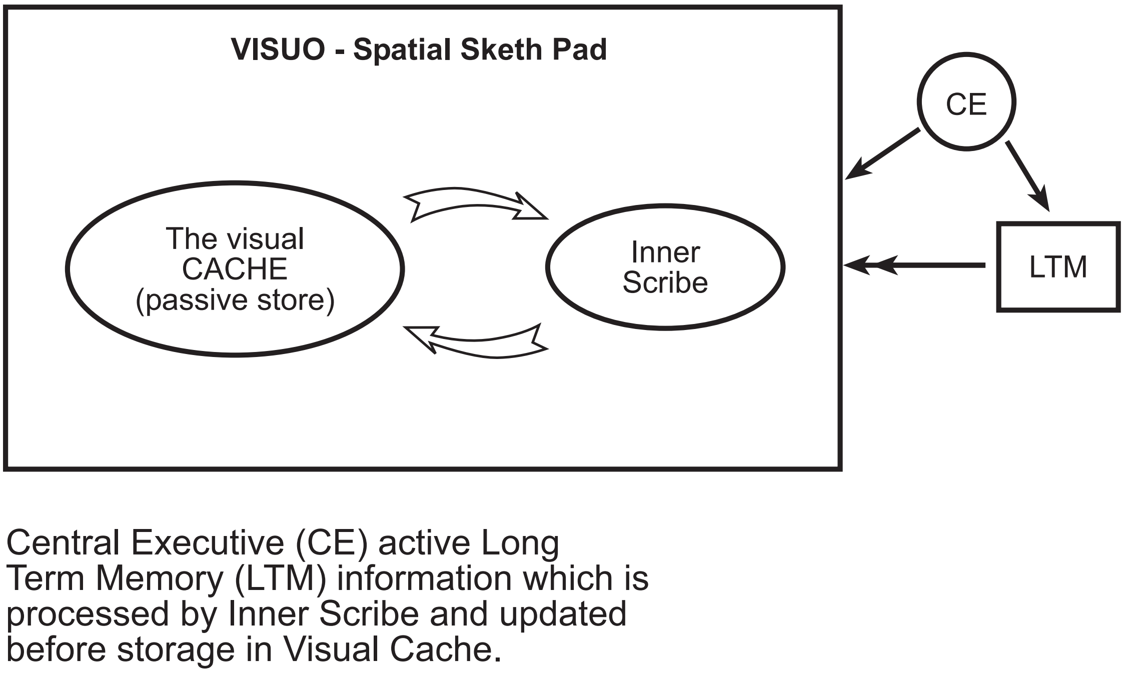


Figure 4.2: The visuo-spatial sketch pad showing the visual cache and the inner scribe.

4.2.9 Selective interference techniques

One fruitful method for investigating the discrete processes involved in the visuo-spatial sketch pad is that of visual interference from **visual noise** presentations presented concurrently with various visuo-spatial tasks. For example, Quinn and McConnell (1996) employed visual noise similar to that seen on a television screen when no programmes are transmitted, as a method of selective interference to examine the resulting disruption to the sketch pad. Specifically, the authors instructed their participants to employ one of two types of encoding techniques; the **pegword mnemonic** (see Figure 4.3), in which numbers and rhyming images are interspersed with each individual item, and the **method of loci**, in which an individual mentally places items to be recalled in various locations in an imagined scene. The first of these two techniques, the pegword mnemonic, requires an individual to learn new images that, by their nature, are initially arbitrary. Quinn and McConnell (1996) argue that, in learning such material, the participants would be expected to employ both the passive visual store and the active rehearsal component. In contrast, the method of loci would be expected to employ less rehearsal and mainly rely upon the passive visual store.

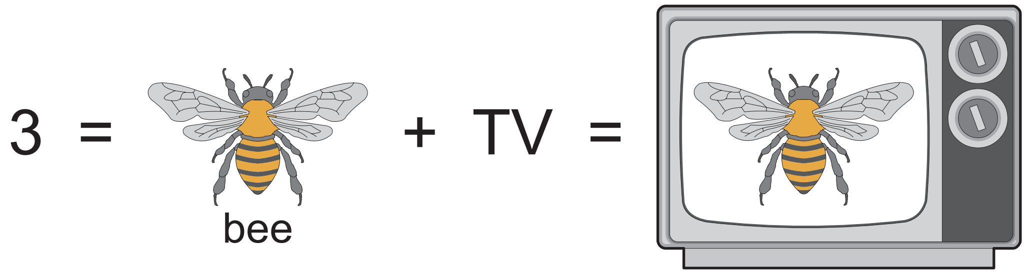


Figure 4.3: An example of the pegword mnemonic.

The concurrent interference tasks utilised during both types of technique were patterns of dynamic visual noise and the monitoring of a **dynamic dot** that moved through a series of simple and predictable locations on the screen. The former being expected to employ the passive visual store and the latter to involve the active spatial component.

It was found that when using the dynamic visual noise technique the method of loci was disrupted, as was the pegword mnemonic, however the moving dot was found to significantly disrupt only the pegword mnemonic. As Quinn and McConnell (1996b) point out, these results suggest that the method of loci technique, relying mainly upon employment of the passive visual cache, was not susceptible to noticeable disruption by the spatially loaded moving dot interference. However, the pegword mnemonic technique, employing resources of both visual and spatial rehearsal, showed disruption by both forms of interference suggesting that both components of the visuo-spatial sketch pad were employed. It is clear that the passive visual cache appears susceptible to disruption by dynamic visual noise. McConnell and Quinn (1999) point out that the visual noise pattern contained no spatial or temporal markers that might be expected to engage attentional central executive processes.

Therefore it might be assumed that the visual cache can operate independently of central executive function, but requires the inner scribe to update its contents if a stimulus is not static.

4.3 Working Memory and Long Term Memory

4.3.1 Processing of information in working memory

Miyake and Shah (1999) state that the traditional view of short-term memory models is that incoming information enters **modality specific** sensory stores (stores associated with a particular faculty such as vision or hearing) and then some of this information, determined by selective attention, enters a store in short term memory. The information is then either transferred by encoding and rehearsal into the long term memory store or is lost (see Figure 4.4). These early models, such as those of Atkinson and Shiffrin 1968, Broadbent 1958, Waugh and Norman 1965, viewed short-term memory as a gateway into long term memory for information that had been sufficiently rehearsed or organised.

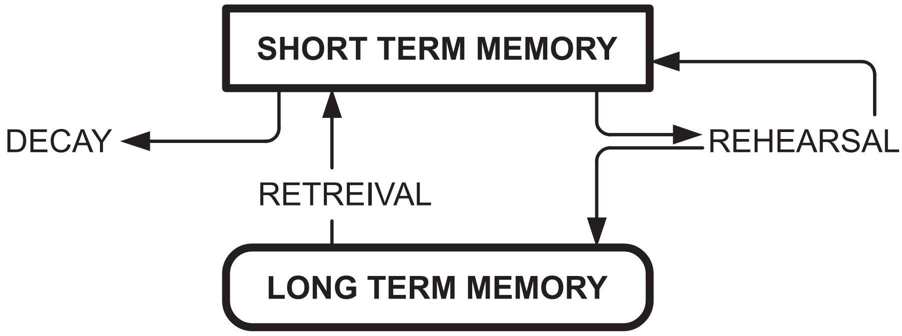


Figure 4.4: Diagram showing the processes involved in the gateway theory.

4.3.2 Working memory as a gateway?

The view that working memory is a gateway to long term memory is still widely assumed to the extent that it is still found in some contemporary text books (Logie 1996). However, this view does not explain published evidence such as that derived from patients with very poor working memory performance but with normal intact long term memory. For example, patients KF and PV (Vallar & Baddeley 1984) could readily learn new material but showed very meagre verbal short-term memory. Some of the most striking evidence against the gateway view of working is derived from those patients suffering from **unilateral visuo-spatial neglect**. Such patients are unaware of one side of visual space but, nevertheless, seem to be able to process the visual information presented to that side without conscious rehearsal or maintenance in working memory.

4.3.3 Direct long term memory activation

In view of such evidence, working memory should not be thought of as a gateway into long term memory but rather as a workspace served by a series of processes that work upon information that has initially entered long term memory. For example, according to Ellis, Della Sala and Logie (1996), sensory input initially activates long term memory representations and it is only afterwards that the information becomes available to working memory for manipulation. Manipulation by working memory involves transiently storing the information from activated long term memory representations and subjecting it to on-line processing. This information then returns to long term memory where the representations are altered and strengthened accordingly (see Figure 4.5). Logie (1995) also offers the alternative hypothesis that processing by working memory might generate new information, allowing new associations and traces to be laid down in long term memory. On reflection it is fair to argue that these two hypotheses are by no means mutually exclusive, indeed they are very complementary and should be taken as different aspects of a single hypothesis. In order to more fully understand this hypothesis it is useful to consider the relationship between working memory and long term memory in more detail.

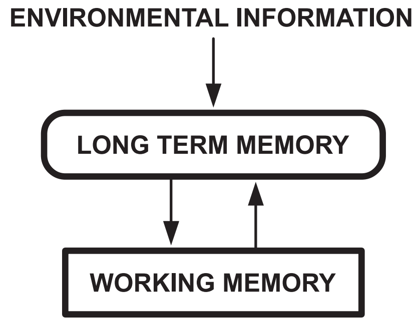


Figure 4.5: The direct long term memory activation model.

