

AQA Psychology A-level

Biopsychology

Summary Notes

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Part 1 — Divisions of the Nervous System

The **nervous system** allows the body to **receive information, process it and respond**. It is divided into the **central nervous system (CNS)** and the **peripheral nervous system (PNS)**.

1. Central Nervous System (CNS)

The **CNS** consists of the **brain and spinal cord**. It processes information received from the body and coordinates the appropriate response.

2. Peripheral Nervous System (PNS)

The **PNS** consists of the **nerves outside the brain and spinal cord**. Its role is to **carry information to and from the CNS**.

- **Sensory neurones** carry information **from sensory receptors to the CNS**.
- **Motor neurones** carry instructions **from the CNS to effectors**, such as muscles and glands.

The PNS is divided into the **somatic nervous system** and the **autonomic nervous system**.

Somatic Nervous System	Autonomic Nervous System
Controls voluntary actions .	Controls involuntary actions that happen automatically.
Carries sensory information from receptors to the CNS.	Controls automatic functions such as heart rate, breathing and digestion .
Sends instructions from CNS to skeletal muscles through motor neurones.	Controls the activity of internal organs and glands .
Example: choosing to move your hand.	Example: your heart continues to beat without conscious control.

The **autonomic nervous system (ANS)** is further divided into two branches: the **sympathetic** and **parasympathetic** nervous systems. These branches work together to control the body's **involuntary functions** and have **opposite effects** on the body



Sympathetic Nervous System

The **sympathetic nervous system** activates the body's **fight or flight response** when a person perceives a threat.

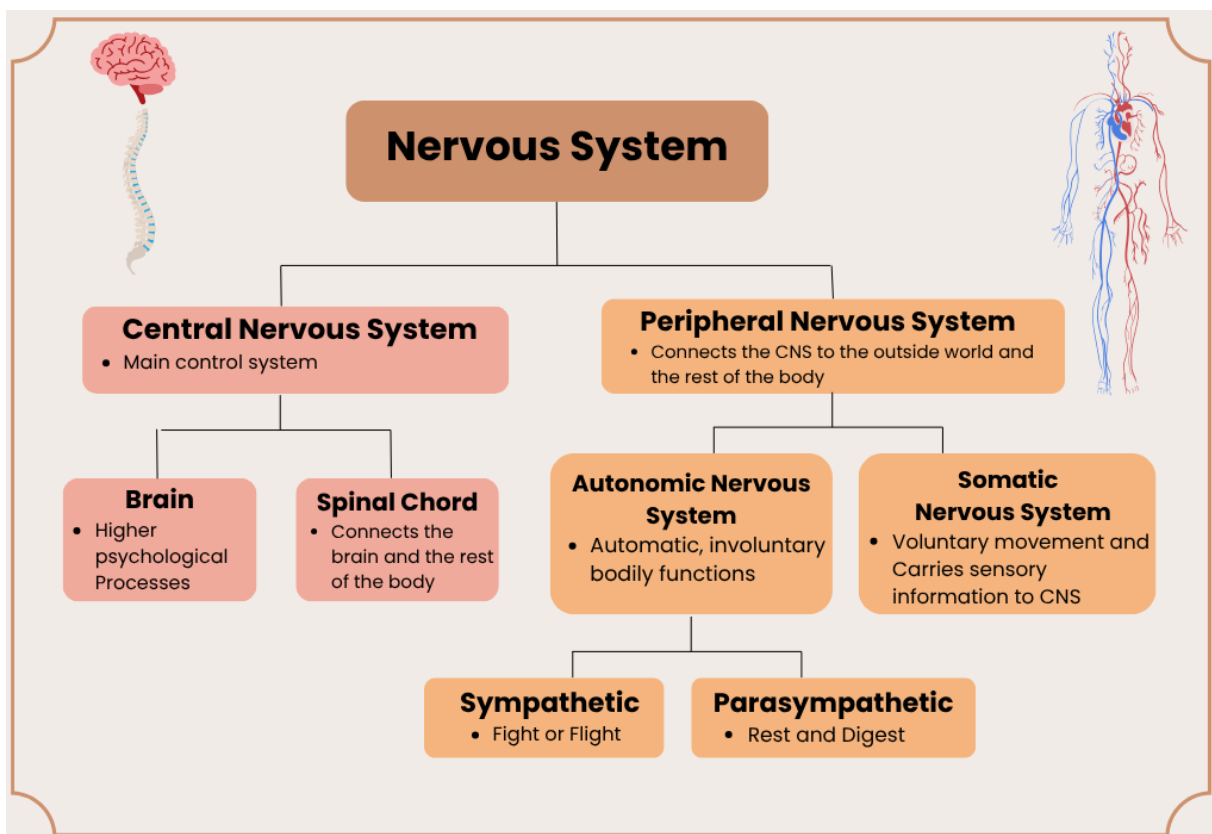
- **Increases heart rate** and breathing rate to prepare the body for action.
- **Dilates the pupils** to allow more light into the eyes.
- Causes **vasoconstriction**, which narrows blood vessels and increases blood pressure.

Parasympathetic Nervous System

The **parasympathetic nervous system** helps the body return to its normal state after a threat has passed. It is associated with the **rest and digest** response.

- **Decreases heart rate** and breathing rate.
- **Constricts the pupils**.
- Causes **vasodilation**, which widens blood vessels.
- Supports processes such as **digestion**.

The sympathetic and parasympathetic systems work as an **antagonistic pair**, meaning that they have **opposite effects** on many of the body's functions.



Part 2 — Structure and Function of Neurons including Synaptic Transmission

Neurons are specialised cells that make up the **nervous system**. Their main function is to **receive, process and transmit information** around the body.

Neurons communicate using **electrical impulses** called **action potentials**. These electrical impulses travel along the neuron, allowing information to be passed quickly from one part of the body to another.

Neurons communicate with other neurons at **synapses**. They use **electrical impulses** to carry information along the neuron, while **neurotransmitters** allow information to be passed between neurons at the synapse. This process is known as **synaptic transmission**.

The Structure of a Neuron

1. Dendrites

Dendrites are branch-like structures that **receive signals** from other neurons or sensory receptors. These signals are passed towards the **cell body** for processing.

2. Cell body

The cell body contains the **nucleus** and other structures needed to keep the neuron alive and functioning. It helps to **process incoming signals** before information is passed along the axon.

