Biopsychology

Paper 2

<u>Specification: Year 1</u>

- **Nervous System:** The divisions of the nervous system: central [CNS] and peripheral [PNS] [somatic and autonomic]
- **Neurons:** The structure and function of sensory, relay and motor neurons
- **Synaptic Transmission**: including reference to neurotransmitters, excitation and inhibition
- **Endocrine System:** The function of the endocrine system: glands and hormones; fight or flight response including the role of adrenaline
- **Stress Response**

<u>Specification: Year 2</u>

- **Localisation of function in the brain and hemispheric lateralisation**: Broca's and Wernicke's areas, split brain research
- **Plasticity** and functional recovery of the brain after trauma.
- **Ways of studying the brain**: scanning techniques, including [fMRI]; [EEGs], [ERPs]; post-mortem examinations.
- **Biological rhythms**: circadian, infradian and ultradian and the difference between these rhythms. The effect of endogenous pacemakers and exogenous zeitgebers on the sleep/wake cycle.

Contents

Biopsychology

Biopsychology is the study of the biological aspects of behaviour and focuses on the nervous system and in particular the brain. The biological approach was addressed in a previous section and covered:

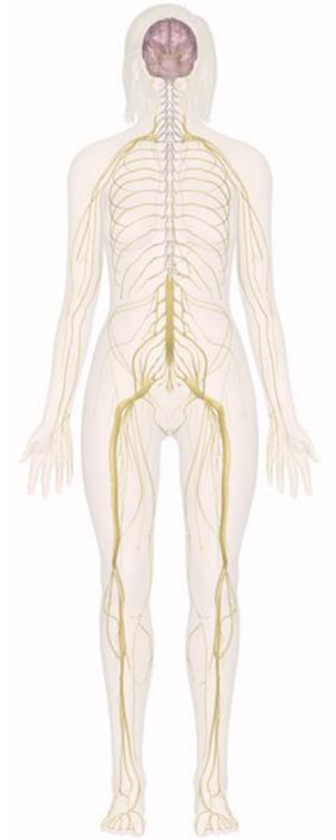
- Neurotransmitters: Serotonin and Depression
- Brain structure: Clive Wearing and Amnesia/Phineas Gage and brain injury
- Genetics: OCD and inherited disorders

Biopsychology does involve a lot of terminology and seems complicated however the study of **brain function** has provided a vital background to the study of behaviour; for example Broca worked briefly with a patient who could only say the word **Tan** although he could understand speech and follow instructions. After he died Broca performed an autopsy and discovered an area at the base of the left frontal lobe involved in speech production; this is now known as Broca's area. In all autopsies with patients who had received the same diagnosis Broca found damage in the same area and more importantly only in the left area; these findings suggest that speech production is located in the left frontal lobe. This is one example of biopsychology and how it can help identify brain structures and associated functions.

It is difficult to know where to begin in this topic; some text books begin with the nervous system others begin with the brain. This topic extends to A level so this workbook covers the complete topic – some will be covered in the first year; the rest in year 2.

We are going to begin with the nervous system. The nervous system is broken down into two major systems and then further subsystems:

- Central Nervous System
- Peripheral Nervous System



Central Nervous System [CNS]

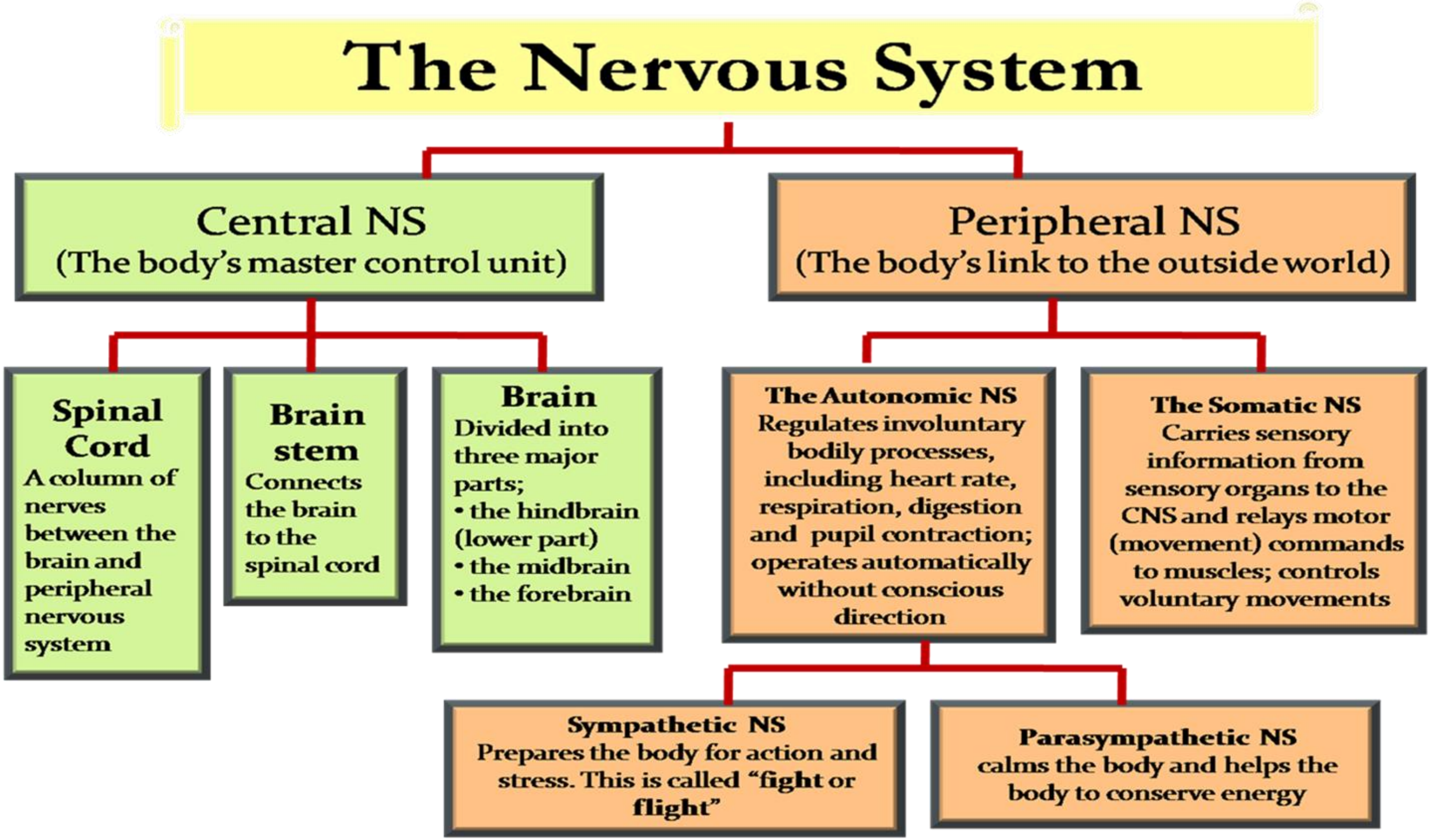
Brain & Spinal Cord

Nervous System

Consists of the CNS & PNS

Peripheral Nervous System [PNS]

[1] Autonomic & [2] Somatic Nervous System


The Nervous System
Central NS
(The body's master control unit)
Peripheral NS
(The body's link to the outside world)
Spinal Cord
A column of nerves between the brain and peripheral nervous system
Brain stem
Connects the brain to the spinal cord
Brain
Divided into three major parts;
• the hindbrain (lower part)
• the midbrain
• the forebrain
The Autonomic NS
Regulates involuntary bodily processes, including heart rate, respiration, digestion and pupil contraction; operates automatically without conscious direction
The Somatic NS
Carries sensory information from sensory organs to the CNS and relays motor (movement) commands to muscles; controls voluntary movements
Sympathetic NS
Prepares the body for action and stress. This is called "fight or flight"
Parasympathetic NS
calms the body and helps the body to conserve energy

The Central Nervous System

The Nervous System as you can see from the diagram [p.4] is divided into 2 sub-sections:

- **Central Nervous System**: which consists of the brain and the spinal cord
- **Peripheral Nervous System**: which consists of the Autonomic NS; Somatic NS and the Sympathetic and Parasympathetic NS

Youtube Site: Human Nervous system.mp4:
https://www.youtube.com/watch?v=aboVLnsCH44

Central Nervous System [CNS]

The nervous system consists of the brain, spinal cord, and a complex network of neurons. This system is responsible for sending, receiving, and interpreting information from all parts of the body. The nervous system monitors and coordinates internal organ function and responds to changes in the external environment. It receives information from, and sends information to, the peripheral nervous system. The brain processes and interprets sensory information sent from the spinal cord. The spinal cord is a cylindrical shaped bundle of nerve fibres that is connected to the brain

The spinal cord

The main function is to relay information between the brain and the rest of the body. This allows the brain to monitor and regulate bodily processes, such as digestion and breathing, and to coordinate voluntary movements such as walking or pulling your hand away from something hot.