4.3.4 Working memory and long term memory relationship

Miyake and Shah (1999) state that the current consensus of opinion is that working memory should not be viewed as a structurally distinct unit separated from the rest of the cognitive system. Rather it should be conceived in terms of its peculiar mechanisms and processes within the cognitive system as a whole, and indeed that one way of viewing working memory is as the currently activated elements of long term memory (Anderson 1983, Cowan 1988, Norman 1968). However, such a stance may be misleading and simplistic (Baddeley & Logie 1999). It is clear however, that for practical purposes these memory systems are usually discussed as separate entities and so, for present purposes, working memory and long term memory are treated as separate systems. Apart from such theoretical considerations it is logical to assume that working memory, as either a separate system or process, comprises material from long term memory, activated by the central executive (Baddeley & Logie 1999, Cowan 1993, 1999, Hasher & Zacks 1988). For example, in terms of visual information, the visual cache and inner scribe therefore handle on-line processing of retrieved long term memory representations, synthesising these activated representations into a coherent, meaningful whole for conscious utilisation and reflection. In this way, each activation by the central executive of long term memory representations results in them being strengthened and modified by integration of additional information.

4.3.5 Working memory, attention and consciousness

It is clear that the role of attention and consciousness in working memory must play a central role in normal perception in order that long term memory representations activated by incoming information can be fully utilised. As Baddeley (1997) states, it has been common speculation for some time within the field of memory research that conscious awareness may have a connection with the operation of working memory. Indeed, Atkinson and Shiffrin (1971) offered the view that the thoughts and information of which an individual is currently aware can be looked upon as being part of the contents of short-term memory. Moscovitch and Umilta (1990) also take this view but do not stipulate whether consciousness should be viewed as wholly or only a part of WM. However, other researchers such as Cowan (1988) and Baars (1997) are more cautious and view conscious awareness as occurring within working memory, but add that we are not consciously aware of everything in working memory. Such a position holds that individuals are only consciously aware of that material which falls within the focus or spotlight of attention. Other parts of working memory, such as the executive processes are viewed as shaping conscious awareness but not part of consciousness per se.

4.3.6 Activation levels of working memory

It has been claimed that when material is within the focus of attention an individual is consciously aware of it, but is not consciously aware of material outside the focus of attention (Cowan 1995, 1999, Klatzky 1984, Posner & Boies 1971). It is becoming increasingly clear in working memory research that there exists an interim stage of processing between working memory in full consciousness and material existing in long term memory. For example, Cowan (1993, 1999) postulates two levels of activation in WM. The first level contains material that is the current focus of attention, which corresponds to that which an individual is conscious of at a given moment. The second level of activation corresponds to the store of information that is readily available to working memory but is not necessarily material of which an individual is consciously aware. This second type of activation, has been variously termed, **temporary memory**, virtual short term memory (Cowan 1993), and long term working memory (Ericsson & Kintsch 1995). It is probable that such activation is modality specific in that it occurs within the slave systems rather than in a separate homogeneous store.

Temporary memory then can be equated with a level of activation between long term memory representation and conscious working memory. Specifically, material that is processed by firstly activating long term memory representations, but that is not in the focus of attention, can be seen as being activated in a non-conscious working memory representation that is below the threshold of conscious perception. It seems clear that such representations must be stored in working memory and, as such, visual information must be represented in the visuo-spatial sketch pad and auditory information in the phonological loop.

4.4 Summary

This topic has dealt with several aspects of working memory. The components of working memory: the central executive, phonological loop and visuo-spatial sketch pad were discussed in relation to their roles and sub-components. Specifically, both the sub-components of the phonological loop (the articulatory control system and phonological store) and the visuo-spatial sketch pad (the visual cache and inner scribe) were described in terms of their roles and experimental evidence from interference techniques. The relationship between working memory and long term memory was then examined in terms of the route information takes into memory, attention and conscious awareness.

4.5 Further Reading

Baddeley, A.D. (1997) *Human Memory: Theory and Practise (revised edition)*. Hove: Psychology Press.

Eysenck, M.W. & Keane, M.T. (2000) *Cognitive Psychology: A Student's Handbook (4th Edition)*. Hove: Psychology Press.

Logie, R.H. (1995) *Visuo-Spatial Working Memory*. Hove: LEA

4.6 Assessment

Q1: According to Baddeley (1986) working memory should be viewed as

a) A form of long term memory
b) A rag bag
c) An active workspace
d) A passive store

Q2: The component of working memory responsible for controlling attention and resource allocation is the

a) Inner scribe
b) Articulatory loop
c) Pegwood mnemonic
d) Central executive

Q3: The phonological loop is responsible for handling

a) Gustatory information
b) Olfactory information
c) Visual information
d) Auditory information

Q4: The slave system responsible for processing imagery is called the

a) Supervisory activating system
b) Visuo-spatial sketch pad
c) Modal model of memory
d) The Tulving component

Q5: Bartlett (1932) thought memory could be viewed as consisting of

a) 8 components
b) Spatial images
c) Schemas
d) Auditory information

Q6: Unactivated long term memory representations are probably

a) Unavailable to conscious awareness
b) Unlikely to be strongly registered
c) Unavailable to activation
d) Unlikely to ever be recalled

Q7: The phonological loop has been implicated in carrying out

a) Technical drawing
b) Architecture
c) Mathematics
d) Astronomy

Q8: Storage in the phonological loop has been estimated to last around

a) 10 minutes
b) 2 seconds
c) 15 minutes
d) 30 seconds

Q9: The articulatory control system deals with

a) Sub-vocal rehearsal
b) Acoustic storage
c) Visual mnemonics
d) Spatial representations

Q10: Experimental evidence for the word length effect supports

a) The transience of long term memory
b) The existence of the inner scribe
c) The control processes of the central executive
d) The duration of the phonological store

Q11: Colle and Welsh (1976) found that recall of words was impaired by an unattended

a) Car engine
b) Electronic noise
c) Barking dog
d) German voice

Q12: One component of the visuo-spatial sketch pad is called the

a) Inner scribe
b) Articulatory loop
c) Pigment epithelium
d) Central executive

Q13: The passive store of the visuo-spatial sketch pad is called the

a) Bottle neck
b) Visual cache
c) Retinal store
d) Visual loop

Q14: Numbers and rhyming images are employed in the

a) Method of loci
b) Word length effect
c) Pegword mnemonic
d) Word restoration effect

Q15: One method of exploring the components of the visuo-spatial sketch pad is through use of

a) Visual noise
b) Dichotic listening
c) Auditory feedback
d) Vestibular stimulation

Q16: Early models viewed short term memory as a

a) Loop
b) Purely visual mechanism
c) Workspace
d) Gateway

Q17: Patients with unilateral visuo-spatial neglect are unaware of

a) Their surroundings
b) One half of visual space
c) Their own faces
d) The faces of family members

Q18: The second type of activation in working memory is called

a) Temporary memory
b) The spotlight of attention
c) The schema of memory
d) Secondary memory

Q19: The alternative theory to the gateway view is that incoming information directly activates

a) The visuo-spatial sketch pad
b) Working memory representations
c) Conscious awareness
d) Long term memory representations

Topic 5

Memory in the Real World

Contents

Learning Objectives

After studying this topic you should be able to:

- *Differentiate between flashbulb memories and other memories.*
- *Understand the relationship between leading questions and corruption of eyewitness memories.*
- *Discuss ways of ensuring identity parades are bias free.*
- *Demonstrate awareness of such concepts as misinformation acceptance and source confusion.*

Prerequisites

In order to comprehend the concepts discussed in this topic the student must have a knowledge of memory and attention in general, and of the distinctions between different types of memory.

5.1 Introduction

This topic investigates memory in the real world in terms of two main areas of discussion: flashbulb memories and eyewitness testimony. For the former topic, the meaning of the term flashbulb memory has been explained and examples given. The theoretical views on such memories are then discussed and data from studies examining memories of Margaret Thatcher's resignation and the Challenger disaster offered in support of the opposing viewpoints. Eyewitness testimony is next considered, looking at eyewitness confidence, the problem of leading questions and reasons for inaccuracy. Misinformation acceptance is then discussed and pitfalls encountered in the identification of crime perpetrators examined.

5.2 Flashbulb Memories

5.2.1 What are flashbulb memories?

Flashbulb memories are exceptionally vivid memories of major events. The "classic" example of a flashbulb memory is the 1960s assassination of President Kennedy in the USA. Most Americans, who were old enough when this event occurred, report that they recall exactly where they were and what they were doing when they heard the news. More recent flashbulb events include the Challenger space shuttle disaster in 1986, when the American space craft exploded on launch, killing all its crew, and the 11th September terrorist attack on the world trade building in New York.

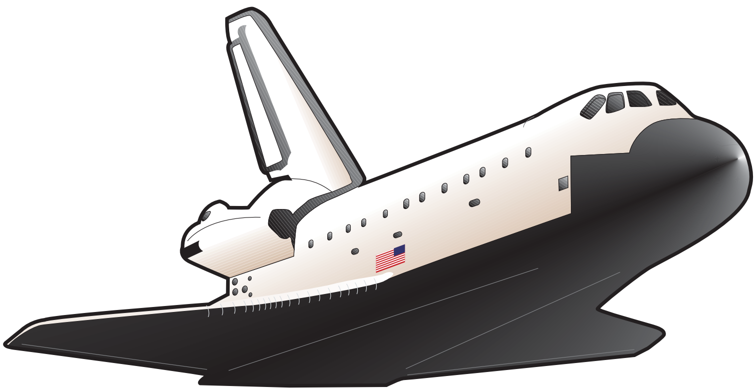


Figure 5.1: The Challenger space shuttle disaster is one relatively recent example of an event that produces flashbulb memories.