3. Nucleus

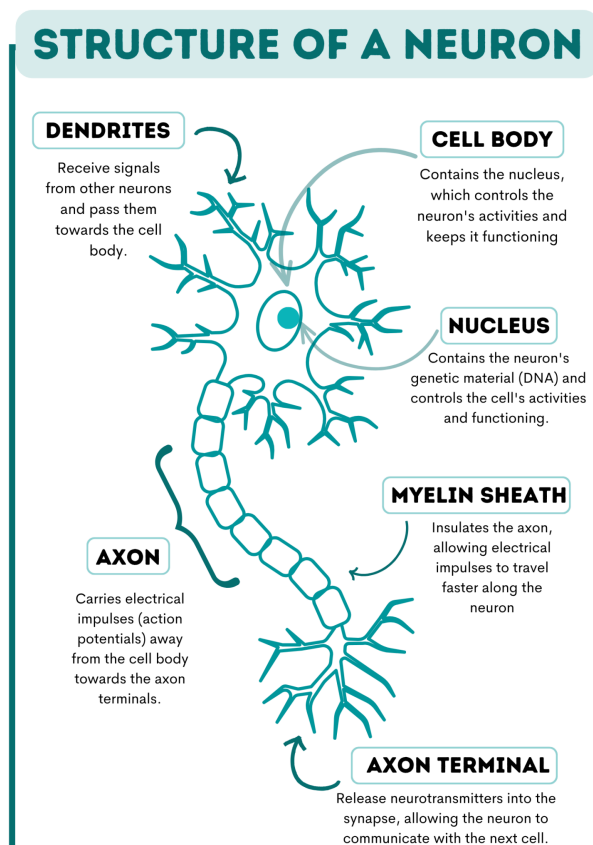
The nucleus contains the neuron's **DNA**, which provides the instructions needed for the cell to function and produce proteins.

4. Axon

The axon is a long fibre that carries the **action potential** away from the cell body towards the axon terminals. The electrical impulse travels along the length of the axon.

5. Myelin sheath

The myelin sheath is a **fatty layer surrounding the axon**. It insulates the axon and allows action potentials to travel **much faster**. Gaps between sections of myelin, called **The Node of Ranvier**, allow the impulse to effectively jump between them.



6. Axon terminal

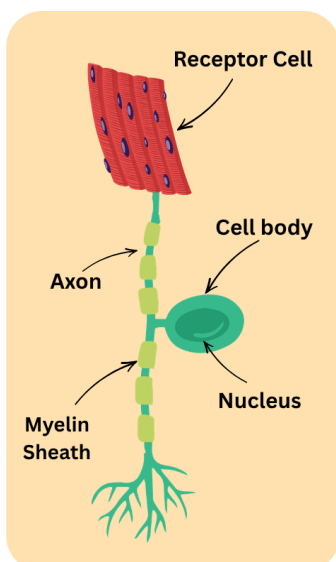
Axon terminals are found at the **end of the axon**. When an action potential reaches them, they release **neurotransmitters** into the synapse, allowing the neuron to communicate with the next cell.

The Three types of Neurons

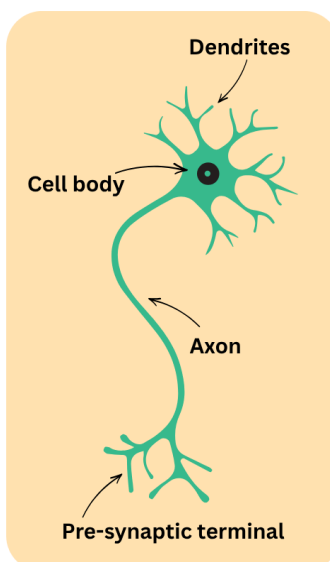
There are **three main types of neurons** involved in transmitting information around the nervous system:

Type of neuron	What does it do?	Where does it carry information?
Sensory neuron	Detects information from sensory receptors , such as those involved in touch, pain, light and sound.	Carries information from sensory receptors towards the CNS .
Relay neuron	Connects neurons together within the CNS.	Carries information between sensory and motor neurons in the CNS.
Motor neuron	Carries instructions to effectors , such as muscles and glands.	Carries information from the CNS to effectors i.e. muscle.

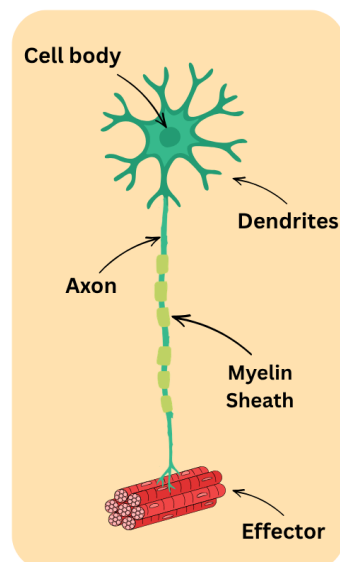
SENSORY



RELAY



MOTOR

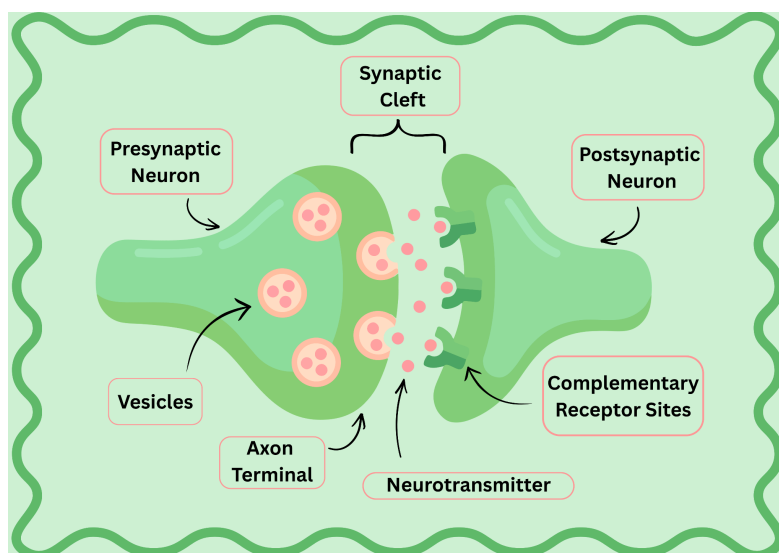


Synaptic Transmission

Synaptic transmission is the process by which **neurons communicate with each other**. Neurons pass information through the nervous system, with **sensory neurons** carrying information towards the CNS and **motor neurons** carrying information from the CNS to **effectors**, such as muscles and glands.