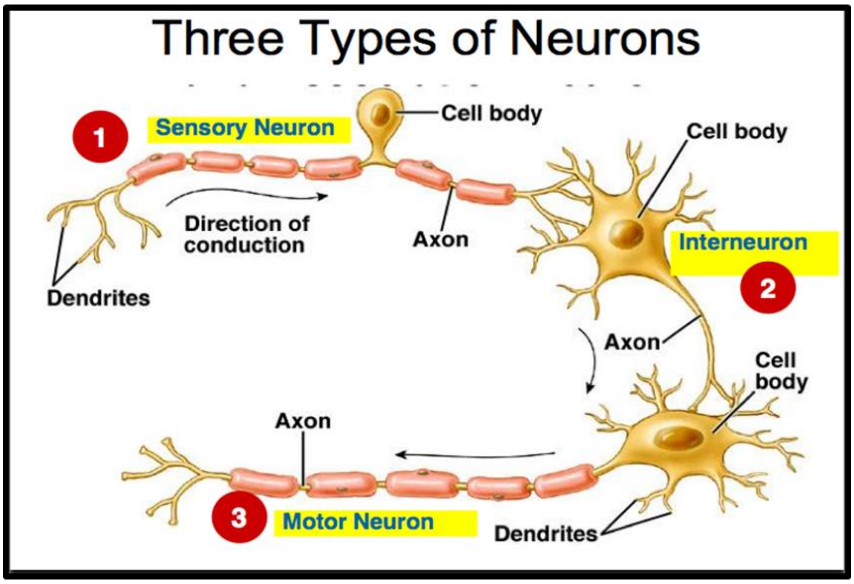
- Runs down the centre from the neck to the lower back
- Ascending nerve tracts carry sensory information from the body to the brain; transmitting information from body organs and external stimuli to the brain
- Descending nerve tracts send information from the brain to the rest of the body

If the spinal cord is damaged, areas supplied by spinal nerves below the damaged site will be cut off from the brain and will stop functioning.

Neurons

What is a neuron?

The body is made up of billions of cells – these cells are called neurons and as you can see by the youtube clip – it is an electrically excitable cell that processes and transmits information through electrical and chemical signals. These signals between neurons occur via synapses, specialised connections with other cells.



Sensory Neurons: Sensory neurons carry electrical signals [impulses] from receptors or sense organs to the CNS. Sensory neurons are also called afferent neurons. They carry nerve impulses from sensory receptors (e.g. vision, taste, touch) to the spinal cord and the brain. Sensory receptors are found in various locations in the body, for example in the eyes, tongue and skin.

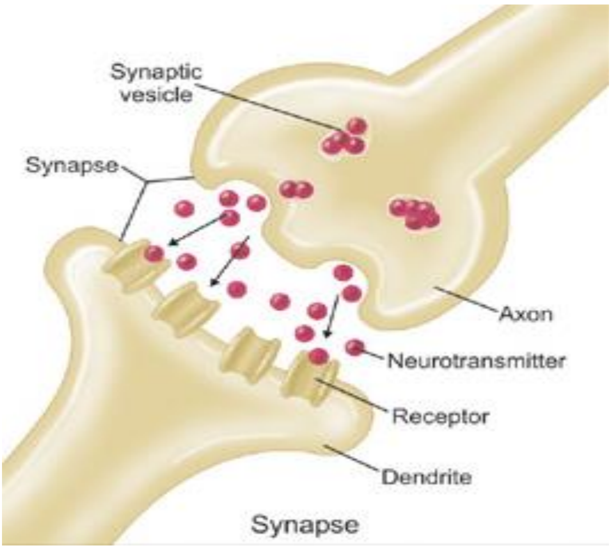
Motor Neurons: Motor neurons carry impulses from the CNS to effector organs Motor neurons are also called efferent neurons. When stimulated, the motor neuron releases neurotransmitters that bind to receptors on the muscle and trigger a response which leads to muscle movement.

Relay [Interneuron]: They carry information between sensory and motor neurons. Relay neurons allow sensory and motor neurons to communicate with each other. These relay neurons (or interneurons) lie wholly within the brain and spinal cord.

Neurotransmitters: Packets of chemicals stored within the axon; they enable nerve impulses to pass across the synapse to the postsynaptic neuron

Synapses

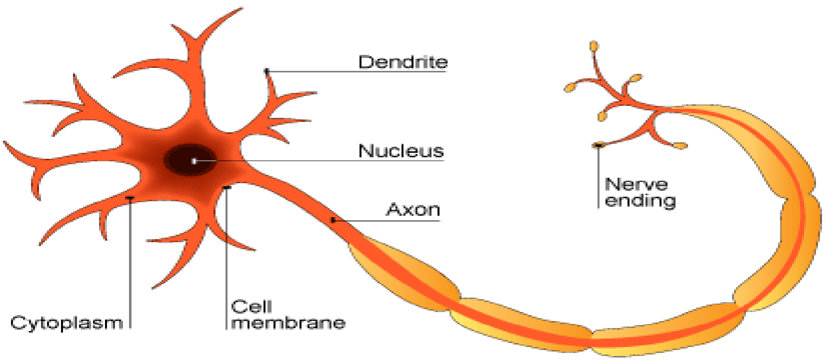
When someone is diagnosed with Depression one of the explanations is that their serotonin levels are low. Serotonin is the body's 'happy' neurotransmitter; if there is too little then the individual is 'low'; 'down' or depressed – if there is too much serotonin then the individual may be 'manic' or 'too happy'. The question is how do these neurotransmitters like serotonin make their way around your body?



The Action Potential

Neurons communicate with each other within groups known as neural networks. Neurons must transmit info both within the neuron and from one neuron to the next. The dendrites of neurons receive info from sensory receptors or other neurons. This info is then passed down to the cell body and on to the axon. Once the info has arrived at the axon, it travels down its length in the form of an electrical signal known as action potential.

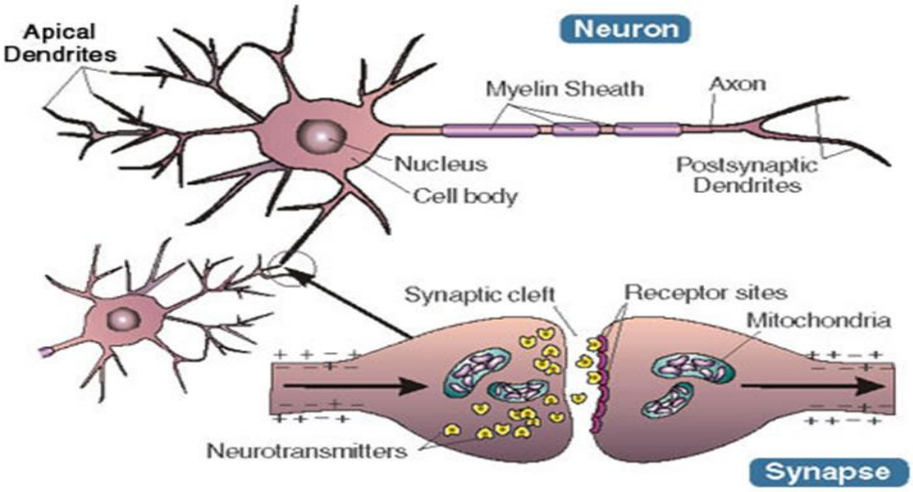
This diagram shows a typical neurone [**a motor neurone**], which has tiny branches at each end and a long fibre that carries the signals in the form of chemical or neurotransmitter



Neurotransmitters are the brain chemicals that communicate information throughout our brain and body. The brain uses neurotransmitters to tell your heart to beat, your lungs to breathe, and your stomach to digest; they can also affect mood, sleep, concentration, and can cause adverse symptoms when they are out of balance. There are two kinds of neurotransmitters

- **Inhibitory**: Calm the brain and help create balance; are easily depleted when the excitatory neurotransmitters are overactive e.g. Serotonin; GABA
- **Excitatory:** Stimulate the brain e.g. Adrenaline

Where two neurones meet there is a tiny gap called a **synapse**. Signals cross this gap using chemicals. One neurone releases the chemical into the gap. The chemical diffuses across the gap and makes the next neurone transmit an electrical signal.



Synaptic connections can be defined by the neurotransmitter they release; so there are synapses solely for serotonin; dopamine, adrenaline, GABA etc. Synapses can be excitatory or inhibitory;

- **Excitation:** Activate the postsynaptic neuron increasing neural activation in the CNS

- **Inhibition:** Inhibit activity in the postsynaptic neuron decreasing activation in the CNS

It is important to remember that normal brain function relies on a careful balance between excitatory or inhibitory influences. For example it was found that benzodiazepines [BZ's] stimulate the release of GABA in the brain thus inhibiting the release of other transmitters such as Serotonin if they are releasing too much.

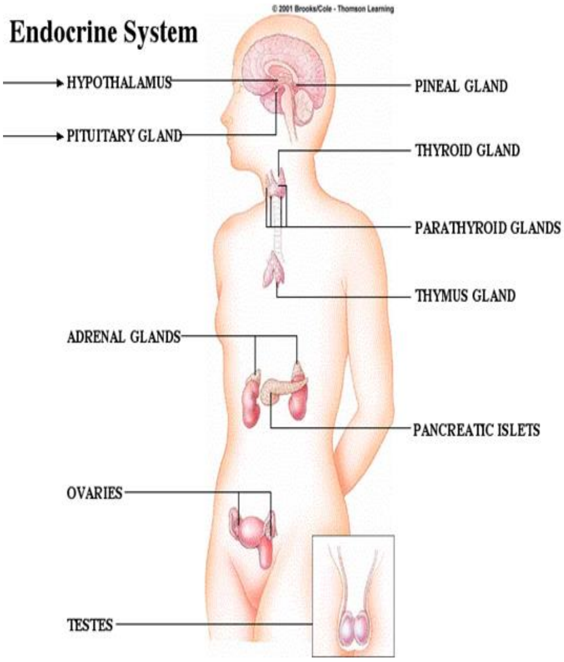
Youtube Sites:

The Nervous System, Part 2 - Action! Potential!: Crash Course A&P #9

https://www.youtube.com/watch?v=OZG8M_ldA1M

Watch Pat 3 as well. The Nervous System, Part 3 - Synapses!: Crash Course:

Endocrine System



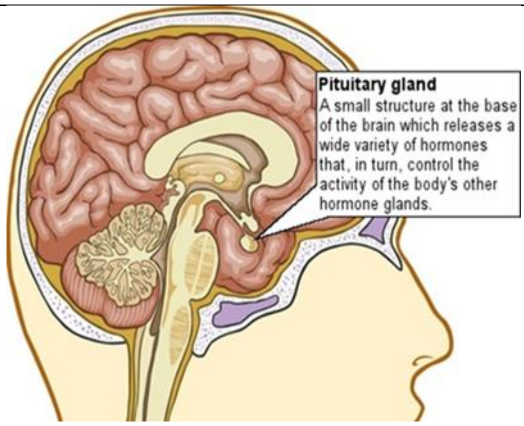
The work of the nervous system is supplemented by a second system in the body, the endocrine system. This is a network of glands throughout the body that manufacture and secrete chemical messengers known as hormones. It works alongside the nervous system to control vital functions in the body. It instructs glands to release hormones directly into the bloodstream via blood vessels. These hormones are carried towards target organs in the body.