5.2.2 A special kind of processing?

In the 1970's Brown and Kulik (1977) made claim that flashbulb memories constitute a special neural event in which the memory is processed differently by the cognitive system. They argued that as long as an event is both surprising and has perceived consequences for an individual's life, then a special kind of memory is "printed" in the memory system. This special flashbulb memory, Brown and Kulik argue, is characterised by several features. They view flashbulb memories as both long lasting and accurate, commonly containing information regarding the place they heard the information and the person that told them, the emotional state of themselves and others, the consequences of the flashbulb event for them personally, and what ongoing event was occurring when they received the information.

Although Brown and Kulik (1977) were rather vague regarding both the specific mechanisms underlying the creation of a flashbulb memory and those parts of the brain that might be implicated, there appears much support for the concept of the flashbulb memory. However, just how much flashbulb memories differ in quality to other memories is less certain, as is their accuracy and endurance.

5.2.3 Memories of Margaret Thatcher

Conway, Anderson, Larsen, Donnelly, McDaniel, McClelland and Rawles (1994) agreed with Brown and Kulik's (1977) assertions that flashbulb memories are different in quality and provide evidence from their study of memories for Margaret Thatcher's resignation from the post of prime minister in 1990. Magaret Thatcher's resignation was a particularly emotional one for the population of Great Britain since she and her had run the UK for 11 years with such strong force of personality that she split the people into those who admired her and those who detested her. Volunteers were asked to describe their memory for the event after 11 months. It was found that 86% of those asked displayed definite flashbulb memory characteristics. However, a follow up study by Wright, Gaskell and O'Muircheartaigh (1998) asked volunteers for their memories of the resignation 18 months after the event, but found only 12% of those quizzed recalled what occurred in the rich detail synonymous with flashbulb memories. This result appears to cast some doubt upon the "special" long lasting qualities claimed for flashbulb memories by Brown and Kulik (1977).

5.2.4 Memories for the Challenger disaster

In another study that cast doubt on the inherent unique quality of flashbulb memories, Bohannon (1988) utilised the opportunity afforded by the Challenger tragedy to investigate the veracity of the flashbulb memory concept. He interviewed a number of individuals at intervals of a fortnight and 8 weeks, asking them a variety of detailed questions about the event. After two weeks recall was only 77% accurate, while at 8 weeks it was down to 58% accuracy suggesting flashbulb memories are just as susceptible as other memories. It was found though that individuals who were upset by the event, and indulged in many rehearsals of what occurred, displayed a far greater recall than those who were not (see Figure 5.2). In the light of such evidence many researchers, such as Finkenauer, Luminet, Gilse, El-Ahmadi, and Van der Linden (1998), now feel that although flashbulb memories are very rich, clear and durable, they are best viewed as particularly efficient examples of normal memory coding.

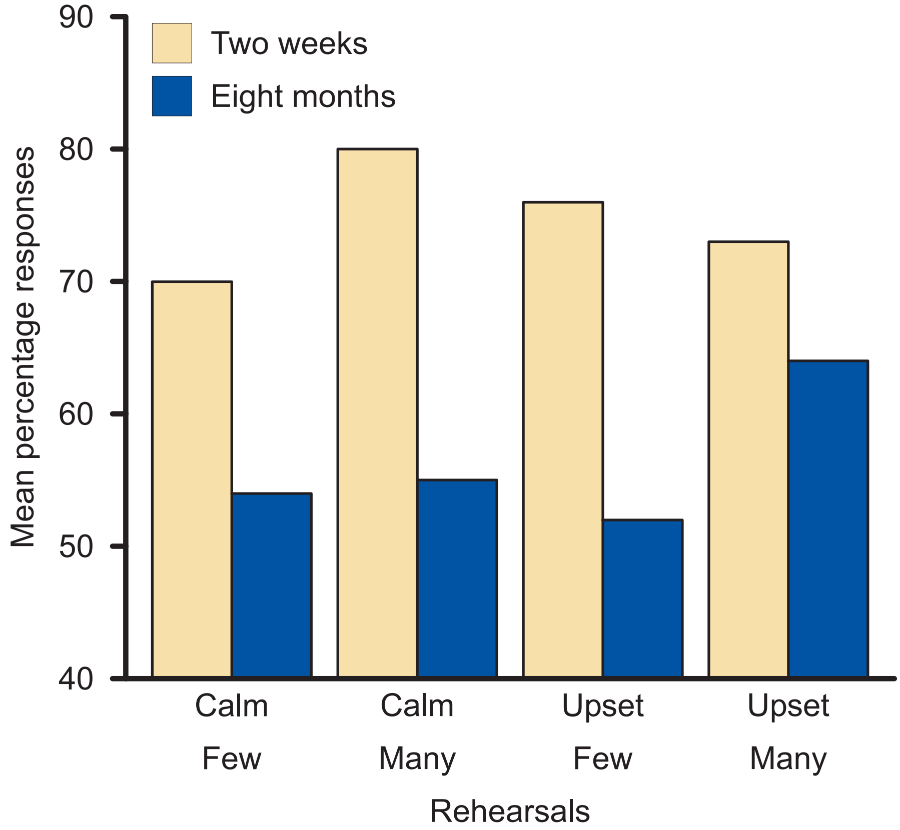


Figure 5.2: Graph showing the percentage of recall for the Challenger disaster.

5.3 Eyewitness Testimony

5.3.1 Eyewitness testimony

One important role of cognitive and social influences is the way in which they can influence everyday opinions, attitudes and perceptions. A clear example of the insidious workings of such social influences is apparent in the seemingly straightforward process of an eyewitness identifying the perpetrator of a misdemeanour. In western societies much emphasis is placed by the court system and police on eyewitness accounts of crimes. Eyewitness testimony is quite often sufficient cause to send somebody to prison. The validity of eyewitness testimony is obviously a serious consideration, but it might be expected that when an individual is identified as being the perpetrator of a crime, then that person must be the culprit. Furthermore, witnesses to all kinds of crime are surely likely to give an unbiased and accurate account of these incidents? However, the results of various studies and real life events have suggested that these assumptions may be far from the real truth of the matter. Eyewitness testimony is, in fact, often highly inaccurate. It has been pointed out that even a very low rate of misidentification can result in hundreds of innocent individuals being imprisoned every year for crimes that they did not commit (Fruzetti, Toland, Teller & Loftus 1992).

5.3.2 Eyewitness confidence

Even the confidence of eyewitnesses in the infallibility of their own testimony is, unfortunately, no guarantee of the objectivity of their evidence or **lineup** selection. Indeed Gleitman, Fridlund and Reisberg (1999) point out that research has shown eyewitness confidence in their own testimony is almost worthless as an indication of accuracy. Reisberg (1997) for example, categorically states that a witness whose information is inaccurate can offer evidence that is every bit as detailed and emotional as that given by witnesses with accurate testimony.

5.3.3 Why is there inaccuracy?

As Eysenck (2000) states, one simple reason for the inaccuracy of eyewitness testimony is that, due to the witness not being fully aware that an event was taking place, their attention was not focussed on all the important aspects of the scene. They might have been carrying on a conversation and only realised later that something important had taken place. A second reason for inaccuracy is that the eyewitness's memory of events is typically fragile and subject to distortion, influence and bias.

5.3.4 Leading questions

One major source of distorting influence upon eyewitnesses is the effect of **leading questions**. There is much evidence to support the supposition that leading questions can drastically alter the recollection of an event by an eyewitness. Police and examining magistrates may, whether intentionally or not, ask leading questions of the witness during any of a number of crucial post-event periods. These would include both the period when the witness is presenting their description of the perpetrator to the police and when cross-examined in court over a defendant's relative resemblance to the perpetrator. Even the wording of an innocent question has been found to influence recall of a previous event. The now classic study carried out by Loftus and Palmer (1974) illustrates this influence of extraneous **post-event information** on eyewitness memory.

A number of volunteers were shown film, by Loftus and Palmer (1974), showing a car accident involving several vehicles. They were then asked some very specific questions regarding what they had seen. Crucially, a select experimental group was asked a question about the speed. Half of this group were asked "How fast were the cars going when the smashed into each other?" while the remainder were asked the same question, but with words "smashed into" replaced with the word "hit". All of the other individuals questioned were not asked about vehicle speed at all. It was found that, on average, the estimation of speed in the experimental group was 34mph when the "hit" version of the question was asked, but that it rose to 41mph when the words "smashed into" were substituted.

As a further test of the effect biasing information can have upon eyewitness testimony, one week later Loftus and Palmer (1974) asked all participants if they had seen any broken glass during the accident. In actuality there was no broken glass, and only 12% of the control group (not asked questions about vehicle speed) said they saw some. This is remarkable in itself and suggests that these eyewitnesses must have reasoned there must be broken glass at a car crash incident. Of the experimental group, 14% of those that had been asked the question containing the word "hit" said they saw broken glass, whereas 32% of the smashed into volunteers said they had seen it.

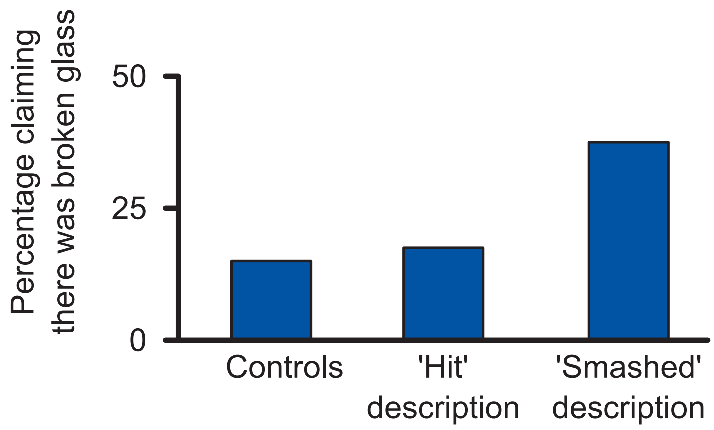


Figure 5.3: The results of the study by Loftus and Palmer (1974) showing the effect of leading questions.