The process of synaptic transmission is as follows:

1. **Action potential (electrical impulse) travels down the axon:** The electrical impulse travels down the **axon** towards the end of the presynaptic neuron.
2. **Calcium ion channels open:** When the action potential reaches the end of the neuron, **voltage-gated calcium ion channels** open. **Calcium ions (Ca^{2+})** enter the presynaptic neuron.
3. **Neurotransmitters are released:** The calcium ions cause **vesicles containing neurotransmitters** to move towards and fuse with the presynaptic membrane. The neurotransmitters are released into the **synaptic cleft**. This release is called **exocytosis**. The release of neurotransmitters **converts the electrical signal** into a **chemical signal**, which can cross the synapse.
4. **Neurotransmitters cross the synaptic cleft:** The neurotransmitters **diffuse across the synaptic cleft**, moving from an area of **high concentration to low concentration**.
5. **Neurotransmitters bind to receptors:** The neurotransmitters bind to **complementary receptor sites on the postsynaptic membrane**. The receptors are complementary, meaning the neurotransmitter **fits the receptor**.
6. **The next neuron is affected:** This causes ion channels to open or close, producing either an **excitatory or inhibitory effect**. If the neuron reaches the **threshold**, a new **action potential** is generated, **converting the chemical signal back into an electrical signal** that travels along the next neuron's axon.
7. **Neurotransmitters are removed:** Any remaining neurotransmitter molecules are removed from the synaptic cleft. They can be **taken back up into the presynaptic neuron through reuptake** or **broken down by enzymes**.



Excitatory and Inhibitory neurotransmitters

Neurotransmitters can have either an **excitatory** or **inhibitory** effect.

Type	Example	Effect	What happens?
Excitatory	Glutamate	Increases the likelihood of an action potential	Causes depolarisation (net positive charge influx), making the postsynaptic neuron less negative and bringing it closer to threshold .
Inhibitory	GABA	Decreases the likelihood of an action potential	Causes hyperpolarisation (net negative charge influx), making the postsynaptic neuron more negative and moving it further from threshold .

Summation is when **excitatory and inhibitory signals are combined** in the postsynaptic neuron. If **excitatory signals outweigh inhibitory signals** and reach the **threshold**, the neuron fires. If **inhibitory signals outweigh excitatory signals**, the neuron does not fire.



Part 3 — Function of the Endocrine System

The **endocrine system** is the body's main **chemical messenger system**. It is made up of **glands** that produce and release **hormones directly into the bloodstream**. The **blood acts as the transport system**, carrying hormones around the body until they reach their **target cells or organs**, which have specific **receptors** that the hormone can bind to.

Hormones can influence **behaviour, emotions and physiological processes**, including growth, metabolism, reproduction and the **stress response**.

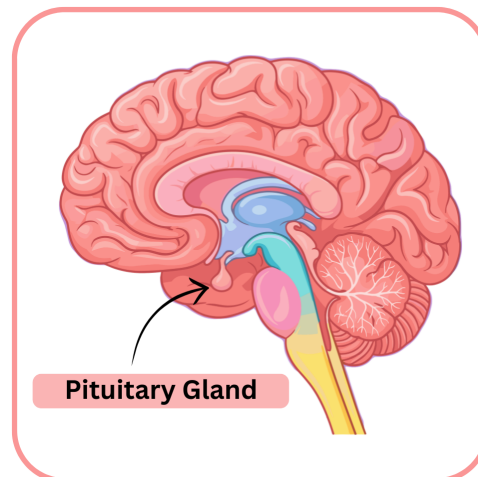
Unlike the **nervous system**, which uses electrical impulses carried by neurones and produces **rapid, short-lasting responses**, the endocrine system uses hormones carried in the **bloodstream**, producing generally **slower but longer-lasting effects**.

1. The Pituitary Gland

The **pituitary gland** is often called the '**master gland**' because it releases hormones that control the activity of several other endocrine glands.

For example, the pituitary gland releases **ACTH (adrenocorticotrophic hormone)**, which stimulates the **adrenal glands** to release **cortisol** during the stress response.

The pituitary gland is located at the base of the **brain** and is influenced by the **hypothalamus**, which links the nervous and endocrine systems.



Key Glands and Hormones

Gland	Key hormone(s)	Main function
Pituitary gland	ACTH	Stimulates the adrenal glands to release cortisol , which is involved in the stress response .
Thyroid gland	Thyroxine	Regulates metabolism and is involved in growth and development.
Adrenal Medulla	Adrenaline and noradrenaline	Triggers the fight or flight response , increasing heart rate and breathing rate and preparing the body for action.
Adrenal cortex	Cortisol	Helps the body respond to long-term stress . Increases blood glucose availability and suppresses non-essential functions such as digestion and immune activity.



Pancreas	Insulin	Helps regulate blood glucose levels by allowing cells to take up glucose from the blood.
Ovaries	Oestrogen	Involved in the development of female secondary sexual characteristics and regulation of the menstrual cycle.
Testes	Testosterone	Involved in the development of male secondary sexual characteristics , such as facial hair and a deeper voice.

Hormones

Hormones only affect cells that have the correct **receptor**. Once a hormone reaches its target cell, it binds to the receptor and produces a specific response.

For example, when a person experiences a **threat**, the sympathetic nervous system activates the **adrenal glands**. The adrenal glands release **adrenaline** into the bloodstream. This causes changes such as an **increased heart rate and breathing rate**, preparing the body to respond to the threat.

This shows how the **nervous and endocrine systems work together** to influence behaviour and physiological responses.



Part 4 — Fight or Flight

The **fight or flight response** is the body's automatic response to a perceived **threat or stressor**. It prepares the body to either **confront the threat or escape from it**.