For example, a signal is sent from the hypothalamus to the pituitary gland in the form of a 'releasing hormone'. This causes the pituitary to secrete a 'stimulating hormone' into the bloodstream. This hormone then signals the target gland (e.g. the adrenal glands) to secrete its hormone. As levels of this hormone rise in the bloodstream, the hypothalamus shuts down secretion of the releasing hormone and the pituitary gland shuts down secretion of the stimulating hormone. This slows down secretion of the target gland's hormone, resulting in the stable concentration of hormones circulating the bloodstream.

Timing of hormone release is critical for normal functioning, as are the levels of hormones released. Too much or too little at the wrong time can result in dysfunction of bodily systems. E.g. too high a level of cortisol can lead to Cushing's syndrome, characterised by obesity, high blood pressure and depression. The endocrine glands are:

- Pituitary
- Adrenal
- Testes
- Ovaries

We will focus on 2, the Pituitary and Adrenal Gland

Gland	Function	
Pituitary	Often referred to as the master gland. Has 2 parts: the anterior (front) and the posterior (back) The anterior pituitary produces adrenocorticotrophic (ACTH) as a response to stress. ACTH stimulates the adrenal glands to produce cortisol	

Adrenal Gland: Cortex & Medulla [see main diagram for position]	Adrenal Cortex: An important part of the fight-or-flight response as it facilitates the release of adrenaline; the adrenal medulla releases adrenaline and noradrenaline – hormones that prepare the body for flight or flight. Adrenaline helps the body response to a stressful situation e.g. increasing heart rate and blood flow to the muscles and brain.

Of all the glands, the **pituitary gland** is often referred to as the 'Master' gland in the endocrine system. It has two parts;

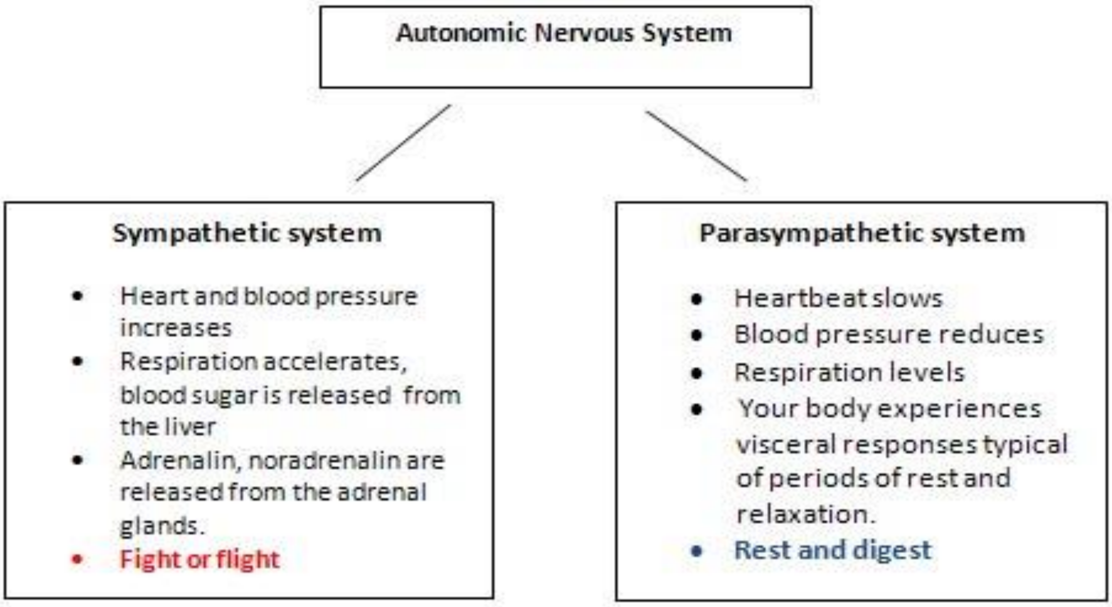
- The anterior (front) the anterior pituitary produces adrenocorticotrophic (ACTH) as a response to stress. ACTH stimulates the adrenal glands to produce cortisol.
- The posterior (back). They each release different hormones that target different parts of the body. E.g.

So how do we bring the topic of Biopsychology [Central Nervous System, Brain; Neurons and Synapses] together?

STRESS RESPONSE

Stress Response

For the last time we are going to look at the Nervous System – only this time we are going to concentrate on the Autonomic Nervous System and in particular the **Sympathetic and Parasympathetic Nervous System.** The Autonomic Nervous System regulates primarily involuntary activity such as heart rate, breathing, blood pressure, and digestion. This system is further broken down into two complimentary systems: Sympathetic and Parasympathetic Nervous Systems.



Fight or Flight Response

Sympathetic NS	**Parasympathetic NS**
Imagine walking down a dark street at night by yourself; suddenly you hear footsteps approaching you rapidly from behind	Now imagine that the footsteps belong to a good friend who catches up to you and offers to walk you home

The Sympathetic Nervous System controls what has been called the 'Fight or Flight' phenomenon because of its control over the necessary bodily changes needed when we are faced with a situation where we may need to defend ourselves or escape.

- When someone is faced with a threat, an area of the brain called the amygdala is mobilised. The amygdala associates sensory signals (what we see, hear or smell) with emotions associated with fight or flight, such as fear and anger. The amygdala then sends a distress signal to the hypothalamus, which functions like a command centre in the brain, communicating with the rest of the body through the sympathetic nervous system

- Your **Sympathetic NS** kicks in to prepare your body: your heart rate quickens to get more blood to the muscles, your breathing becomes faster and deeper to increase your oxygen, blood flow is diverted from the organs so digestion is reduced and your pupils dilate for better vision. In an instant, your body is prepared to either defend or escape.

Now imagine that the footsteps belong to a good friend who catches up to you and offers to walk you home. You feel relief instantly, the **Parasympathetic NS** kicks in. This system is slow acting, unlike its counterpart, and may take several minutes or even longer to get your body back to where it was before the scare **[Homeostasis].** These two subsystems are at work constantly shifting your body to more prepared states and more relaxed states. Every time a potentially threatening experience occurs e.g., you hear a noise in your house at night] your body reacts. The constant shifting of control between these two systems keeps your body ready for your current situation.

Body's response to stress

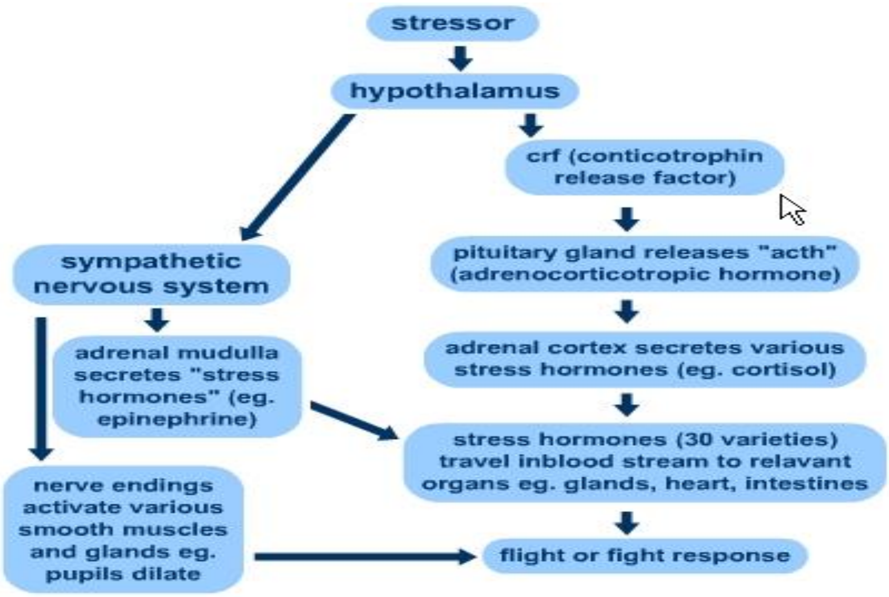
What is stress? According to the **Transactional Model** it is when there is an imbalance between perceived demands on an individual and their perceived coping resources:

- A **Stressor** is the situation or stimulus imposing demands on an individual [e.g. exam]
- **Stress** is the body's alarm reaction requires a physical, mental or emotional response

Think of the demands on you every day; deadlines for homework/coursework, getting to college in the mornings; relationships. The key point is they need to be coped with. You will do this by;

- **Primary Appraisal**: First you assess the stressor and identify potential threats or demands
- **Secondary Appraisal**: You will then assess your ability to cope with the situation

If an imbalance is identified between demands and coping resources, the hypothalamus activates both SAM system and the HPA Axis.