5.3.5 The phantom school bus

Further evidence for the bias effect of leading questions was provided by Loftus (1975), who showed volunteers a film of a car accident before splitting them into either an experimental or control group for questioning. One question, asked only of the experimental group, was "Did you see the children getting on the school bus?" However, there was in fact no school bus featured in the film so no children could have been seen getting on one. Nevertheless, when both groups were asked a week later if they had seen a school bus, the experimental group were found to be up to four times as likely to claim they had seen one. It appears then that we do not just witness a crime and store that information, sealed and incorruptible, like a photograph. Social and cognitive influences can intrude upon our memories for that event, contaminating and changing recollections. As Loftus (1992) states, individuals will treat the information in questions as if it were true. This is termed **misinformation acceptance**.

5.3.6 Susceptibility to post-event information

Tomes and Katz (1997) investigated which individuals were most at risk from bias during recall of events due to the interference of post-event information. Perhaps unsurprisingly the individuals most likely to be affected by post-event information had generally poor memory for the salient event in general and scored highly on measures of imagery vividness and empathy. These latter two findings are highly suggestive as to how such an individual might empathise with what another witness has said occurred and visualise it vividly, so amalgamating the other person's memories for the event with their own.

5.3.7 Identification of crime perpetrators

One area of eyewitness testimony in which recall is particularly susceptible to extraneous influence and mistakes is that of **eyewitness identification**. In eyewitness identification the individual is required to select the perpetrator of a crime from either a line up, series of photographs, or a video. The very fact that the police have gone to the trouble of organising a formal **identity parade** is often sufficient to convince eyewitnesses that the perpetrator must be present and so one of the people in the lineup must be selected. Wells (1993) recommends that witnesses be told that the culprit is not necessarily present in the lineup before viewing commences. **Lineup size** has also been found to be a major influence upon mistaken identification. Lindsay and Wells (1980) found that in line ups where the perpetrator of a crime was not present, innocent individuals being more likely to be selected the smaller the number of people in the lineup.

When eyewitnesses to a crime are initially interviewed it is common that they are often shown photographs or photo fits of possible culprits. Memon and Wright (1999) found that after being showed such **mugshots**, the eyewitness was far more likely to select the individuals depicted in them when asked to select a perpetrator from an identity parade. This effect is called **source confusion** (see Figure 5.4).

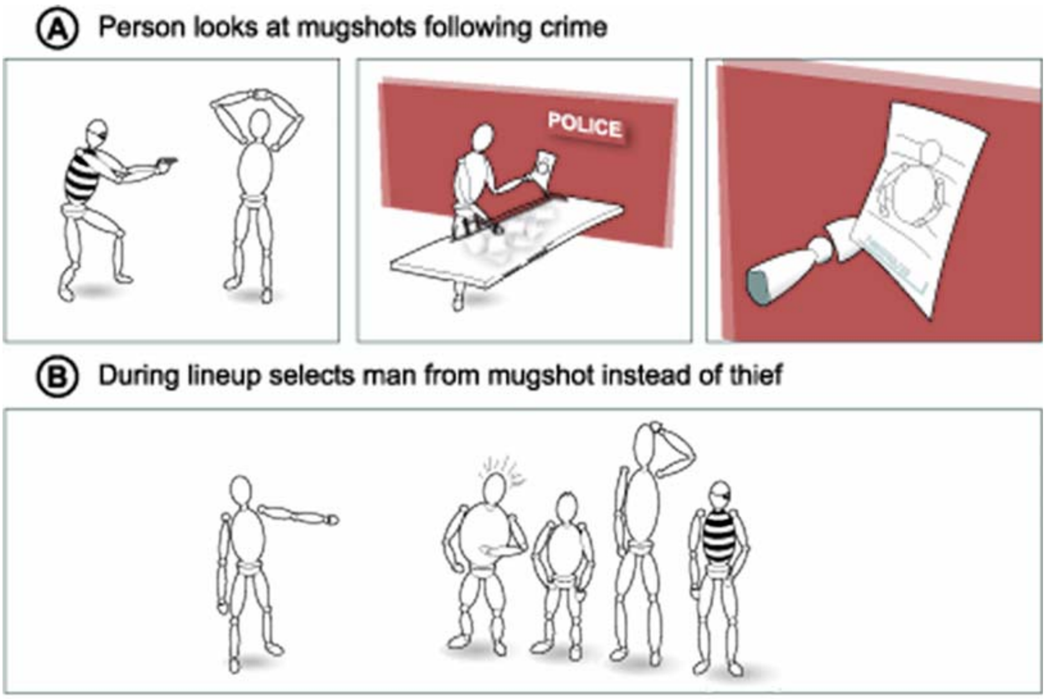


Figure 5.4: One way in which misidentification of a perpetrator may occur; source confusion.

5.3.8 Further influences on identification

In order to more fully examine the mechanisms involved in eyewitness identification several studies have been carried out using staged crimes. For example, Perfect and Hollins (1996) showed volunteers a film of a girl being kidnapped and then asked a general knowledge quiz as well as questions about the events in the film. It was found that, when asked, the participants were far more confident in their answers to the general knowledge questions than to those concerning the film they had just watched. This suggests that in at least some circumstances, witnesses are aware of their own shortcomings.

In another study Loftus and Burns (1982) showed volunteers a film of a robbery featuring a child being shot in the face. It was found that the memory of volunteers for details up to 2 minutes before the shooting were impaired. In contrast memory for the same details in a version of the film without the shooting, shown to another set of volunteers, was not impaired. As Eysenck and Keane (2000) point out, this suggests that the effect of violent incidents in real life crimes might cause even greater memory impairment.

Brigham and Malpass (1985) found that witnesses take more notice of what the perpetrator of a crime is wearing rather than more salient features such as height, hair colour and so forth. Information relating to the perpetrator of a crime, which is discussed within the hearing of a witness, may also prejudice their eyewitness recollections. For example, a witness may hear someone say "The criminal had a big nose" and this is then likely to be taken on and affect the recollection of the witness. Witness mistakes in identification are also likely to occur if the perpetrator of a crime is of different racial extraction to them. This is because individuals are more likely to recognise members of their own racial group (Gross 2001). Therefore a Japanese person would find it easier to recognise another Japanese individual more readily than an Australian.

5.3.9 Comparisons with face identification

It might be considered puzzling why witnesses find it difficult to identify the correct person during eyewitness identification considering the data showing that face recognition studies yield a relatively high success rate. However, as Shapiro and Penrod (1986) point out, face identification studies rely upon the same photo of a face being used both on the initial encounter (**acquisition**) and for identification. In real crime circumstances, and even in staged experimental scenarios designed to test eyewitness identification, the perpetrator will typically change in appearance to a greater or lesser degree before the witness is asked to identify him/her.

5.4 Summary

This topic has examined memory in the real world from the perspectives of flashbulb memories and eyewitness testimony. Firstly the meaning of the term flashbulb memory was discussed and then the opposing theoretical views of researchers examined and illustrated with studies looking at the type of memories individuals have for Prime Minister Thatcher's resignation and the Challenger space shuttle disaster. Eyewitness testimony was then examined in terms of eyewitness confidence and the problem of leading questions. Misinformation acceptance was then discussed and problems encountered in the identification of crime perpetrators examined. Finally, the differences between face identification experiments and eyewitness testimony successes are discussed.

5.5 Further Reading

Baddeley, A.D. (1997) *Human Memory: Theory and Practise (revised edition)*. Hove: Psychology Press.

Eysenck, M.W. & Keane, M.T. (2000) *Cognitive Psychology: A Student's Handbook (4th Edition)*. Hove: Psychology Press.

Gross, R. (2001) *Psychology: The Science of Mind and Behaviour (4th Edition)*. London (Hodder & Stoughton).

5.6 Assessment

Q1: Flashbulb memories are

a) Memories from early childhood
b) Vivid memories of major events
c) Memories of a semantic category
d) Body memories such as how to ride a bike

Q2: Most Americans state that they know exactly what they were doing when they heard President Kennedy was

a) Elected
b) Made Governor
c) Shot
d) Buried

Q3: Brown and Kulik (1977) claim flashbulb memories constitute

a) A special neural event
b) A working memory function
c) Normal long term memory encoding
d) A new kind of procedural memory

Q4: A flashbulb memory is required to be

a) Exciting
b) Funny
c) Surprising
d) Tragic

Q5: Conway and colleagues found that 86% of those asked displayed flashbulb-type memories for

a) Armstrong's moonwalk
b) Reagan's assassination attempt
c) Thatcher's resignation
d) The Challenger disaster

Q6: Bohannon (1988) found that average recall accuracy of the Challenger disaster after 8 weeks was

a) 98%
b) 72%
c) 58%
d) 14%

Q7: According to Fruzetti et al (1992), every year low misidentification rates can result in

a) Hundreds of innocent people going to prison
b) Scores of innocent people going to prison
c) A couple of innocent people going to prison
d) Several innocent individuals almost going to prison

Q8: What did Gleitman, Fridlund and Reisberg (1999) find "Almost worthless"?

a) Jury opinion
b) Eyewitness memory
c) Eyewitness confidence
d) Flashbulb memory reports

Q9: A lineup is another term for

a) Identity Parade
b) A mug shot
c) A photofit
d) Eyewitness misidentification

Q10: Eysenck (2000) states that one main reason for eyewitness inaccuracy is

a) Bad eyesight
b) Fear of revenge
c) Low IQ
d) Unfocussed attention

Q11: What is typically open to distortion, influence and bias?