Stage	Example	What happens in the body
1. Threat detected	A person hears a speeding car approaching.	The hypothalamus processes information about the threat and activates the sympathetic nervous system .
2. Sympathetic nervous system activated	The person recognises the situation as dangerous .	The sympathetic nervous system stimulates the adrenal medulla in the adrenal glands.
3. Adrenaline released	The body needs to respond quickly .	The adrenal medulla releases adrenaline into the bloodstream , which carries it to target organs.
4. Body prepares for action	The person prepares to fight or escape .	Adrenaline causes several changes, including: • Increased heart rate → more blood is delivered to muscles. • Increased breathing rate → more oxygen is available. • Pupil dilation → more light enters the eyes. • Vasoconstriction → blood pressure increases and blood is redirected towards important muscles. • Reduced digestion and saliva production → energy is directed away from non-essential processes.
5. Physiological arousal	The person is now highly alert and ready to act .	These physiological changes provide the energy and oxygen needed to respond to the threat , increasing the likelihood of survival .
6. Body returns to normal	The car has passed and the threat is over .	The parasympathetic nervous system becomes more active, producing the rest and digest response and returning the body towards its resting state.



AO3 - EVALUATION

A strength is that the fight or flight response can be investigated using **objective physiological measures**. This includes measuring heart rate, breathing rate and blood pressure. These measures can be compared before and during a stressful situation, providing observable evidence of **physiological arousal**. This gives researchers a way of objectively measuring the body's response to stress rather than relying entirely on self-report. Therefore, there is **objective evidence** supporting the physiological changes involved in fight or flight.

A weakness of the fight or flight response is that it may be **too simplistic**, as people do not always immediately fight or flee when faced with danger. **Gray (1988)** suggested that the initial response to a threat may be to **freeze**. During this response, an individual becomes **hyper-vigilant**, allowing them to assess the situation before deciding how to respond. This suggests that there may be an important stage between detecting a threat and choosing whether to fight or flee. Therefore, the fight or flight response may provide an **incomplete explanation** of how humans respond to danger because it does not account for the **freeze response**.

A further weakness of the fight-or-flight response is that it may be gender biased.

Much of the early research into stress responses was based on **males**, yet the findings were often assumed to apply to females. This is an example of **beta bias**, as differences between males and females were overlooked and a response observed in males was treated as **universal**. **Taylor et al. (2000)** proposed a **tend-and-befriend response**, suggesting that females may respond to stress by tending to their offspring and seeking **social support** and forming protective social networks. This suggests that females may respond to stress differently from the traditional fight-or-flight response. Therefore, the fight-or-flight explanation may be **androcentric** and have limited **generalisability**.

Another weakness of the fight-or-flight response is that it may be maladaptive in modern environments. The response evolved to help humans deal with **immediate physical threats**, such as being chased by a predator. However, modern stressors such as **exams, work deadlines and financial problems** are often psychological and long-lasting, so there is no need to physically fight or escape. Despite this, the sympathetic nervous system can still trigger the same physiological response. **Repeated activation can place strain on the cardiovascular system**, increasing the risk of health problems such as cardiovascular disease. Therefore, the fight-or-flight response may be **less adaptive for modern humans** than it was for our ancestors.



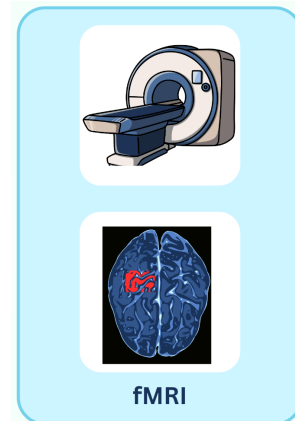
Part 5 — Ways of Studying the brain

Psychologists use a range of methods to investigate **brain structure and activity**. Each method has different **strengths and limitations**, meaning some are better suited to investigating particular aspects of brain function.

1. Functional Magnetic Resonance Imaging (fMRI)

An **fMRI scan** measures changes in **blood flow and oxygen levels** in different areas of the brain. When an area of the brain becomes more active, it requires more **oxygenated blood**. The fMRI detects these changes through the **BOLD (blood-oxygen-level-dependent) response**, allowing researchers to identify which areas of the brain are more active during a particular task.

This allows researchers to investigate **brain function and localisation**, as different areas of activity can be linked to particular behaviours or cognitive processes.



Strengths

- **High spatial resolution** — fMRI can produce very detailed images of the brain, allowing researchers to identify **where** activity is occurring.
- Participants can perform **tasks while being scanned**, allowing researchers to investigate which brain areas become active.
- fMRI does **not use ionising radiation**, making it safer than techniques such as **PET scans**.

Weaknesses

- **Poor temporal resolution** — there is a delay of several seconds between neural activity occurring and the BOLD response being detected. This means fMRI is less effective at showing **exactly when** neural activity occurs.
- fMRI scanners are **expensive and restrictive**, meaning participants have to remain very still inside the scanner. This can make it difficult to investigate some behaviours in realistic situations.

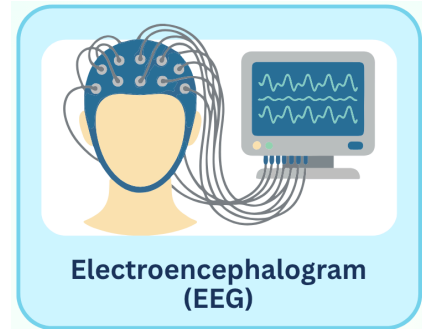


2. Electroencephalogram (EEG)

An **EEG** measures the brain's **electrical activity** using electrodes placed on the **scalp**. The electrodes detect the combined electrical activity produced by large groups of neurons, which is then amplified and recorded as **brainwaves**.

EEGs are particularly useful for measuring **ongoing brain activity** and identifying patterns associated with different mental states.

For example, **Dement and Kleitman (1957)** used EEG recordings to investigate the different **stages of sleep**, identifying distinct patterns of brainwave activity during different stages.



Strengths

- **Very high temporal resolution** — EEG can detect changes in brain activity within **milliseconds**, making it useful for measuring exactly **when** neural activity occurs.
- It is particularly useful for investigating **ongoing brain activity**, such as the different stages of sleep.
- EEGs are relatively **cheap, portable and non-invasive** compared with methods such as fMRI.

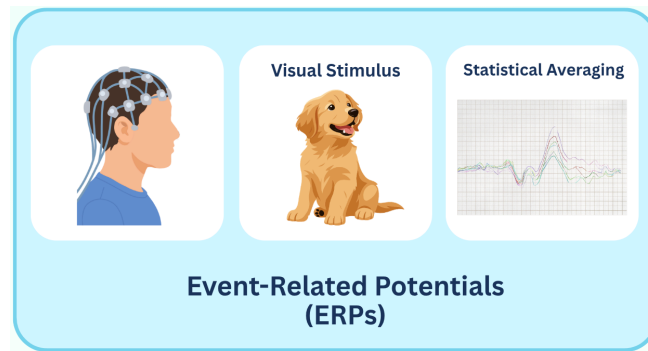
Weaknesses

- EEG has **poor spatial resolution**. As electrodes measure activity across large areas of the brain, it can be difficult to determine **exactly where** activity is occurring.
- Electrical signals can also be affected by **background noise**, including muscle movements and eye movements, which can make the data more difficult to interpret.