SAM system and Acute Stress

Your SAM system plays a vital role in your ‘stress response’; it arouses the fight or flight response;

↓

Adrenal Medulla is stimulated to release adrenaline and noradrenaline into the bloodstream

↓

Glycogen stored in liver is converted to glucose

↓

Heart rate will increase; your pupils will dilate & oxygen is rapidly pumped to the muscles of the skeleton allowing for increased physical activity

↓

Once the danger/stressor has been avoided or dealt with your body will return to a state of relaxation [**homeostasis**]

Hypothalamic-pituitary Adrenal Axis HPA] - Chronic Stress

Let’s imagine that the stress is on-going i.e. chronic. Your HPA recognises this and needs to ensure that your body can sustain this long period of stress, so the;

The hypothalamus releases the hormone known as corticotrophin-releasing factor [CRF] to stimulate the pituitary gland

↓

The pituitary releases ACTH [stress hormone] into the blood stream

↓

This ACTH travels to the adrenal cortex and stimulates the release of corticosteroids such as cortisol into the bloodstream

↓

Corticosteroids increase the release of glycogen stored in the liver and the fat reserves in the liver so the glucose levels and fatty acids are increased so the fight/flight response can be maintained

Youtube: Stress Response @ https://www.youtube.com/watch?v=FBnBTkcr6No

Task: Write each response as a paragraph

However it has been found that raised levels of corticosteroids suppress the body's immune system and this system is vital against infection.

1. **Kiecolt-Glaser [1984]**

Aim: Kiecolt-Glaser [1984] studied human responses to stress by using a naturally occurring situation – examinations.

Procedure: The researchers took blood samples from 75 1st-year medical students [49 males and 26 females], all of whom were volunteers to **measure NK cell activity**. Samples were taken one month before their final examination [the baseline sample] and again on the first day of their final examinations, after the students had completed two of the examinations. This was the 'stress samples' taken when the students' stress levels should be at their highest.

The volunteers were also assessed using **behavioural measures**. On both occasions they were given **questionnaires** to assess negative life events and social isolation. This was because there are theories which suggest that these are associated with increased levels of stress.

Findings: It was found that NK cell activity was significantly reduced in the high stress samples compared to the low stress samples, confirming other research findings that stress is associated with a reduced immune response.

The greatest reductions in NK cell activity were in students reporting higher levels of social isolation.

Conclusion: That examination stress reduces NK cell activity in the immune function making people more vulnerable to illness and infection. This vulnerability was more noticeable in students experiencing high levels of isolation

A02: Evaluation of Kiecolt-Glaser [1984]

- Kiecolt measured the activity of the NK cell in the immune system and did not link this to illness

- This study used medical students and so it can be argued that it can't be generalised

- **Correlation studies** investigate relationships so cause and effect cannot be established. However a number of other studies have found the same correlation [relationships & stress; Alzheimer patients patients] so it is highly suggestive of a relationship between life stress and reduced immune system

Ethical Issues

- Participants should be in good health with no illnesses or infections prior to the study & should be constantly monitored to check any reactions to the viral challenge

- Participants should be able to give fully informed consent with debriefing afterwards

Exam Questions:

1. Explain how a signal transfers from one neuron to another. Use the following words:
   Axon
   Dendrite
   Synapse
   Terminal button
   Neurotransmitter
   Action potential

   4 marks
2. Explain the function of:
   a. A motor neuron
   b. A sensory neuron

   2 marks

3. Name the two divisions of the nervous system 2 marks

4. Name two glands that release hormones as part of the endocrine system 2 marks

5. Name the 4 lobes of the brain 4 marks

6. Name the two areas of the brain responsible for language 2 marks

Checklist: Biopsychology AQA Paper 2				
Specification sections		Do I have class notes?	Do I know it?	Have I revised it?
The Nervous System	Overview of the Nervous System			
	Central Nervous System			
	Peripheral Nervous System [Somatic & Autonomic]			
Neurons	The structure & function of sensory, relay & motor neurons			
	The process of synaptic transmission including reference to neurotransmitters [excitation & inhibition]			
Long & Short Term Stress Responses	The function of the endocrine system [glands & hormones]			
	The fight or flight response [including the role of adrenaline]			

To help you I have made a list of youtube clips: each of these clips last between 5-11 minutes

Phobias – Behavioural Approach

Youtube: Part 1 Primal Fear – BBC Explorations https://www.youtube.com/watch?v=BzNSYw7xwpU

Youtube: Part 2 Primal Fear – BBC Explorations https://www.youtube.com/watch?v=A4vh5ZGJTHg

Youtube: The Little Albert Experiment: https://www.youtube.com/watch?v=9hBfnXACsOI

OCD – Biological Approach

Youtube: OCD & Anxiety Disorders- https://www.youtube.com/watch?v=aX7jnVXXG5o

Youtube: Obsessive Compulsive Disorder: https://www.youtube.com/watch?v=rh8TLaXGvMs

Depression – Cognitive Approach

Youtube: I had a black dog, his name was depression: https://www.youtube.com/watch?v=XiCrniLQGYc

Youtube: Depressive and Bipolar Disorders: https://www.youtube.com/watch?v=ZwMlHkWKDwM

Maslow's Hierarchy of Needs

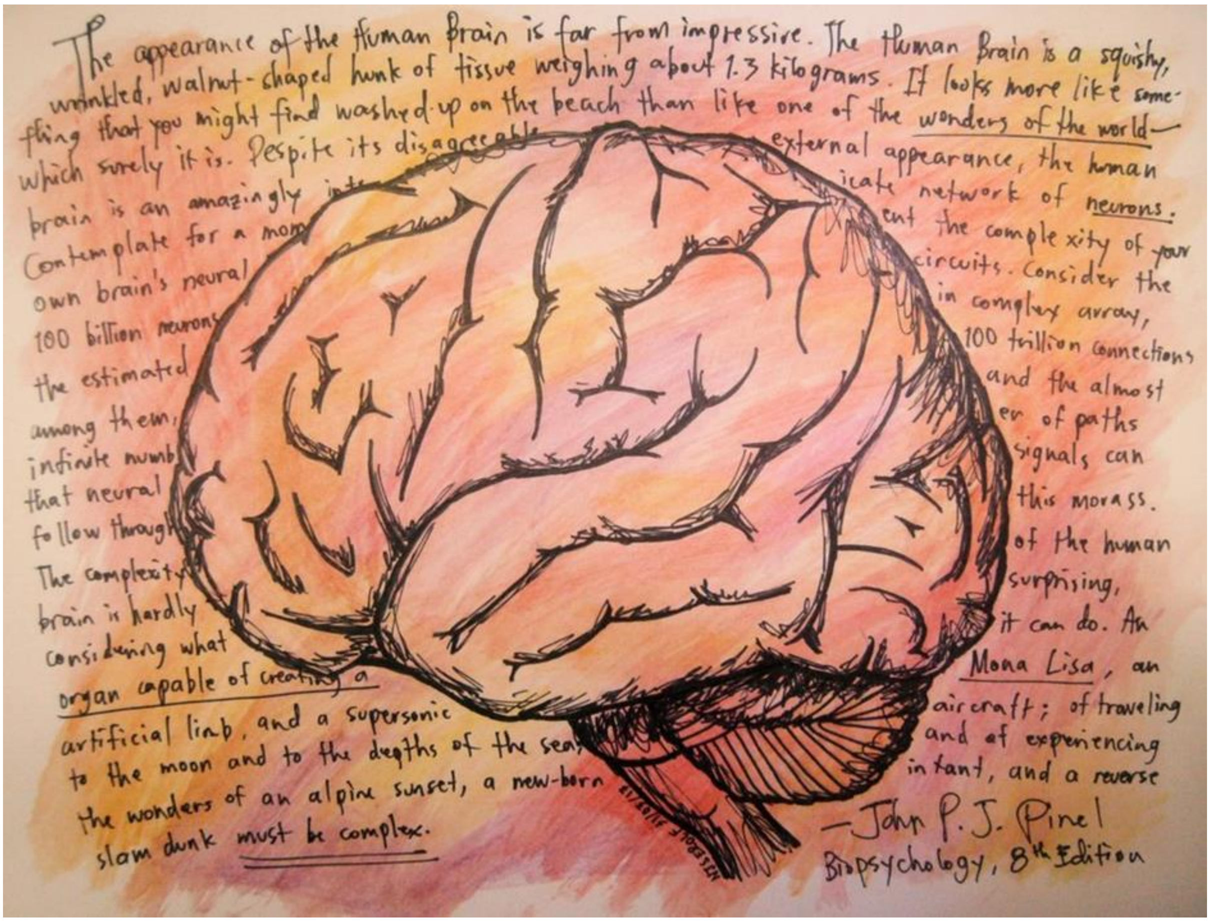
Youtube: Up and the Hierarchy of Needs: https://www.youtube.com/watch?v=Iucf76E-R2s

Stress Response

Youtube: https://www.youtube.com/watch?v=FBnBTkcr6No

A Level

Biopsychology & Biological Rhythms



- **Localisation of function in the brain and hemispheric lateralisation**: Broca's and Wernicke's areas, split brain research
- **Plasticity** and functional recovery of the brain after trauma.
- **Ways of studying the brain**: scanning techniques, including [fMRI]; [EEGs], [ERPs]; post-mortem examinations.
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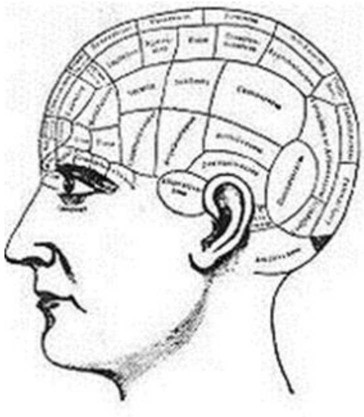
Language and Hemispheric Lateralisation



Throughout the ages there has been a lot of support that the brain has localised functions. In the 1790s **Gall** began to develop the principles of phrenology out of his observations of his fellow students. Those with protuberant eyes, he noted, had particularly good memories; He then suggested that the bumps, indentations and shape of the skull could be linked to different aspects of a person's personality, character and abilities. With his young pickpockets, for example, he suggested that the bump behind their ears was associated with a tendency to steal, lie or deceive.