a) Flashbulb memories
b) Police lineups
c) Eyewitness testimony
d) Taking mugshots

Q12: A major source of distorting influence upon recollection are

a) Tiredness
b) Leading questions
c) Truth drugs
d) Courtrooms

Q13: The crashing car study by Loftus and Palmer (1974) demonstrated the effect of

a) Identity parade bias
b) Post-event information
c) Lineup selection
d) Flashbulb memories

Q14: A week after they saw the film by Loftus and Palmer, 34% of one group mistakenly asserted that they had seen

a) A school bus
b) Children
c) Blue cars
d) Broken glass

Q15: A study by Loftus (1975) demonstrated the phenomenon of

a) Bystander misidentification
b) Misinformation acceptance
c) Memory blending
d) Identity parade bias

Q16: Tomes and Katz (1997) identified which characteristic of being one of the main indicators of individuals whose memories were at risk from post-event information

a) High scores on manual dexterity
b) Low scores on vividness of imagery
c) Low scores on manual dexterity
d) High scores on vividness of imagery

Q17: Selection of the wrong individual in an identity parade after being shown their mugshot can be due to

a) Objective contraction
b) Source confusion
c) Synaesthesia
d) Standard acceptance syndrome

Q18: Loftus and Burns (1982) discovered that violent incidents

a) Enhanced memory for events beforehand
b) Impaired memory for events beforehand
c) Impaired memory for events beforehand
d) Enhanced memory for events afterwards

Q19: It has been found that eyewitnesses take most notice of a perpetrator's

a) Clothes
b) Eyes
c) Build
d) Height

Q20: Face identification experiments and eyewitness identification success rates differ due to face identification using

a) The same picture at acquisition and recognition
b) Individuals from the same ethnic background for recognition
c) Individuals wearing the same clothes
d) Very different faces in recognition arrays

Topic 6

Amnesia

Contents

Learning Objectives

After studying this topic you should be able to:

- *Differentiate between anterograde and retrograde amnesia.*
- *Understand the relationship between amnesia and brain damage.*
- *Discuss different causes of amnesia.*
- *Demonstrate awareness of the contrasting effects and outcomes of permanent and transitory amnesia.*

Prerequisites

In order to comprehend the concepts discussed in this topic the student must have a knowledge of memory and attention in general, and of the distinctions between different types of memory. Knowledge of the basic distinctions between working memory and long term memory is especially important.

6.1 Introduction

This topic investigates amnesia in all its main varieties and discusses the causes of such memory loss and the brain areas which, when damaged, are associated with amnesia. The nature of amnesia is firstly considered and its two main varieties introduced. The main causes of amnesia are then listed before the main brain areas associated with memory loss, the medial temporal lobes and the diencephalon, are introduced. The various types of amnesia are then discussed in more depth, taking in the case history of HM and considering the type of material that can be learned by amnesic patients. The distinctions between permanent and transitory amnesia as well as specific and global amnesia are then examined. Finally the comparatively rare phenomenon of working memory amnesia is briefly outlined.

6.2 The Nature of Amnesia

6.2.1 What is amnesia?

Most individuals are aware that amnesia refers to a loss of memory in general and the layperson might even confidently explain that amnesia is caused by a knock to the head. However, the subject is far more complex than these simplistic explanations suggest and it is useful to study amnesia in some detail as this can inform the study of how normal healthy memory systems function. The first point to make clear is that there are two main forms of amnesia each of which, although the causes or **aetiology** may differ, results in distinct patterns of deficits. These two varieties of amnesia are called and anterograde and retrograde. Ribot (1882) identified the distinction between **anterograde** and **retrograde** amnesia, also noting that recent memories are more susceptible to loss than earlier ones. This loss of more recent memories is due to the inability of a process called **consolidation** to take place. Although the actual processes involved in consolidation are unclear, the term refers to the creation of a permanent, retrievable memory trace: an operation that is not instantaneous. Note that despite the distinction between these two varieties of amnesia, it is fairly common for both to appear in tandem in a single patient.

6.2.2 Aetiology of amnesia

There are several distinct causes of amnesia onset in otherwise healthy adults. A bang to the head (**a closed head injury**) can often result in amnesia. A cerebral haemorrhage (stroke) can produce loss of memory too, as can lack of oxygen and viral infections. Carbon monoxide poisoning and insulin overdose have been also been implicated as being causes of amnesia (Parkin 1996) and there is even a form of amnesia that affects chronic alcoholics. The distinct causes of different types of amnesia are discussed in more detail in the relevant sections. It is important though to be familiar with the brain areas associated with various types of amnesia immediately as these are referred to throughout the topic.

6.2.3 Affected brain areas

Although there are numerous brain areas that, when damaged, can produce amnesia of one sort or another, these are generally clustered in two definite regions of the brain: the **diencephalon** and the **medial temporal lobe**. The medial temporal lobe is **cortical** or on the surface of the brain, while the diencephalon is **sub-cortical** or beneath the brain surface and comprises 2 principal structures- the **thalamus** and hypothalamus. The diencephalon is typically damaged, especially in the mamillary body and thalamus (see Figure 6.1), in those individuals suffering from Korsakoff's syndrome. In Korsakoff's syndrome (Korsakoff 1887) the patient cannot learn or retain new memories or recall events just prior to the disorder. The damage is caused by a combination of poor nutrition and severe alcoholism. The medial temporal lobes mainly comprise the **hippocampus** and **amygdala**. The type of amnesia observed following damage to this area of the brain is described when discussing the case of HM (see Section 6.3.2).

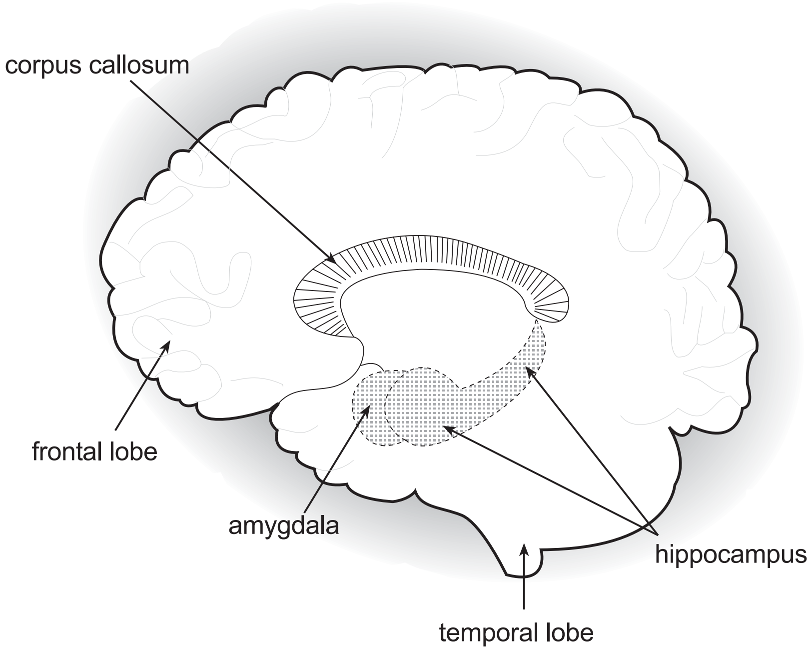


Figure 6.1: The human brain showing regions of brain damage associated with amnesia.

6.3 Types of Amnesia

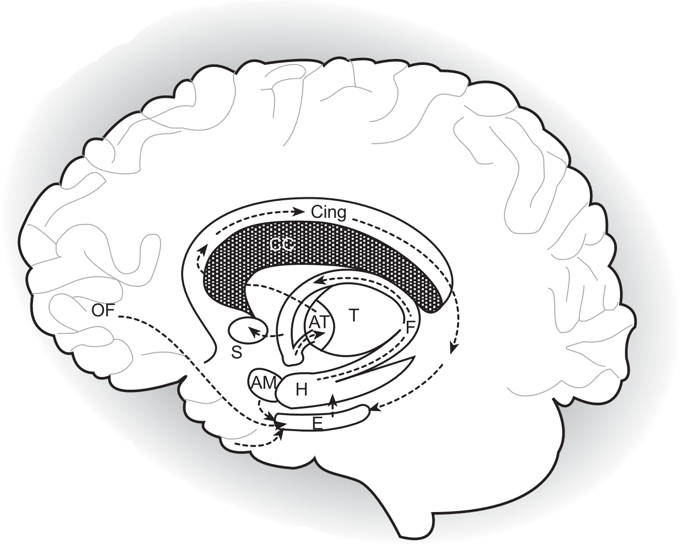
6.3.1 Anterograde amnesia

Anterograde amnesia refers to the failure to properly learn new information after amnesia onset. Damage to the hippocampus of the brain and associated sub-cortical regions, often results in this variety of amnesia. Although sufferers from anterograde amnesia have great difficulty in recalling anything that has occurs to them after the lesion, such patients have little problem in recalling memories for events that happened before the damage.

The aetiology of anterograde amnesia varies widely. For example, Korsakoff's syndrome is a disease that is characterised by this type of amnesia and the memory losses associated with Alzheimer's disease are also anterograde. However, gross damage to certain brain areas can also result in such losses of normal memory function, with perhaps the most famous case being that of HM.