3. Event-Related Potentials (ERPs)

Event-related potentials (ERPs) are a more specific form of EEG measurement. Researchers **average EEG recordings from repeated presentations of the same stimulus** to **isolate the brain's electrical response to a particular stimulus or event**.



For example, a researcher may record brain activity each time a participant is shown a particular image. By repeatedly presenting the stimulus and averaging the EEG responses, **background brain activity is reduced**, leaving the electrical activity associated with that specific event.

Different types of ERP have been identified and linked to processes such as **attention, perception and memory**.

Strengths

- **Excellent temporal resolution** — ERPs can measure the timing of brain responses to a stimulus with very high precision, often within **milliseconds**.
- ERPs can be used to investigate specific **cognitive processes**, such as attention and perception.
- They have been used to investigate **cognitive deficits and disorders**, helping researchers understand differences in brain processing.

Weaknesses

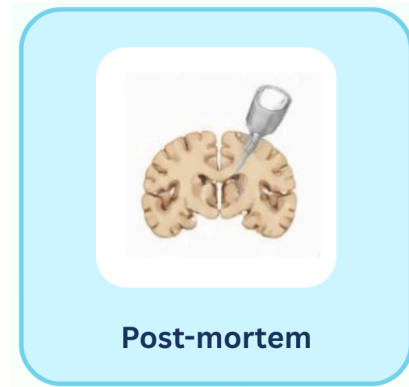
- There is a **lack of standardisation** in ERP methodology between studies. Researchers may use different procedures for recording and analysing ERPs, making it difficult to **compare findings** across research.
- ERPs can be affected by **background electrical activity and extraneous material**, meaning statistical averaging is needed to isolate the response to the specific event.



4. Post-mortem Examinations

A **post-mortem examination** involves examining the brain of a person **after death**. Researchers may compare the brain with a healthy brain to identify abnormalities such as **lesions, damage or unusual differences in particular brain areas**.

Researchers can then consider whether these differences may explain **neurological, behavioural or cognitive problems** experienced by the individual during their lifetime.



Strengths

- Post-mortem examinations have helped advance our understanding of **localisation of brain function**. For example, **Broca's (1861)** examination of the brain of his patient **Tan** provided evidence for the role of **Broca's area in speech production**.
- They allow researchers to examine the brain in **great detail**, including areas of damage that may not be easily investigated using other methods.
- Findings can provide a basis for **further research** into the relationship between brain structure and behaviour.

Weaknesses

- Researchers cannot be certain that a brain abnormality **caused** a person's cognitive or behavioural problem. Other factors, such as **genetics, drug use or stress**, may have contributed to the problem.
- There are **ethical issues surrounding consent**, as the individual cannot give consent for the examination after death. Researchers may therefore need to obtain consent from relatives or rely on consent given before death.
- Post-mortem examinations are often based on **individual cases**, meaning findings may have limited **generalisability** to the wider population.



Key comparison

Method	What it measures	Main advantage	Main limitation
fMRI	Changes in blood flow and oxygenation	High spatial resolution	Poor temporal resolution
EEG	Electrical activity of the brain	Very high temporal resolution	Poor spatial resolution
ERPs	Electrical response to a specific event/stimulus	Excellent temporal resolution	Lack of standardisation
Post-mortem	Brain structure/damage after death	Detailed examination of brain structure	Cannot establish cause and effect



Part 6 — Localisation of Function

Localisation theory suggests that **specific areas of the brain** are responsible for particular behaviours, cognitive processes and functions.

Area	Where is it?	What does it do?	What happens if it is damaged?
Motor area	Frontal lobe , just in front of the central sulcus.	Controls voluntary movement . Each hemisphere controls movement on the opposite side of the body.	Difficulty controlling voluntary movements, particularly fine motor skills such as using scissors, writing or chopping food .
Somatosensory area	Parietal lobe , just behind the central sulcus.	Processes information from the body, including touch, pain, pressure and temperature .	Difficulty detecting sensations, such as feeling heat, cold, pain or pressure on parts of the body.
Visual area	Occipital lobe , at the back of the brain.	Processes visual information received from the eyes.	Problems with vision , which can include difficulty recognising what is being seen or, with more extensive damage, blindness .
Auditory area	Temporal lobe .	Processes sounds , including speech and other noises.	Difficulty processing and making sense of sounds , particularly speech

Language is a complex cognitive function that relies on different areas of the brain working together. Damage to these areas can affect a person's ability to speak or understand language.

1. Broca's Area

Broca's area is located in the **left frontal lobe** and is involved in **speech production**. Damage to this area can result in **Broca's aphasia**, where speech becomes **slow, effortful and difficult to produce**. Although the person generally knows what they want to say, they may struggle to put their thoughts into words.

For example, instead of saying "*I want a cup of tea,*" they may say "**Want... tea... cup.**"