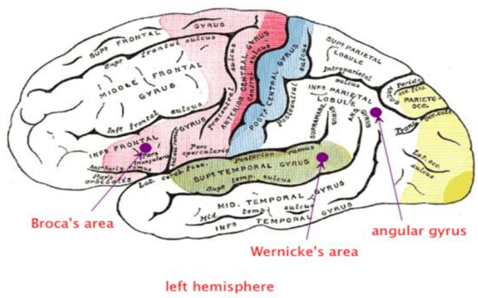
Unfortunately Gall's methods lacked scientific rigor and although phrenology has long been identified as a pseudoscience, it did help make important contributions to the field of neurology. Phrenology pointed researchers to the concept of cortical localisation, the idea that that certain mental functions were located in particular areas of the brain.

Lateralisation

The brain is divided into two halves, a left hemisphere and a right hemisphere. This is called lateralisation; the idea that some functions might be found in only one hemisphere rather than in both.

In human beings, it is the left hemisphere that usually contains the specialised language areas. While this holds true for 97% of right-handed people, about 19% of left-handed people have their language areas in the right hemisphere and as many as 68% of them have some language abilities in both the left and the right hemispheres. Lateralisation was first discovered in the 1800's by physicians such as Broca and Wernicke who performed autopsies on patients who had had several language difficulties before their deaths. These physicians found damage to particular areas of the brain now named after them, and these areas were consistently on the left hemisphere.

Broca



The first language area within the **left hemisphere** to be discovered is called **Broca's Area**, after Paul Broca a French neurologist who had a patient with severe language problems: Although this patient could understand the speech of others, the only word he could produce was 'tan'. Because of this, Broca gave the patient the pseudonym 'Tan'. After the patient died, Broca performed an autopsy, and discovered that an area in the left hemisphere at the base of the frontal lobe had been seriously damaged. He correctly hypothesised that this area was responsible for speech production. In all cases autopsies revealed damage to the same area at the base of the frontal lobe and more importantly the damage in all cases was only in the left hemisphere.

Broca concluded that this area of the left hemisphere was responsible for speech production. The syndrome where speech production is lost but comprehension is intact is called Broca's aphasia or expressive aphasia.

Wernicke

The second language area to be discovered is called **Wernicke's Area** after Carl Wernicke, a German neurologist. Wernicke was studying patients with the opposite syndrome to Tan's. These patients could speak quite well, but were unable to understand the speech of others or follow instructions. After the patient's death, Wernicke performed an autopsy and found damage to an area in the left hemisphere at the top of the temporal lobe. He correctly hypothesised that this area was responsible for speech comprehension. The syndrome of intact speech but loss of speech comprehension is known as Wernicke's Aphasia or receptive aphasia.

An early model of speech saw Wernicke's area as containing our store of words. When we want to speak the word is located and activated in Wernicke's area and the information is transmitted to Broca's area. Here muscles of our vocal apparatus are activated and the word is spoken.

Later research investigated reading and writing. The word we read is transmitted to the visual cortex for initial processing, then passed to the angular gyrus and then to Wernicke's area where the word can be recognised. Where there is damage to the angular gyrus the individual cannot read – this is called Alexia. The work of Broca and Wernicke has contributed to our understanding of the brain mechanisms in language and in particular to the location of language. This has led to the view that the left hemisphere as dominant for language.

Structure of the Brain

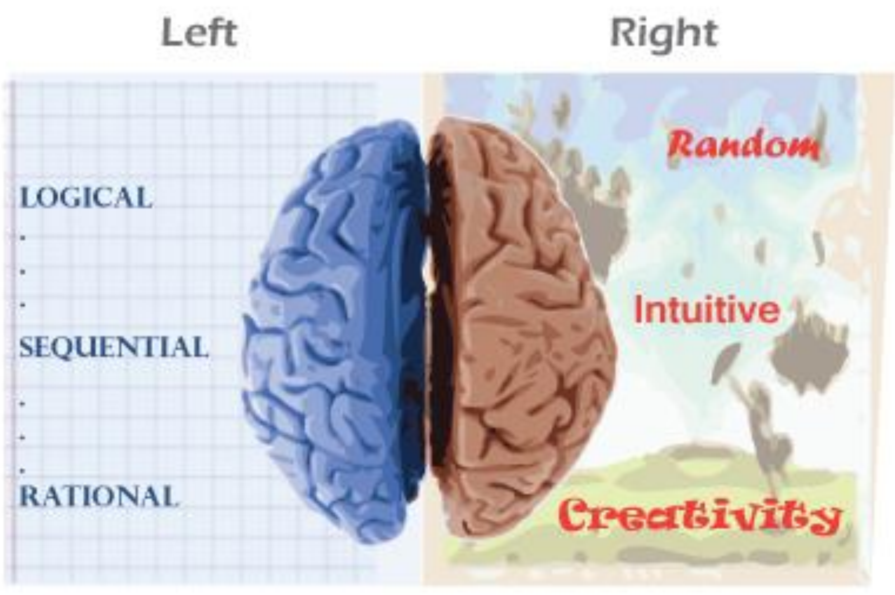
It seems the appropriate moment to study the structure of the brain. The brain is the control centre for your body and it sits in your skull at the top of your spinal cord. It is wrapped in 3 layers of tissue and floats in a special shock-proof fluid to stop it from getting bumped on the inside of your skull as your body moves around.

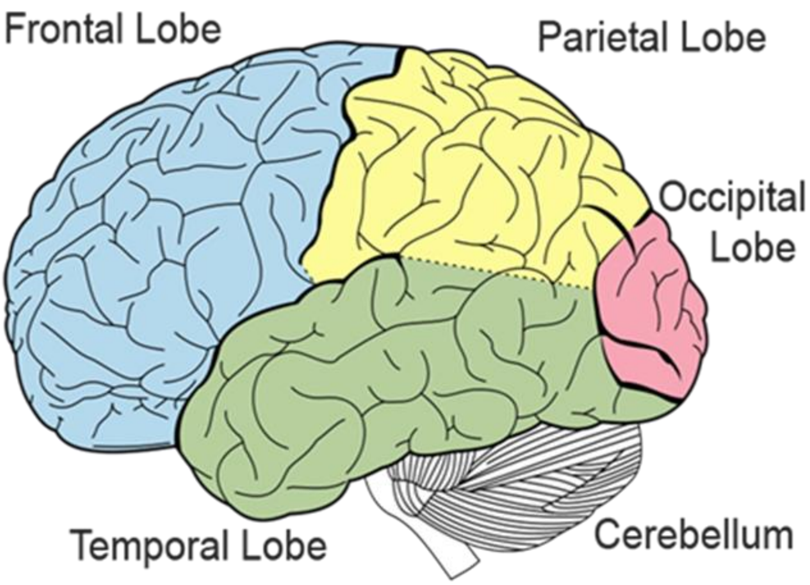
The brain has three main parts:

1. The cerebellum is sometimes referred to as the 'little brain' is comprised of small lobes and is involved in the coordination of motor movements as well as basic facets of memory and learning.
2. The brain stem controls a lot of the 'automatic' actions of your body such as breathing and heart-beat, and links the brain to the spinal cord and the rest of the body
3. The cerebrum which has two parts, the left and right cerebral hemispheres

The brain is divided into two symmetrical hemispheres:

- **Left:** language, the 'rational' half of the brain, associated with analytical thinking and logical abilities
- **Right**: more involved with musical and artistic abilities





The brain is also divided into four lobes:

Frontal: Motor cortex: motor behaviour, expressive language, higher level cognitive processes, and orientation to person, place, time, and situation

Parietal: Somatosensory Cortex: involved in the processing of touch, pressure, temperature, and pain

Occipital: Visual cortex: interpretation of visual information

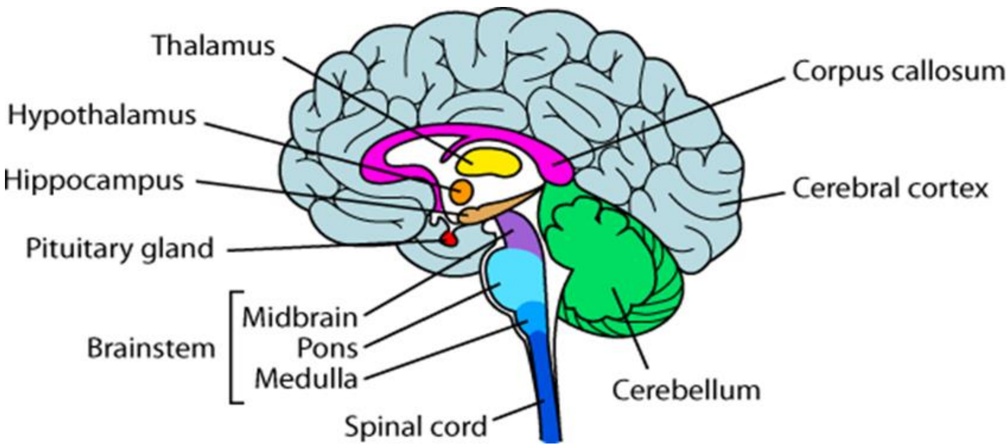
Temporal: Auditory cortex: receptive language [understanding language], as well as memory and emotion

Lastly there is the:

Cerebellum: Located on the back of the brainstem; major functions relate to control of movement and damage results in a loss of motor coordination