6.3.2 The case of HM

The case of HM, as first described by Milner (1966), concerned a 27 years old male with severe epilepsy. In an attempt to alleviate his frequent convulsions surgeons operated to remove those sections of the brain that were pinpointed as responsible for the attacks, the medial temporal lobes. However, either because surgical techniques were not as sophisticated as they are now or perhaps because of ignorance, the surgeons also removed his amygdala and a fair section from the front of HM's hippocampus (see Figure 6.2 for an indication of these brain areas). Following surgery HM's memory for events before the operation appeared fine and his working memory, as tested on such tasks as digit span, was normal, but his ability to recall anything new was grossly impaired. HM seemed unable to recall anyone he had met or any new events that had occurred after his operation- a gap of 30 minutes being sufficient for him to forget anything that occurred beforehand. It is worth noting that HM is a special case and most instances of anterograde amnesia are not nearly as severe. However, another famous case of anterograde amnesia involved a patient known as NA who accidentally suffered a fencing foil up a nostril after he tuned around quickly when his friend tapped him on the shoulder with the weapon. The resulting diencephalonic damage produced severe anterograde amnesia and a milder form of retrograde amnesia.



H	—	Hippocampus
F	—	Fornix
E	—	Entorhinal Cortex
T	—	Thalamus
AT	—	Anterior Thalamic Nucleus
Cing	—	Cingulate
CC	—	Corpus Callosum
AM	—	Amygdala
OF	—	Orbitofrontal Cortex
S	—	Septum

Figure 6.2: A picture of the brain showing the areas damaged or removed in HM.

6.3.3 Limited learning in anterograde amnesia

Although amnesic patients may have little recall of recent events it is clear, from a variety of studies, that they are able to learn new and often quite complex perceptual motor tasks, although failing to recall the learning experience. Anterograde amnesics can learn certain kinds of new information, but such learning is usually task based and procedural (knowing "how") rather than declarative (knowing "that") memory and despite learning quite complex tasks the patients never recall the learning of the task or that they can carry it out such tasks skilfully. Declarative memory refers to all those personal memories, like what you did on your 18^{th} birthday, and semantic knowledge that can be expressed consciously and vocally, whereas procedural memory is difficult to express as it is largely unconscious. Procedural memory is best thought of as being a memory for action and bodily behaviour such as recalling how one drives a car or operates a computer keyboard. It is not a memory that one needs to consciously think about when it is being employed. For example, amnesics can learn mirror tracing (see Figure 6.3) although forgetting they have ever practised the technique with each new session (Cohen & Squire 1980). In mirror tracing a line is traced within a double outlined drawing of a shape while patients monitor their own progress from a mirror reflection. This task is rather difficult to accomplish but can be learned over several sessions.

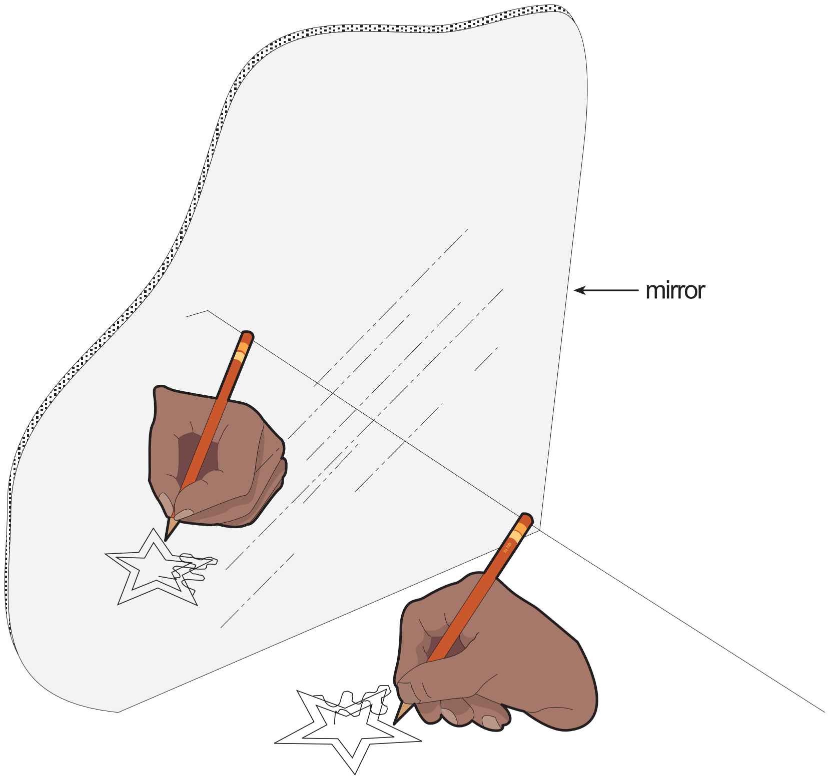


Figure 6.3: Mirror tracing, the learning of which is achieved without awareness in amnesics.

The two types of memory, procedural and declarative, would therefore seem to rely upon distinct neural mechanisms or processes, only one of which is disrupted to any great degree in anterograde amnesia.

6.3.4 Retrograde amnesia

Retrograde amnesia refers to a condition in which material learned **pre-morbidly**, or before the onset of the amnesia, is difficult to recall. Aetiology of tumour, stroke and closed head injury are typical causes of retrograde amnesia. Since the 1990s, neuroimaging studies have produced a wealth of data related to damaged areas of the brain in amnesics. One important study by Reed and Squire (1998) has shown that patients with damage to the temporal lobe are likely to experience retrograde amnesia. **Magnetic Resonance Imaging** (MRI) indicated that all the patients in a group of amnesic patients scanned had damage in the hippocampus region, however, only those with additional damage to their temporal lobe areas displayed signs of retrograde amnesia.

6.3.5 Permanent amnesia

Within memory disorders a distinction is made between **transitory** and **permanent** amnesia. In permanent amnesia memory function doesn't return, and the condition can be **stable** or **progressive**. In progressive amnesia the individual's memory worsens as the underlying illness, for example Alzheimer's disease, develops. Permanent amnesia can be devastating for those who suffer from it and their close friends and family. Sufferers often require constant supervision in case they forget what they have eaten, what medication they have taken, or whether they have left something cooking they have forgotten about (Andrewes 2001). A further distinction within permanent amnesia is if the material the patient cannot recall is **specific** or **global**. While global amnesia is not selective in the material forgotten, in specific amnesia only certain types of information are affected. In cases of specific amnesia the brain lesion is usually **unilateral** (confined to one side of the brain) and selectively affects certain classes of information. For example, **right posterior lesions** tend to give rise to selective problems in remembering pictorial and facial information, while left hemisphere lesions give rise to **verbal learning deficits**.

6.3.6 Transient amnesia

Transient global amnesia occurs for anything between 1 to 24 hours and is thought to be **ischaemic** (resulting from a sudden reduction in cerebral blood flow), especially since a high proportion suffer migraine (Hodges & Warlow 1990), while transient epileptic amnesia is due to a grand mal seizure in temporal lobe epilepsy.

At the beginning of this topic it was mentioned that most people probably think of amnesia as loss of memory occurring after a bang on the head. This is the perhaps most common type of amnesia and is termed **concussion amnesia**. The amnesia usually is of both the anterograde and retrograde varieties. Unless there is associated permanent organic damage to the brain this form of amnesia is, for the most part, typically only of a temporary duration. In most cases an individual's memory can eventually be recalled after such an injury. For example, consider a woman who, while out horse riding, falls and suffers a head injury that results in consequent retrograde amnesia. It would be common for her to initially have little or no recollection of the events of that afternoon before the fall. Gradually her memory of lunch, going to the stables, chatting with friends, and even riding the horse will typically return.

As the overall condition ameliorates the retrograde deficit shrinks, the impaired memories being restored in a temporally organised sequence, more remote ones returning first until everything is recalled but the events immediately prior to head injury (Benson & Geschwind 1968). It is very common that the short period of memory relating to events directly before and up until the closed head injury will never return. A small segment of memory for events just prior to the accident is usually subject to permanent loss. Stirling (2002) suggests that this is due to the inability of the cognitive system to process these memories into a permanent form due to the blow on the head, in other words a failure of consolidation.

After most head injuries such a transient form of retrograde amnesia is common (Campbell & Conway 1995). Indeed, the retrograde amnesia often occurs in tandem with a mild form of anterograde amnesia in which memory for typical post accident events such as recovering consciousness, the journey in the ambulance, being in hospital are forgotten. These memories do usually return after a short period of time.

6.3.7 Working memory amnesia

Although the vast majority of amnesia cases are due to impairments of long term memory, it is worth noting that there are also some relatively rare cases where long term memory is normal but working memory is damaged. The classic study of this type of deficit was reported by Shallice and Warrington (1969) and concerned a man whose digit span was never greater than two items and also had grossly impaired performance on free recall of words. As Stirling (2002) points out, this case appeared to selectively impair the patient's phonological loop functions. Comparison of patterns of impairment such as this support the theoretical dichotomy between both working memory and long term memory.

6.4 Summary

This topic has considered the phenomenon of amnesia in its many forms and has additionally discussed the causes of such memory impairment and associated brain areas. Specifically, the two main types anterograde and retrograde amnesia are discussed in terms of their features and associated causes. The brain areas associated with amnesia are then identified. The tragic case of HM is next considered before the types of material that can be learned by amnesic patients are discussed. The differences between transitory and permanent, stable and progressive and specific and global amnesia are then discussed before finally the concept of working memory amnesia is introduced.

6.5 Further Reading

Baddeley, A.D. (1997) *Human Memory: Theory and Practise (revised edition)*. Hove: Psychology Press.

Eysenck, M.W. & Keane, M.T. (2000) *Cognitive Psychology: A Student's Handbook (4^{th} Edition)*. Hove: Psychology Press.