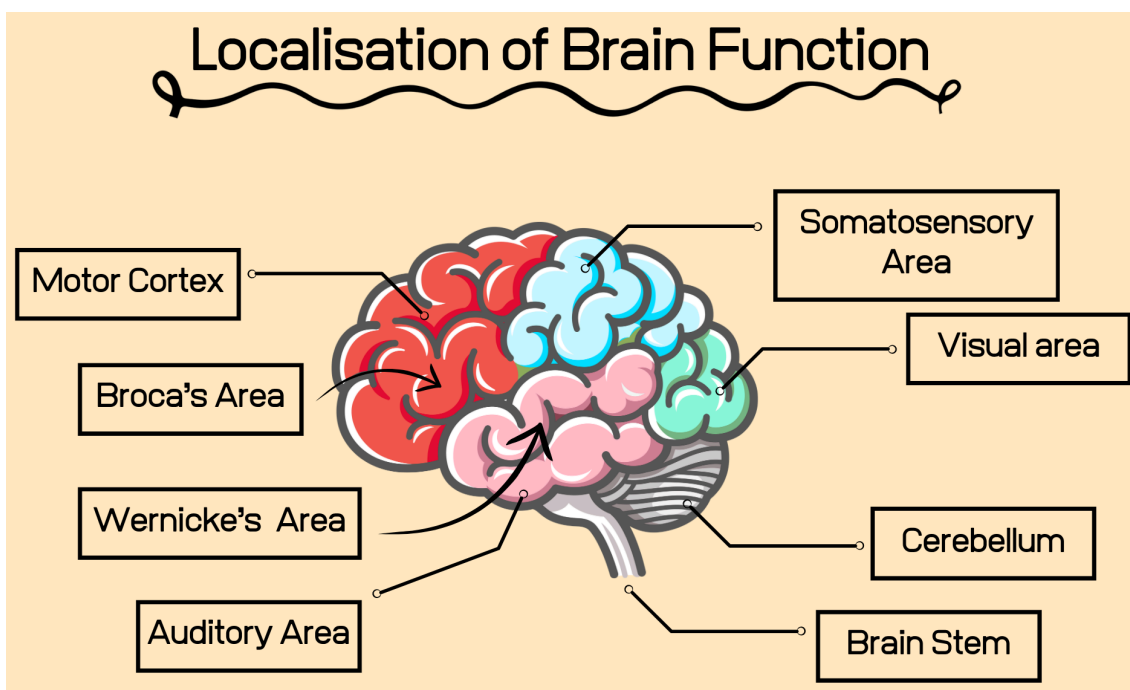


2. Wernicke's Area

Wernicke's area is located in the **left temporal lobe** and is involved in **understanding language**. Damage to this area can result in **Wernicke's aphasia**, where speech remains **fluent** but may make **little or no sense**. The person may also have difficulty understanding what other people are saying.

For example, they may say “**The table is singing the blue telephone**” without realising that what they are saying does not make sense.

Overall, language is an example of a function that is both *localised* (specific brain areas control it) and *lateralised* (it is usually controlled by the left hemisphere).



AO3 - EVALUATION

A strength of localisation theory is that it is **supported by research evidence**. **Tulving et al. (1994)** used **PET scans** to investigate brain activity during memory tasks. They found that different areas of the **prefrontal cortex** were more active during different types of memory processing, with the **left prefrontal cortex** more involved in semantic memory and the **right prefrontal cortex** more involved in episodic memory. This supports the idea that **different areas of the brain are involved in different cognitive functions**, as predicted by localisation theory.

A further strength of localisation theory is that it is **supported by case study evidence**. **Broca (1861)** studied a patient known as **Tan**, who had suffered damage to the **left frontal lobe**. Tan had lost the ability to produce meaningful speech, although he could still understand language. After Tan died, Broca carried out a **post-mortem examination** and found damage to an area of the left frontal lobe, which became known as **Broca's area**. This provided early evidence that **speech production is localised to a specific area of the brain**, supporting localisation theory.



Another strength of localisation theory comes from additional **historical case studies**.

Harlow (1868) reported the case of **Phineas Gage**, who suffered severe damage to his **prefrontal cortex** when a blasting rod passed through his skull. Before the accident, Gage was described as responsible and well behaved, but afterwards he showed major changes in his **personality, behaviour and emotional control**. This suggests that the **prefrontal cortex is involved in controlling behaviour and emotions**, supporting the idea that particular functions are associated with specific areas of the brain.

A limitation of localisation theory is that the **holistic theory** argues that some functions are **distributed across the brain**, rather than being controlled by one specific area. **Lashley (1929)** found that the **amount of brain tissue removed** from rats had a greater effect on their ability to complete a maze than **where the damage occurred**. This suggests that **learning and memory** are not controlled by one single brain area, challenging the idea that all functions are strictly localised. Therefore, localisation may be more useful for explaining **simple functions**, such as movement and vision, than **complex functions** such as learning and memory.

A limitation of localisation theory is that much of the supporting evidence comes from **case studies**, such as **Phineas Gage and Tan**. These provide detailed information about how damage to particular areas of the brain can affect behaviour, but they are based on **individual patients** with unusual patterns of brain damage. This means the findings may not apply to the **wider population**, as people can respond differently to brain damage. Therefore, case studies such as Gage and Tan provide useful evidence for localisation, but their findings have **limited generalisability**.

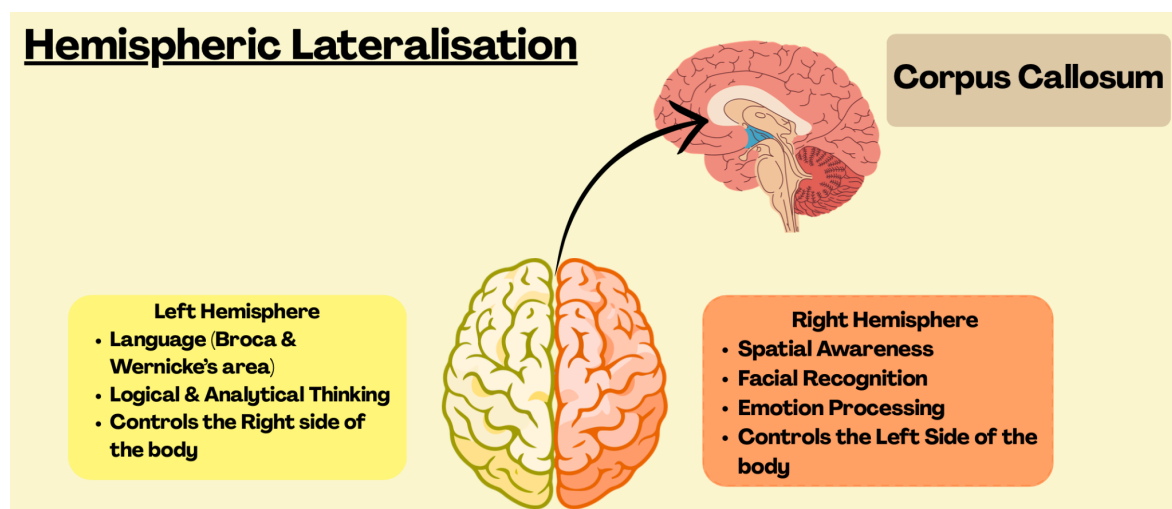


Part 7 — Lateralisation of Function

Hemispheric lateralisation is the idea that the **left and right hemispheres** have different **specialised functions**. For example, the **left hemisphere** is mainly involved in language, while the **right hemisphere** is more involved in visual-spatial processing.