You tube: Meet Your Master: Getting to Know Your Brain - Crash Course Psychology #4

https://www.youtube.com/watch?v=vHrmiy4W9C0



Brainstem: Typically the brain and spinal cord act together, but there are some actions, such as those associated with pain, where the spinal cord acts even before the information enters the brain for processing. Other parts of the brainstem include:

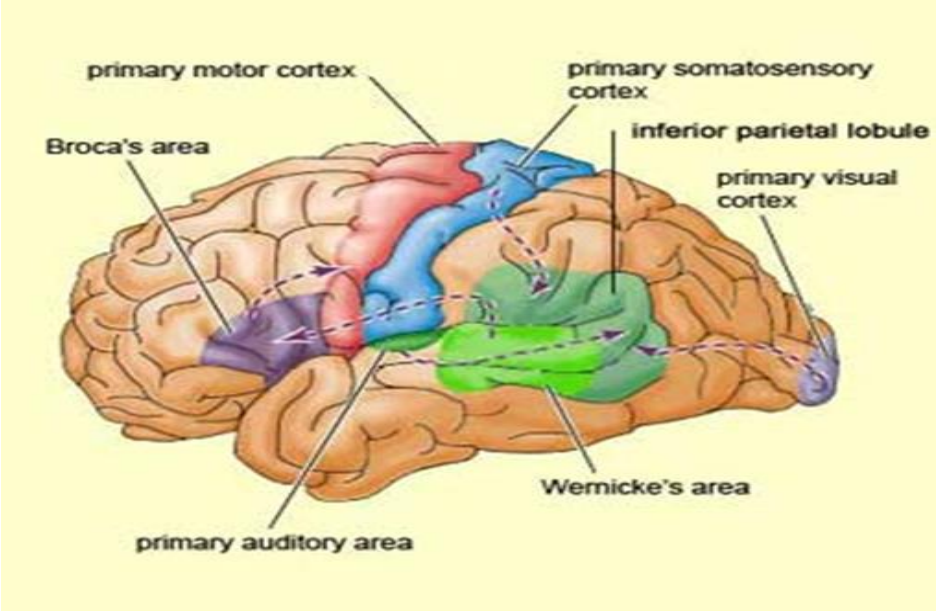
- **Medulla Oblongata**: Controls heartbeat, breathing, blood pressure, digestion;
- **Reticular Activating System** Involved in arousal and attention, sleep and wakefulness, and control of reflexes;
- **Pons**: Regulates states of arousal, including sleep and dreaming.

Cerebral Cortex: is what we see when we picture a human brain, the gray matter with a multitude of folds covering the cerebrum. It is involved in a variety of higher cognitive, emotional, sensory and motor functions. **Three major systems make up the cerebral hemispheres:**

- **Limbic System:** This consists of a set of integrated structures:
  - **Hippocampus:** Involved more in memory, and the transfer of information from short-term to long-term memory
  - **Hypothalamus:** Controls the autonomic nervous system, and therefore maintains the body’s homeostasis, translates emotions into physical responses.
  - **Amygdala:** Attaches emotional significance to information and mediates both defensive and aggressive behaviour

- **Basal Ganglia: Involved in functions related to movement and motor control.** Damage to the basal ganglia results in movement disorders such as Parkinson’s disease

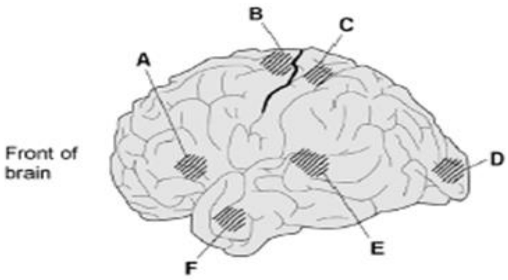
- **Cerebral Cortex:** Planning and problem-solving; language; personality as well as perception and control of movement



0 5 Read the item and then answer the questions that follow.

Figure 1 shows the left hemisphere of the human brain. Six areas of cortical specialisation are labelled **A**, **B**, C, **D**, **E** and **F**.

Figure 1: Left hemisphere of the human brain



Using your knowledge of localisation of function in the brain, identify the area of cortical specialisation. Shade **one** box only for each area.

0 5 . 1 Broca's area

A ○ B ○ C ○ D ○ E ○ F ○

[1 mark]

0 5 . 2 Somatosensory cortex

A ○ B ○ C ○ D ○ E ○ F ○

[1 mark]

0 5 . 3 Visual cortex

A ○ B ○ C ○ D ○ E ○ F ○

[1 mark]

0 5 . 4 Wernicke's area

A ○ B ○ C ○ D ○ E ○ F ○

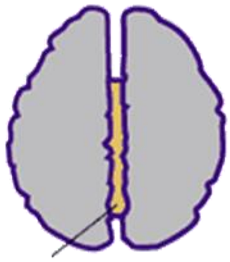
[1 mark]

0 5 . 5 Motor cortex

A ○ B ○ C ○ D ○ E ○ F ○

[1 mark]

Sperry and Split-Brain Research



Epilepsy and split-brain surgery

As we now know the brain is made up of two hemispheres. The corpus callosum is a band of nerve fibres located deep in the brain that connects the two halves [hemispheres] of the brain. It helps the hemispheres share information, but it also contributes to the spread of seizure impulses from one side of the brain to the other. A commissurotomy is an operation that severs [cuts] the corpus callosum, interrupting the spread of seizures from hemisphere to hemisphere. Seizures generally do not completely stop after this procedure [they continue on the side of the brain in which they originate]. However, the seizures usually become less severe, as they cannot spread to the opposite side of the brain.

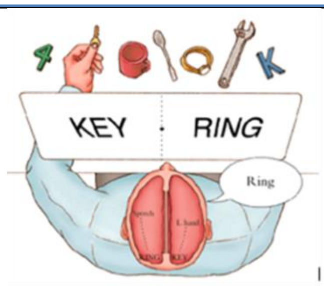
A commissurotomy also known as split-brain surgery, may be performed in people with the most extreme and uncontrollable forms of epilepsy, when frequent seizures affect both sides of the brain. People considered for split-brain surgery are typically those who do not respond to treatment with medications. If you remember, in the memory topic HM underwent surgery for epilepsy which resulted in amnesia.

In the 1950s, American neuroscientist Roger Sperry and his team discovered that severing the corpus callosum in the brain of a cat or monkey had no notable effects on the animal's behaviour. He concluded that that in monkeys' the two hemispheres were equal in terms of their behavioural capacities. This was contrasted with humans where it was known that the key function of language was usually located in the left hemisphere which also controlled the right hand. So the left hemisphere was seen as the dominant and the right as the minor partner.

Sperry wanted to investigate hemisphere function in split-brain patients. In an intact participant a stimulus presented to either the right or left hemisphere would immediately be commuted across the corpus callosum to the other hemisphere so both hemispheres would be aware of the stimulus. Once patients had the operation it was almost as if they had two separate brains that worked independently.

The difficulty lay in the fact that although the two hemispheres were separated by the commissurotomy, each eye sends projections to both hemispheres. So Sperry had to design a method for projecting stimuli to each hemisphere separately. He devised an experimental procedure known as the **divided field**. One limitation to this procedure is that there is a natural tendency for the participant to move their eyes towards the stimulus to deal with this Sperry presented the stimulus for around 200 milliseconds [blink of an eye]

Sperry, 1968: Split-brain research



Aim: To investigate the hemispheric functioning of split brain patients

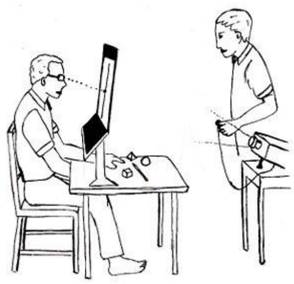
Method: Quasi-experiment [natural occurring IV]

The IV : was whether a person had hemisphere disconnection or not

The DV: was the participant's performance on the task

Case study method; In-depth investigations of the 11 participants

Participants: 11 individuals who had their corpus callosum severed



Procedure: [Several tasks were used]

1. Patients were asked to respond to tactile information. For example, a spoon was put into the patient's hand without the patient being able to see what the object was. The patient was then asked to name the object.

   Findings: Was not be able to name it because the object had not been seen by the right hand side of the brain

2. Two symbols were presented at the same time – a dollar sign to the left field of vision, a question mark to the right field of vision. Patients were then asked to draw and name what they had seen

   Findings: They drew the dollar sign but named it as a question mark

- Sperry also found that hemisphere disconnection did not affect the patients' intelligence [as measured by an IQ test], nor did disconnection affect their personality

- The effects of the surgery did affect the patients in that they had short-term memory difficulties, limited concentration spans, and orientation problems

Conclusion:

- Sperry argued that his studies give considerable support to his argument of lateralisation of function, i.e. each hemisphere of the brain is specialised for the performance of certain tasks. The left hemisphere specialises in language tasks while the right hemisphere specialises in tasks involving spatial analysis

- Sperry showed that each hemisphere can operate as a separate ‘brain’ if the whole brain is divided surgically. He also went on to argue that each hemisphere has its own perceptions, memories and experiences.