6.6 Assessment

Q1: Anterograde amnesia refers to the loss of memory for

a) Facial information
b) Verbal information
c) New information
d) Information learned prior to amnesia onset

Q2: Creation of a permanent, retrievable, memory trace occurs through

a) Standardisation
b) Consolidation
c) Condensation
d) Amelioration

Q3: A knock to the head is also called

a) Cranial event
b) Skull trangression
c) Cranial occurrence
d) Closed head injury

Q4: Which one of the following brain area is not found in the diencephalon

a) Hippocampus
b) Thalamus
c) Hypothalamus
d) Mamillary nuclei

Q5: A cerebral haemorrhage is also called

a) Permanent amnesia
b) Epilepsy
c) Hydrocephalus
d) Stroke

Q6: Amnesia has not been found to result from

a) Insulin overdose
b) Carbon monoxide poisoning
c) Overeating
d) Lack of oxygen

Q7: One of the contributing causes of Korsakoff's syndrome is

a) A bang to the head
b) Removal of the thalamus
c) A viral infection
d) Severe alcoholism

Q8: The medial temporal lobes contain the

a) Prefrontal cortex
b) Amygdala
c) Cerebellum
d) Brain stem

Q9: Memory loss in patients with Alzheimer's disease is not

a) Permanent
b) Progressive
c) Transient
d) Anterograde

Q10: HM was unfortunate enough to have the front section of which of these brain areas removed

a) Occipital lobe
b) Broca's area
c) Hippocampus
d) Cerebellum

Q11: Following his operation HM was found to have intact

a) Face recognition
b) Digit span
c) Long term memory
d) Medial temporal lobes

Q12: The type of memory that is typically spared in suffers from amnesia is

a) Declarative
b) Declarative
c) Procedural
d) Eyewitness

Q13: When learning mirror tracing, patients with amnesia typically

a) Do the task very badly
b) Do the task very well
c) Complete the task more efficiently than non-amnesics
d) Cannot manage the task at all

Q14: Patient NA suffered amnesia following

a) A bang on the head
b) An operation
c) A sword entering his nose
d) A car crash

Q15: Loss of memory for material learned pre-morbidly is called

a) Retrograde amnesia
b) Progressive amnesia
c) Procedural amnesia
d) Anterograde amnesia

Q16: It is usual for transient amnesia to be

a) Permanent
b) Ischaemic
c) Due to tumour
d) Due to brain surgery

Q17: Right posterior lesions have been found to result in problems remembering

a) Faces
b) Verbal information
c) Numbers
d) Sounds

Q18: Following concussion amnesia, the period of time directly before the accident is typically

a) The first thing to be recalled on waking
b) Recalled after a few hours
c) Recalled vividly, like a mental picture
d) Never recalled

Q19: Shallice and Warrington (1969) reported a patient with

a) Impaired long term memory but spared working memory
b) No recollection of any type
c) Impaired working memory but spared long term memory
d) Impaired memory following an asthma attack

Glossary

ABC

ABC is the acronym coined by Skinner to stand for Antecedents, Behaviours and Consequences.

Acquisition

Acquisition refers to the initial encounter an individual has with a source of information, in present circumstances a face.

Aetiology

Aetiology refers to the causes of a disease or condition.

Amygdala

The amygdala is an almond shaped part of the brain found in the temporal lobes.

Antecedents

Antecedents are stimuli that trigger operants.

Anterograde

Anterograde amnesia is the term used to describe deficits in recall of material presented after amnesia onset.

Articulatory Control System

The articulatory control system is a sub-component of the phonological loop that transforms the written word into a phonological state

Articulatory Loop

The articulatory loop is an alternative name for the phonological loop.

Associations

Associations are learned connections between events and/or behaviours.

Avoidance Learning

Avoidance learning is a form of negative reinforcement where an operant is performed to avoid negative consequences.

Behaviours

Behaviours are the actions or operants in which an organism engages.

Buffer

A buffer is a temporary limited capacity store.

Central Executive

The central executive is the part of working memory that controls attention and resource allocation.

Classical conditioning

Classical conditioning refers to a conditioned stimulus eliciting a conditioned response- see text for greater detail.

Closed Head Injury

A closed head injury refers to a bang on the head.

Concussion Amnesia

Concussion amnesia is caused by head injury.

Conditioned Reflex

A conditioned reflex is another term for conditioned response.

Conditioned Response

A conditioned response is a behaviour elicited by a conditioned stimulus- see text for greater detail.

Conditioned Stimulus

A conditioned stimulus is a stimulus that has become associated with an original (unconditioned) stimulus and consequently elicits a comparable (conditioned) response to the original stimulus.

Consequences

Consequences are the term for the end product of operants.

Consolidation

Consolidation refers to the creation of a permanent memory trace.

Continuous

Continuous is one form of reinforcement schedule (see text).

Cortical

Cortical refers to the surface of the brain.

Declarative Memory

Declarative memory is concerned with explicit, factual knowledge.

Deep Processing

Deep processing occurs for semantically rich material and results in strong memory traces.

Diencephalon

The diencephalon is a sub-cortical structure implicated in normal memory function.

Digit Span

Digit span is the amount of digits that can be immediately recalled after presentation.

Direct Unconditioning

Direct unconditioning (or systematic desensitisation) is a technique employed to remove phobias in humans.

Discrimination

Discrimination is the ability to differentiate between similar forms of stimuli.

Dynamic Dot

The dynamic dot is a moving spot displayed on a monitor in experiments.

Encoding

Encoding is the registering of incoming information in a suitable form for manipulation by the human memory system.

Episodic Memory

Episodic memory relates to personal experiences occurring in a certain place and time.

Expectations

Expectations are mental map indications of what section of a route to follow next based upon the previously negotiated section.

Experimental neurosis

Experimental neurosis is the term used by Pavlov to describe the distressed behaviour shown by dogs when stimuli are manipulated to confuse their powers of discrimination.

Extinction

Extinction is the term used to describe the processes whereby the conditioned response becomes progressively weakened and disappears, despite the presence of the conditioned stimulus, in the absence of the unconditioned stimulus.

Eyewitness Identification

Eyewitness identification involves the selection of a person who the individual believes is the perpetrator of a crime.

Fixed interval

Fixed interval is one of the reinforcement schedules.

Fixed Ratio

Fixed ratio is a reinforcement schedule.

Flashbulb Memories

Flashbulb memories are exceptionally vivid memories of major events.

Free Recall

Free recall is recollection of a list of items that have been presented without an attempt to recall their order of presentation.

Generalisation

Generalisation refers to the ability of organisms to respond to stimuli that are similar to the one that usually elicits responses.

Global Amnesia

Global amnesia is a general, unselective, type of amnesia.

Habituation

Habituation is the basic learning processes where a novel stimulus is gradually accepted as a normal feature of the environment.

Hippocampus

The hippocampus is a seahorse shaped brain structure implicated in the formation of memories.

Identity Parade

An identity parade is another term for a lineup - i.e. an array of possible suspects from which the eyewitness might choose the miscreant.

Inner Scribe

The inner scribe holds dynamic information related to movement and updates the information in the visual cache.

Instrumental Conditioning

Instrumental conditioning is another term for operant conditioning.

Ischaemic

Ischaemic refers consequences of a sudden reduction in cerebral blood flow.

Korsakoff's Syndrome

Korsakoff's syndrome is a variety of amnesia caused by excessive alcohol consumption.

Latent Learning

Latent learning is behaviour learned but not displayed fully until reinforcement occurs.

Law of Effect

The law of effect states actions are stamped in if they result in pleasure and stamped out if the reverse is true.

Leading Questions

Leading questions are those types of question that contain words likely to bias, confuse or manipulate a witnesses' evidence.

Learning Theory

Learning Theory is an explanation of learning based on associations- see text for greater detail.

Levels of Processing Model

The levels of processing model concentrates on differences in encoding in relation to different material- see text for details.

Limited Capacity

Limited capacity usually refers to a memory store with finite room for information.

Lineup Size

Lineup size is simply the number of individuals appearing in a given lineup.

Long Term Memory

Long term memory can be thought of the storehouse of all permanent knowledge and memories.

Magnetic Resonance Imaging

Magnetic resonance imaging is one variety of brain imaging technique.

Mamillary body

The mamillary body is an area of the diencephalon.

Medial Temporal Lobes

The medial temporal lobes are one area of the brain implicated in amnesia.

Memory Trace

A memory trace is the term given to the physical change in the brain associated with a given memory.

Mental Maps

Mental maps are a visu0-spatial plan of a given environment.

Method of Loci

Method of loci is mnemonic technique based on location of the objects to be recalled in relation to themselves and an imagined scene.

Misinformation Acceptance

Misinformation acceptance is the phenomenon of treating misinformation, presented to the eyewitness via leading questions or other methods, as if it were true.

Mnemonic

A mnemonic is a device employed to assist in recall.

Modality Specific

Modality specific refers to something that is associated to one specific sense such as vision or hearing.

Modal Model

The modal model postulated a two store memory with control processes- see text for details.

Mugshots

Mugshots are a term for photographs featuring possible culprits for the crime that are shown to the eyewitness.

Operant Conditioning

Operant conditioning is, simply stated, the process that leads to the strengthening of patterns of behaviour that pre-exist in an organism's repertoire.

Operants

Operants are forms of behaviour actively encouraged by an organism's environment.

Pegword Mnemonic

A Pegword mnemonic uses numbers and rhyming images as a tool to assist recall.

Permanent Amnesia

Permanent amnesia, in contrast to transient amnesia, refers to a condition where memory function does not return.

Phonological Loop

The phonological loop is that part of working memory that deals with auditory information.

Phonological Store

The phonological store is the passive, acoustically based, component of the phonological loop.