The hemispheres are **contralateral**, meaning they mainly control and process information from the **opposite side of the body**. For example, information from the **left visual field** is **processed by the right hemisphere**, while information from the **right visual field** is **processed by the left hemisphere**.

The two hemispheres normally communicate through the **corpus callosum**, a **bundle of nerve fibres** that allows information to be passed between them.



Sperry and Gazzaniga (1968) – Split-Brain Research

Aim: To investigate whether the **left and right hemispheres** have different specialised functions.

Participants: **11 split-brain patients** who had undergone a **cerebral commissurotomy** to treat severe epilepsy. This involved **surgically cutting the corpus callosum**, preventing information from being easily transferred between the two hemispheres.

Procedure: Sperry and Gazzaniga used **four main tasks** to test the abilities of the two hemispheres:

1. **Describing what was seen:** Words or pictures were presented to either the **left or right visual field**. Participants were asked to **describe what they had seen**.
2. **Matching words or faces:** Participants were shown **words or faces** and asked to **match them** with similar stimuli.
3. **Two words presented simultaneously:** **Two different words** were presented at the same time, one to each visual field. This allowed researchers to test whether each hemisphere could process **different information simultaneously**.
4. **Recognising objects by touch:** Objects were placed in either the **left or right hand**



while participants could not see them. They were then asked to **identify or match the object**.

Findings

1. Describing what was seen	- A word shown to the right visual field was processed by the left hemisphere and could be said aloud. - A word shown to the left visual field was processed by the right hemisphere and could be written or drawn with the left hand, but could not usually be spoken. This suggests the left hemisphere is dominant for language.
2. Matching words or faces	- Participants were able to match faces more accurately when they were presented to the left visual field. - They were also able to match words presented to the right visual field. This suggests the right hemisphere is more specialised for visual-spatial processing.
3. Two words presented simultaneously	- When two different words were presented simultaneously, one to each visual field, participants could say the word presented to the right visual field and write the word presented to the left visual field with their left hand. Right Visual Field → Left Hemisphere (Language centre) → Can say the word. Left Visual Field → Right Hemisphere (Visual-spatial) → Cannot say it, but can write/draw it with the Left Hand This showed that the two hemispheres could process different information at the same time.
4. Recognising objects by touch	- Objects placed in the right hand could usually be named. - Objects placed in the left hand could often be identified or matched with a similar object, but participants had difficulty naming them. This suggests the left hemisphere is dominant for language, as objects processed by the left hemisphere could be named more easily.

Conclusion: The findings support **hemispheric lateralisation**, showing that the **left and right hemispheres have different areas of specialisation**. The **left hemisphere** is mainly specialised for **language**, particularly speaking and naming objects, while the **right hemisphere** is more specialised for **visual-spatial processing**, such as recognising faces



AO3 - EVALUATION

A strength of Sperry and Gazzaniga's research is that it used **highly controlled procedures**. The researchers carefully controlled where information was presented and which hand was used to respond, allowing them to determine which hemisphere was processing the information. This means that differences in performance could be more confidently linked to **hemispheric functioning**, rather than other factors. Therefore, the research had **high scientific validity** and provided reliable evidence for lateralisation of function.

A further strength of Sperry and Gazzaniga's research is that it has **real-world applications in brain surgery**. Research into hemispheric lateralisation has helped identify which areas of the brain are important for functions such as **language**, allowing surgeons to take these areas into account when planning operations. This can help reduce the risk of damaging important functions during surgery. Therefore, research into hemispheric lateralisation has **practical applications** beyond simply increasing our understanding of the brain.

A limitation of Sperry and Gazzaniga's research is that there was a **lack of control over participant variables**. The 11 participants had severe epilepsy and had been taking **anti-epileptic medication for different lengths of time**, meaning their brain functioning may have been affected differently before the study. There were also differences in the extent and timing of their split-brain surgery. This makes it difficult to know whether differences in performance were caused by **hemispheric disconnection** or other differences between the participants. In addition, **commissurotomy is no longer commonly used to treat epilepsy**, meaning the type of patient studied by Sperry is now unusual. Therefore, the findings have **limited generalisability** to modern patients and the wider population.

A further limitation of Sperry and Gazzaniga's research is that the **differences between the hemispheres may not be as clear-cut as suggested**. Sperry concluded that the left hemisphere was mainly responsible for speech, while the right hemisphere was more involved in visual-spatial processing. However, **Lutsep et al. (1995)** studied a **left-handed split-brain patient** who showed **right-hemisphere dominance for language**, with the right hemisphere performing better than the left on tasks involving oral naming and reading. This suggests that **language is not always dominated by the left hemisphere** and that there are individual differences in how functions are lateralised. Therefore, Sperry and Gazzaniga's findings may **oversimplify the extent of hemispheric lateralisation**.



Part 8 — Plasticity and Functional Recovery

1. Neuroplasticity

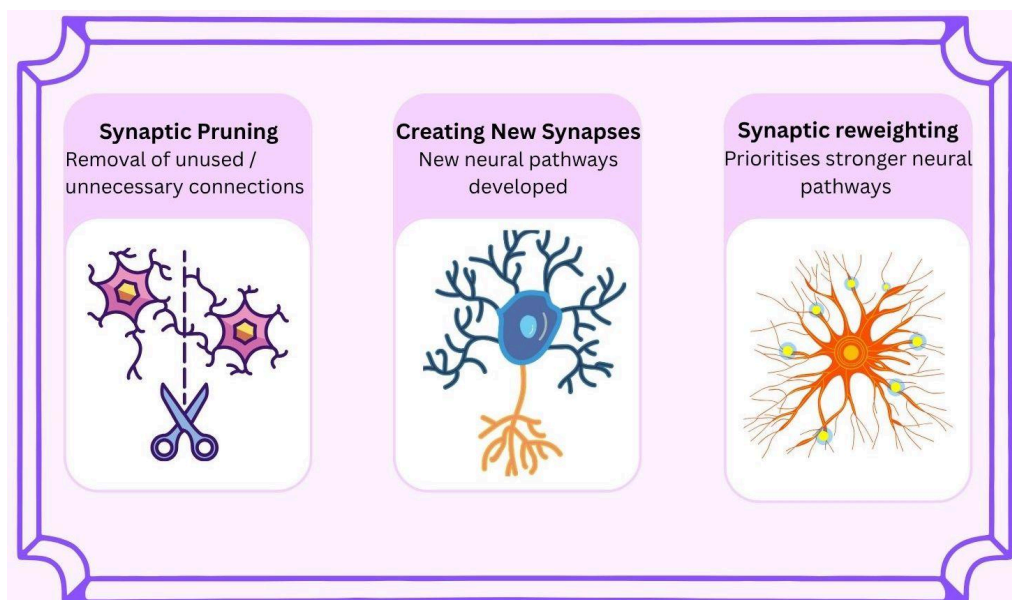
Neuroplasticity refers to the brain's ability to **physically and functionally change** in response to **experience, learning or damage**. This means that the structure and organisation of the brain is not completely fixed.