Strengths

- Highly controlled; using specialised equipment and were highly standardised. The tasks all involved setting tasks separately to the two hemispheres. This provided him with qualitative and quantitative information. This combination of methods allows for the reliable data gathered to be enhanced by the participants’ description of their personal experiences

- Clearly demonstrated the lateralisation of function between the left and right hemisphere

- Although it was a small sample, it was probably representative of the people who have had this operation

Weaknesses

- The tasks are low in ecological validity- the problems participants faced in the task would probably not be a problem in real life however people whose hemispheres have been disconnected use both eyes to compensate for any loss of function

- It may not be possible to compare the brains of severe epileptics who have undergone brain surgery to the brains of ‘normal’ people

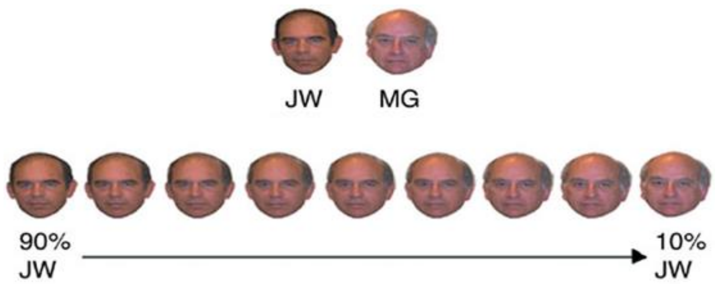
- There were only 11 participants which is a small sample to generalise from - but this was probably beyond his control because of the small number available. However, this did allow him to gather more in-depth data in the case studies.

Sperry and his colleagues repeated the divided field studies with split-brain patients but this time used faces instead of words:

Sperry & Gazzaniga, 2005

- A different face was presented to each hemisphere at the same time
- The patient was then given a set of faces including the ones presented and asked to choose the one they had seen earlier
- **<u>Findings:</u>** They would choose the one presented to the right hemisphere thus supporting evidence that the right hemisphere is visual and better at identifying faces than the left hemisphere

Turk et al [2002]



Investigated face recognition with a patient called JW who had also undergone a commissurotomy due to epilepsy. JW was presented with faces that had been 'morphed' together. These pictures where presented separately to each hemisphere as either himself [JW] or MG [Gazzaniga].

Findings: Both hemispheres showed:

- The left hemisphere showed recognition of self
- The right hemisphere showed recognition for familiar others

Researchers accepted that the right hemisphere is in general better at face-processing ***but*** the left hemisphere may have an important role to play in self-recognition as this would require personal memories and beliefs so perhaps the left hemisphere has a primary role in the networks involved.

Evaluation of the split-brain research

The work of Sperry and his colleagues was ground-breaking and changed views on hemispheric function however,

- There are very few of these patients; only 10-15 have been subjected to extensive systematic study. This is a small sample size

- Those studied differed in aged, gender and handedness [left or right]; also age at which they had the commissurotomy and age at which they were tested

- Their operations were not always comparable. Besides the corpus callosum there are other pathways connecting the two hemispheres such as the anterior commissure. Sometimes this was also severed but in some cases it was left intact possible allowing for some communication between the two hemispheres.

Plasticity

Brain plasticity, also known as neuroplasticity or cortical remapping, is a term that refers to the brain's ability to change and adapt as a result of experience. Up until the 1960s, researchers believed that changes in the brain could only take place during infancy and childhood. By early adulthood, it was believed that the brain's physical structure was permanent. Recovery of function after a brain damage is currently an area of neuroscience research **[functional recovery]**

Plasticity in the new-born brain

From the moment a baby is born the developing brain is exposed to a vast range of experiences, environments and stimuli. A baby has to learn to recognise different people, learn a language, to crawl, stand and walk. To benefit from all these experiences the baby's brain has to respond to all these experiences by altering its organisation and structure. This is plasticity.

In an extraordinary study the most extreme example of plasticity is the ***hemispherectomy***. Very occasionally a baby is born with severe damage to one of the hemispheres due to either a difficult birth, genetics or illness. It has been found that if the hemisphere is removed soon after birth, as an adult that person shows few, if any behavioural or cognitive impairments [Villablanca et al, 2000]. This shows the extraordinary plasticity of the developing brain. Functions that may have been located in the hemisphere that has been removed have been transferred to the other hemisphere. At this stage in development the brain has sufficient neurons and synapses to cope with the dramatic change.

Pathways and networks used regularly will survive while pathways and networks that are not used regularly will die. As the brain matures in adulthood the brain should have adapted to its surroundings and be well-adjusted.

Plasticity in the Adult brain

It has been argued that plasticity would be lost when the brain matures at the age of 20. Whilst new schemas will still be developed the effects of brain damage on behaviour seem permanent. Over the past 50 years however, this view has changed perhaps because we know a lot more about brain plasticity.

Brain Trauma

Common types of brain trauma include:

- **Physical Trauma:** e.g. blows and wounds to skull and brain
- **Cerebral haemorrhage:** Blood vessel in the brain bursts e.g. stroke
- **Cerebral Ischaemia:** Blood vessel in the brain is blocked by a blood clot; brain areas supplied by the blood vessel begin to die
- **Viral or bacterial infection:** e.g. Meningitis

Traumatic brain damage can lead to paralysis, aphasia, memory loss [amnesia] or difficulties in perception. Also with a stroke, one side of the body is affected for example if the stroke occurred in the left hemisphere then the right side of the body would be affected.

Possible mechanism of recovery

- There is often some significant recovery in the first few days or weeks after traumatic brain injury. Besides destroying neurons, brain damage can also cause swelling of brain tissues and this can affect behaviour. The swelling dies down over a period of days or weeks and this aids recovery
- **Neurogenesis:** Growth of new neurons. Until recently it was not thought to occur in the human brain however recent research has found that Neurogenesis occurs in the hippocampus and olfactory bulb. The actual process is still not clear and much of the research has taken place with mice however it is a promising line of research
- **Behavioural strategies:** Kapur [1997] found that recovery after brain trauma was better in doctors than in the general population. This is probably because they have greater cognitive resources
- **Age when trauma occurs:** Teubar [1975] studied soldiers with brain damage. He found that recovery was age dependent:
    - 60% under 20 showed significant improvement
    - 20% over the age 26 showed similar improvement

Possible that reorganisation may be extensive in younger brains

Possible Treatments

Drugs: Chemicals such as NGF [Nerve Growth Factor] may be used to prevent degeneration and death of neurons

Neural Transplantation: The recent discovery of stem cells has revived interest in Neural Transplantation. In theory stem cells implanted in a damaged area have the potential to grow into neurons and make functional synaptic connections that would help restore behavioural functions. This research is in its early days so there is long way to go yet.

Rehabilitation and Brain Reorganisation: It has been found that practising skills alters brain organisation. For example in violin players who use the left hand for the complex fingering of the notes, the area of motor cortex dedicated to the left hand increases with practice. This has led to an approach called the constraint-induced therapy [CIT]. Constraint-induced movement therapy [CIT] is a form of rehabilitation therapy that improves upper extremity function in stroke and other central nervous system damage victims by increasing the use of their affected upper limb

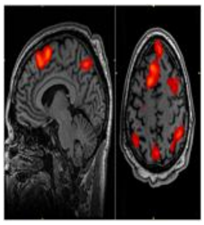
Methods used to identify areas of cortical specialisation

Keywords:

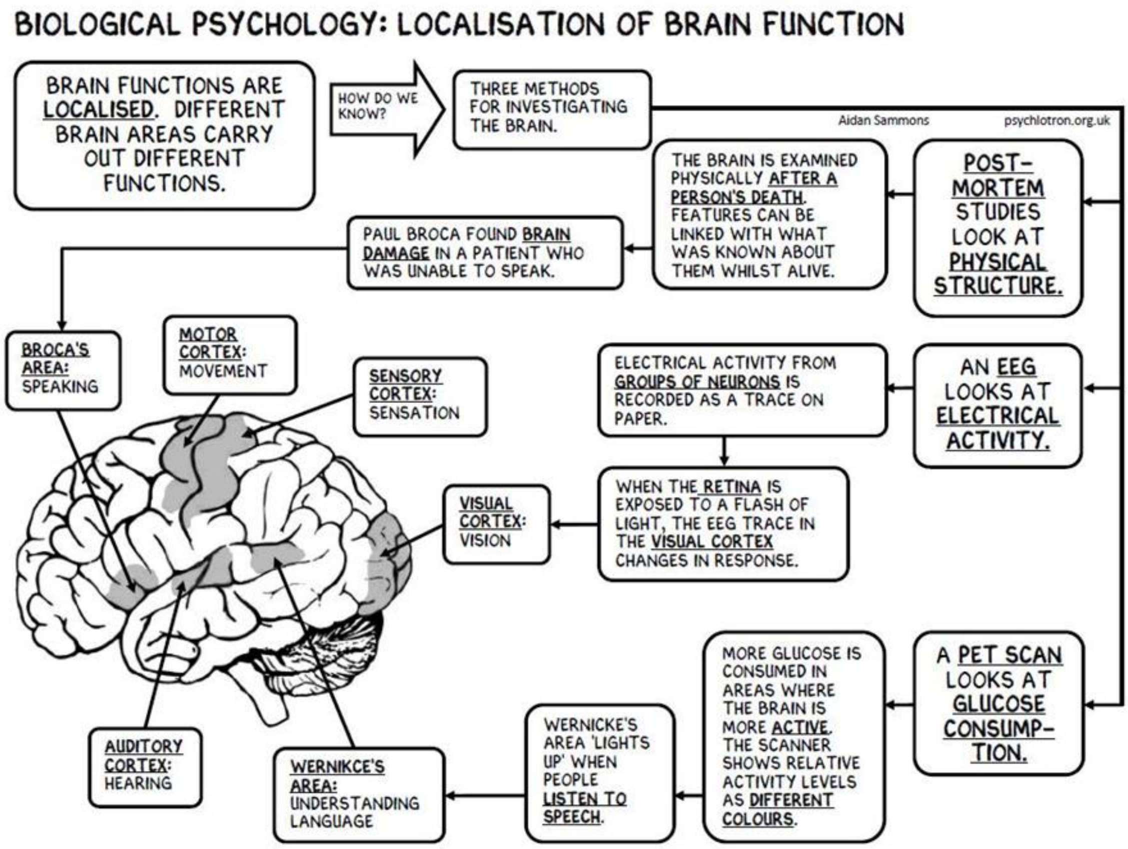
- **Temporal resolution** refers to the precision of a measurement with respect to time