Post-Event Information

Post-event information refers to information introduced after an initial event that affects recall.

Prefrontal Cortex

The prefrontal cortex is an area to the front of the human brain that is implicated in memory processing.

Pre-Morbid

Pre-morbid, in the present context, means prior to the onset of amnesia.

Primacy Effect

The primacy effect refers to the tendency for the first few items on a presented list to be more prone to recall than items in the middle of the list.

Primary Memory

Primary memory is James' term for short term memory.

Probability of Response

Probability of response is one method of measuring the strength of conditioning (see text).

Procedural Memory

Procedural memory is largely unconscious and is largely concerned with the learning of motor actions.

Progressive Amnesia

Progressive amnesia refers to memory loss that worsens over time, for example as observed in Alzheimer's disease patients.

Puzzle box

A puzzle box is an experimental cage for cats that allows escape when a lever is depressed.

Recency Effect

The recency effect refers to the tendency for recall of the last few items on a presented list rather than items from the middle.

Reconditioning

Reconditioning refers to the rapid re-learning of a conditioned response if reintroduced after extinction.

Reflex Behaviours

Reflex behaviours are pre-programmed patterns of behaviour that have existed in an organism since birth.

Refreshed

Refreshment is maintenance of material in cognitive information stores and is typically achieved by rehearsal.

Rehearsal

Rehearsal refers to mentally repeating information to oneself.

Reinforced Trial

A reinforced trial refers to the presence of both the conditioned and unconditioned stimuli during a learning phase.

Reinforcement

Reinforcement is the strengthening of operants due to positive consequences experienced.

Reinforcement schedule

Reinforcement schedule is the frequency and interval of reinforcement in relation to performance of desired operants.

Respondents

Respondents, in the present context, refers to patterns of behaviour elicited passively from organisms.

Response Amplitude

Response amplitude is one method of measuring the strength of conditioning (see text).

Response Latency

Response latency is one method of measuring the strength of conditioning (see text).

Retrieval

Retrieval is the recall of information from memory.

Retrograde Amnesia

Retrograde amnesia refers to memory loss for material learned prior to the onset of amnesia.

Right Posterior Lesions

Right posterior lesions are areas of damage to the back of the right hemisphere of the brain.

Secondary Memory

Secondary memory is James' term for long term memory.

Second Order Conditioning

Second order conditioning is the pairing of a conditioned stimulus with a second stimulus so that too becomes, in turn, a conditioned stimulus.

Semantic

Material that is semantic holds intrinsic meaning to the perceiver.

Semantic Memory

Semantic memory is impersonal knowledge about the world.

Serial Position Curve

A serial position curve is the graphic representation of items remembered in free recall.

Shallow Processing

Shallow processing refers to unelaborated, non- semantic processing of information. This typically leads to a weak trace according to the levels of processing model of memory.

Shaping

Shaping is a method of reinforcing a number of behaviours successively until they approach a complex repertoire of action. Shaping is, for example, used in training animals to perform.

Short Term Memory

Short term memory is an impermanent, limited capacity store.

Shuttle Box

A shuttle box is an experimental cage divided into two halves that allows shocks to be administered to animals in one half at a time.

Sign Learning Theory

Sign learning theory is an explanatory concept of rote learning in a novel environment.

Skinner Box

the Skinner box is an experimental cage in which animals perform operants in exchange for food reinforcement.

Source Confusion

Source confusion is the mistaken belief that a person shown to the eyewitness in a mugshot was at the scene of the observed crime.

Specific Amnesia

Specific amnesia, as opposed to global amnesia, refers to memory loss for a particular type of material such as memory for faces.

Stable Amnesia

Stable amnesia is memory loss that does not progressively worsen.

Storage

Storage refers to the amount of capacity available and its temporal duration.

Sub-Cortical

Sub-cortical refers to structures that are found below the surface of the brain. For example, the hippocampus is sub-cortical.

Sub-Vocal Rehearsal

Sub-vocal rehearsal is a term referring to silent mental repetition.

Supervisory Activating System

The supervisory activating system is an attentional device that activates schemas.

Systematic desensitisation

Systematic desensitisation is another term for direct unconditioning.

Temporary Memory

Temporary memory is the store of information that is readily available to working memory but of which an individual is not necessarily aware.

Thalamus

The thalamus is an area of the brain lying within the diencephalon.

Transitory Amnesia

Transitory amnesia is a non-permanent form of memory loss.

Two Component Model

The two component model was a gateway model that postulated a short and long term memory, the only route into long term memory being via rehearsal in the short term store.

Unconditioned reflexes

Unconditioned reflexes are Pavlov's original term for unconditioned responses.

Unilateral Lesions

Unilateral lesions occur on one side of the brain only.

Unilateral Visuo-Spatial Neglect

Unilateral visuo-spatial neglect is a neurological condition in which the patient is unaware of one side of visual space.

Unitary

A unitary concept has just one component. Early theories of memory were largely unitary in nature.

Unreinforced trial

An unreinforced trial is one in which the unconditioned stimulus is not present.

Variable Interval

Variable interval is one type of reinforcement schedule.

Variable Ratio

Variable ratio is one type of reinforcement schedule.

Verbal Learning Deficits

Verbal learning deficits refer to a reduced ability to recall words encountered following amnesia onset.

Visual Cache

The visual cache is that component of visuo-spatial working memory that deals with visual imagery.

Visual Noise

Visual noise is random visual patterns shown on a monitor.

Word Length Effect

Word length effect refers to the ability to more easily recall shorter words.

Answers to questions

1 Learning and Classical Conditioning

Answers from page 11.

Q1: c) Potential for performance

Q2: d) Habituation

Q3: b) Classical

Q4: b) Innate reflexes and senses

Q5: d) Associations

Q6: d) Digestion

Q7: d) Conditioned response

Q8: b) Ants

Q9: a) Most individuals

Q10: c) Second order conditioning

Q11: b) Generalisation

Q12: b) Discrimination

Q13: c) Experimental neurosis

Q14: a) The unconditioned stimulus

Q15: c) Extinction

Q16: b) Response amplitude

Q17: a) Systematic desensitisation

Q18: d) Reinforced

Q19: a) Reconditioning

Q20: c) A marked reduction in strength of response

2 Learning and Operant Conditioning

Answers from page 24.

Q1: d) Instrumental conditioning

Q2: c) Operants

Q3: a) Active learning

Q4: c) Cats

Q5: c) Animals don't need to leave the Skinner box for reinforcement

Q6: b) 5 seconds

Q7: d) Stamped out

Q8: d) Behaviours

Q9: d) Antecedents

Q10: a) Money

Q11: b) Consequences

Q12: d) Shaping

Q13: b) Delayed reinforcement

Q14: b) Every time

Q15: a) Extremely high

Q16: c) Strengthened

Q17: b) Avoidance learning

Q18: c) Two process theory

Q19: a) Latent learning

3 Memory Models and Long Term Memory

Answers from page 36.

Q1: a) Encoding

Q2: d) Retrieval

Q3: b) Primary memory

Q4: b) Verbal rehearsal

Q5: c) Free recall

Q6: a) A serial position curve

Q7: a) Storage

Q8: d) Gateway theory

Q9: c) Patients with amnesia

Q10: b) More with dynamic processes

Q11: d) Shallow processing

Q12: d) Strong memory trace

Q13: c) Use of imagery

Q14: a) An objective measure of processing depth

Q15: b) Procedural memory

Q16: c) The answers to biology exam questions

Q17: c) Tulving

Q18: d) Episodic memory

Q19: c) Left prefrontal cortex

Q20: a) Declarative memory

4 Working Memory

Answers from page 48.

Q1: c) An active workspace

Q2: d) Central executive

Q3: d) Auditory information

Q4: b) Visuo-spatial sketch pad

Q5: c) Schemas

Q6: a) Unavailable to conscious awareness

Q7: c) Mathematics

Q8: b) 2 seconds

Q9: a) Sub-vocal rehearsal

Q10: d) The duration of the phonological store

Q11: d) German voice

Q12: a) Inner scribe

Q13: b) Visual cache

Q14: c) Pegword mnemonic

Q15: a) Visual noise

Q16: d) Gateway

Q17: b) One half of visual space

Q18: a) Temporary memory

Q19: d) Long term memory representations

5 Memory in the Real World

Answers from page 59.

Q1: b) Vivid memories of major events

Q2: c) Shot

Q3: a) A special neural event

Q4: c) Surprising

Q5: c) Thatcher's resignation

Q6: c) 58%

Q7: a) Hundreds of innocent people going to prison

Q8: c) Eyewitness confidence

Q9: a) Identity Parade

Q10: d) Unfocussed attention

Q11: c) Eyewitness testimony

Q12: b) Leading questions

Q13: b) Post-event information

Q14: d) Broken glass

Q15: b) Misinformation acceptance

Q16: d) High scores on vividness of imagery

Q17: b) Source confusion

Q18: b) Impaired memory for events beforehand

Q19: a) Clothes

Q20: a) The same picture at acquisition and recognition

6 Amnesia

Answers from page 71.

Q1: c) New information

Q2: b) Consolidation

Q3: d) Closed head injury

Q4: a) Hippocampus

Q5: d) Stroke

Q6: c) Overeating

Q7: d) Severe alcoholism

Q8: b) Amygdala

Q9: c) Transient

Q10: c) Hippocampus

Q11: b) Digit span

Q12: c) Procedural

Q13: b) Do the task very well

Q14: c) A sword entering his nose

Q15: a) Retrograde amnesia

Q16: b) Ischaemic

Q17: a) Faces

Q18: d) Never recalled

Q19: c) Impaired working memory but spared long term memory