Previously, psychologists believed there was a **critical period** during early childhood when most neural connections were formed. After this period, it was thought that the brain had limited ability to form new connections. However, research into **neuroplasticity** shows that the brain can continue to **change and reorganise throughout life**.

Some of the **processes involved in neuroplasticity** include:

- **Synaptic pruning** – **unused or unnecessary neural connections are removed**, while frequently used connections are strengthened. This makes communication between neurons more **efficient**, this is **especially common during childhood/adolescence**.
- **Creating new synapses** – the brain can form **new connections between neurons** in response to **learning and experience**. This allows new neural pathways to develop.
- **Synaptic reweighting** – existing synaptic connections can become **stronger or weaker** depending on how frequently they are used. Frequently used connections become stronger and better connected, while less-used connections become weaker.

The brain is particularly **plastic during childhood**, when many new connections are formed and later refined through synaptic pruning. However, **neuroplasticity continues throughout adulthood**, allowing the brain to adapt to new experiences and learning.



Maguire et al. (2000) - London Taxi Driver Study

Aim	To investigate whether the brain changes as a result of learning and experience .
Participants	Experimental group: 16 right-handed male London taxi drivers • Had completed The Knowledge • Had extensive experience with spatial navigation. Control group: 50 right-handed male non-taxi drivers • Provided a comparison group without the same extensive experience of navigating London's streets.
Procedure	• Researchers used MRI scans to examine the participants' brains. • The scans measured the volume of grey matter in different areas of the hippocampus. • Researchers compared hippocampal grey matter volume between the taxi drivers and the control group. • They also examined whether hippocampal grey matter volume was related to the length of time participants had been taxi drivers.
Findings	• Taxi drivers had greater grey matter volume in the posterior hippocampus than the control group. • The posterior hippocampus is associated with spatial memory and navigation, which was particularly important for taxi drivers because of The Knowledge. • There was a positive correlation between the length of time spent as a taxi driver and the volume of grey matter in the posterior hippocampus.
Conclusion	The findings suggest that extensive spatial navigation experience is associated with structural changes in the hippocampus . The researchers proposed that the larger posterior hippocampus may support expert navigation , although the correlational nature of the study means that it cannot establish that taxi-driving experience directly caused the differences.



2. Functional Recovery

Functional recovery is the brain's ability to **recover functions that have been lost following brain damage or trauma**. This can happen because healthy areas of the brain can **reorganise** and take over some functions that were previously controlled by damaged areas.

Some of the **processes involved in functional recovery** include:

Process	What happens?
Neuronal unmasking	Previously inactive neural pathways become active and help support functions affected by brain damage.
Recruitment of homologous areas	The opposite hemisphere takes over some functions previously controlled by the damaged area.
Axonal sprouting	Surviving neurons develop new branches and connections , creating alternative pathways.
Reformation of blood vessels	New blood vessels develop, providing oxygen and nutrients to surviving brain tissue and supporting recovery.

The extent of functional recovery depends on:

- **Severity and location of brain damage** – more severe or widespread damage is generally harder to recover from.
- **Age** – **younger brains** generally have greater potential for recovery because they tend to have greater **neuroplasticity**.
- **Cognitive reserve** – the brain's ability to **cope with damage by using existing neural networks efficiently and finding alternative ways of processing information**. A higher cognitive reserve, which can be developed through **education and mentally stimulating activities**, may improve a person's ability to compensate for brain damage.



AO3 - EVALUATION

A strength of neuroplasticity is that it is **supported by research evidence**. **Ramachandran and Hirstein (1998)** provided evidence of **negative plasticity** through research into phantom limb syndrome. They suggested that following amputation, areas of the **somatosensory cortex** reorganise and become activated by sensory information from other parts of the body, contributing to phantom limb sensations and pain. **Positive plasticity** has also been demonstrated through the case of **Jodi Miller**, where other areas of the brain reorganised following brain damage and helped support functions previously carried out by the damaged area. Therefore, research provides evidence that neuroplasticity is a **real phenomenon** that can produce both **beneficial and harmful changes** in the brain.

A further strength of neuroplasticity is that there is **supporting evidence from animal research**. **Hubel and Wiesel (1970)** sutured one eye of kittens closed during an important period of visual development and examined activity in their **visual cortex**. They found that closing one eye affected the development of the visual cortex, demonstrating that neural connections can change depending on the sensory information received. This suggests that the brain can **adapt its neural connections in response to experience**, supporting the concept of neuroplasticity. However, because the research was conducted on **kittens**, the findings may have limited **generalisability to humans**.

Another strength of functional recovery is that **cognitive reserve may increase the likelihood of recovery following brain damage**. **Cognitive reserve** refers to the brain's ability to **cope with damage by using existing neural networks efficiently and finding alternative ways of processing information**. Education is thought to contribute to cognitive reserve because extended education provides greater opportunities for **learning and intellectual activity**. **Schneider et al. (2014)** studied **769 patients with traumatic brain injury** and found that those with more years of education were more likely to achieve **disability-free recovery** one year after their injury. This suggests that a higher cognitive reserve may allow individuals to **compensate for brain damage more effectively**, increasing their likelihood of functional recovery.

A limitation of functional recovery is that there are **limits to how much recovery can occur spontaneously**. Although the brain can reorganise following trauma, this does not always result in a complete return to normal functioning. **Liepert et al. (1998)** found that **constraint-induced movement therapy** significantly improved the motor performance of stroke patients. This suggests that the brain's natural recovery processes may not always be sufficient to restore lost functions and that **rehabilitation may be necessary to maximise functional recovery**.