- **Spatial resolution:** The ability to sharply and clearly define the extent or shape of features within an image
- **EEGs** have good temporal resolution as they take readings every millisecond, but poor spatial resolution as they can only tell roughly where in the brain the electrical signals are originating from

- **MRI, PET, & CAT** scans have good spatial resolution but poor temporal resolution

Method	Description & What it measures	Evaluation
MRI 	Areas of the brain which are most active need more blood. Blood contains haemoglobin, which contains iron, which is magnetic. Magnetic resonance will change as blood flow changes. Measures blood flow in the brain, by magnetic resonance.	**Positive** • No harmful effects on patient or operator. • Scans are non-invasive and therefore raise fewer ethical issues, e.g. less harm. • Good spatial resolution. **Negative** • Poor temporal resolution. • Cannot usually be used on people with pacemakers, or metal implants / metal fragments in the body. Can be uncomfortable due to loud noise, vibrations, and claustrophobic nature of the device - people with even mild claustrophobia are often unable to tolerate an MRI scan
fMRI 	fMRI works by detecting the changes in blood oxygenation and flow that occur in response to neural activity – when a brain area is more active it consumes more oxygen and to meet this increased demand blood flow increases to the active area	**Positive** • Can be used to produce activation maps showing which parts of the brain are involved in a particular mental process. **Negative** • fMRI is expensive, and has poor temporal resolution [whole brain images can typically only be collected every 2 seconds]

PET 	Radioactive glucose is injected into the participant. The parts of the brain which are most active, use more glucose, and show on the scan.	**Positive** • Good spatial resolution • Non-invasive way of studying the brain. **Negative** • Poor temporal resolution. • Need permission from ethics committees to inject radioactive material, although dose is very small. • Expensive and difficult to use
EEG 	Electrodes are placed on the scalp. The brain is believed to work through it's electrical activity. EEGs provide natural measurements of brain activity, Measures electrical activity in the cerebral cortex.	**Positive** • Good temporal resolution. Can record changes on a millisecond level. Very few other techniques have high temporal resolution. • Non-invasive. • EEG measures are less harmful than surgical procedures, **Negative** • Poor spatial resolution. Limited anatomical specificity – can only detect when groups of neurons are firing, and not precisely where.
ERP 	The Event Related Potential [ERP] technique allows us to take raw EEG data, the electrical activity recorded from the brain, and use it to investigate cognitive processing. First, we record a subject's EEG while they perform a task designed to elicit the proper cognitive response [e.g. attending to a certain type of object]. To accomplish this, p's have subjects wear a mesh cap embedded with electrodes which record brain activity. Also attached are electrodes to the face to monitor eye movements	
CAT scan 	Measures tissue density Lots of x-rays	Positive • Good spatial resolution • Non-invasive way of studying the brain. Negative • Poor temporal resolution. • Dangerous x-ray radiation
Post mortem examination 	Examination of brain after death	Positive • Useful for looking at the brain closely and in detail. • Post-mortem studies provide understanding of rare disorders; • Useful for studying the brains of people with specific psychological problems. e.g. schizophrenia, speech problems Negative • Participant needs to die before the brain can be examined.


BIOLOGICAL PSYCHOLOGY: LOCALISATION OF BRAIN FUNCTION
BRAIN FUNCTIONS ARE LOCALISED. DIFFERENT BRAIN AREAS CARRY OUT DIFFERENT FUNCTIONS.
HOW DO WE KNOW?
THREE METHODS FOR INVESTIGATING THE BRAIN.
Aidan Sammons
psychlotron.org.uk
POST-MORTEM STUDIES LOOK AT PHYSICAL STRUCTURE.
THE BRAIN IS EXAMINED PHYSICALLY AFTER A PERSON'S DEATH. FEATURES CAN BE LINKED WITH WHAT WAS KNOWN ABOUT THEM WHILST ALIVE.
PAUL BROCA FOUND BRAIN DAMAGE IN A PATIENT WHO WAS UNABLE TO SPEAK.
BROCA'S AREA: SPEAKING
MOTOR CORTEX: MOVEMENT
SENSORY CORTEX: SENSATION
AN EEG LOOKS AT ELECTRICAL ACTIVITY.
ELECTRICAL ACTIVITY FROM GROUPS OF NEURONS IS RECORDED AS A TRACE ON PAPER.
WHEN THE RETINA IS EXPOSED TO A FLASH OF LIGHT, THE EEG TRACE IN THE VISUAL CORTEX CHANGES IN RESPONSE.
VISUAL CORTEX: VISION
A PET SCAN LOOKS AT GLUCOSE CONSUMP-TION.
MORE GLUCOSE IS CONSUMED IN AREAS WHERE THE BRAIN IS MORE ACTIVE. THE SCANNER SHOWS RELATIVE ACTIVITY LEVELS AS DIFFERENT COLOURS.
WERNICKE'S AREA 'LIGHTS UP' WHEN PEOPLE LISTEN TO SPEECH.
WERNIKCE'S AREA: UNDERSTANDING LANGUAGE
AUDITORY CORTEX: HEARING

Exam Questions

Section A

Approaches in Psychology

Answer **all** questions in this section

Only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD   WRONG METHODS

If you want to change your answer you must cross out your original answer as shown.

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

0 1 . 1 Complete the following sentence. Shade **one** box only.

Sensory neurons carry information

A away from the brain.

B both to and from the brain.

C towards the brain.

D within the brain.

[1 mark]

0 1 . 2 Complete the following sentence. Shade **one** box only.

The somatic nervous system

A comprises of two sub-systems.

B connects the central nervous system and the senses.

C consists of the brain and spinal cord.

D controls involuntary responses.

[1 mark]

0 2 Which **one** of the following responses results from the action of the sympathetic division of the autonomic nervous system? Shade **one** box only.

A Decreased pupil size ○

B Increased digestion ○

C Increased heart rate ○

D Increased salivation ○

[1 mark]

0 3 Label the **two** areas of the synapse in **Figure 1** by putting the appropriate letter in each box.

A Axon

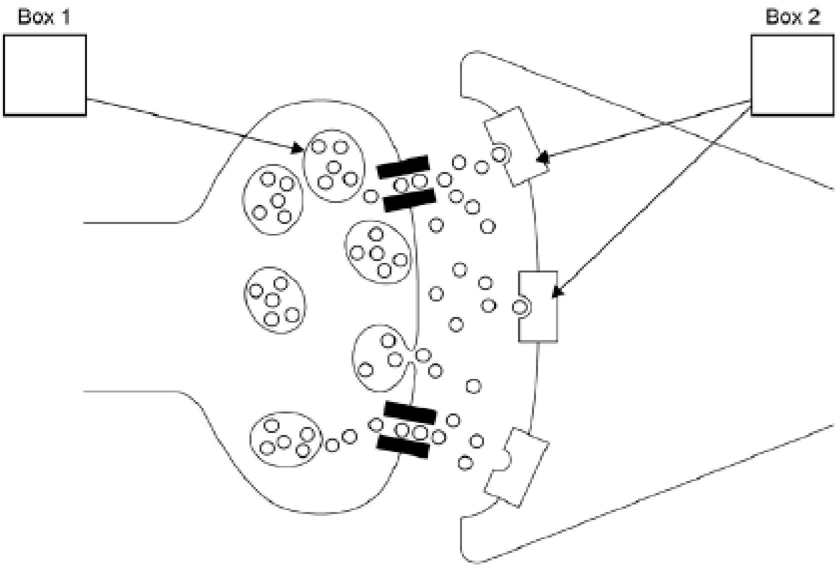
B Dendrites

C Neurotransmitters

D Receptor sites

E Vesicle

Figure 1: The synapse



[2 marks]

Turn over ▸

0 9 Outline the structures and processes involved in synaptic transmission.

[6 marks]

Extra space

Biological Rhythms

The world is full of rhythms. Go to the seaside and the tides flow in and flow out daily; each year the seasons; Spring Summer, Autumn and Winter follow their annual pattern each with its own characteristics such as temperature, snow, sun or rainfall. We also have daily patterns such as day or night. These patterns are determined by the Earth's movement around the sun and its rotation through 360 degrees every 24 hours so the patterns have been around a very long time.

In the living world biological rhythms are found everywhere. Bears and squirrels regularly **hibernate** during the winter months when the days shorten and the temperature falls. **Nocturnal** animals such as Owls sleep during the day and hunt at night. **The study of biological rhythms aims to investigate how these regular patterns are controlled.** In humans we can identify hundreds of different biological rhythms. The most obvious perhaps is the sleep-wake cycle where we are active during the daylight hours and then sleep during the night; the term for this is **diurnal** though even during sleep we see a regular alternation between stages of what is called slow-wave sleep, active or REM sleep. We also find that body temperature in humans has a daily rhythm, peaking in the afternoon and falling to its lowest level in the early morning.

It is clear that there must be internal mechanisms involved in the control of biological rhythms. These mechanism are known as **endogenous pacemakers** or 'body-clocks'. In this topic we consider the three main categories of biological rhythms and the extent to which they are controlled by internal and external factors. We then consider what happens when our rhythms are disrupted.

When marking your exam paper the examiner will award higher grades to those students who demonstrate an appreciation of issues and debates; these include the nature/nurture debate, ethical issues in research, free-will/ determinism, reductionism, gender and culture bias, and the use of animals in research.

However, before discussing the role of endogenous pacemakers you need to find the explanations for the following key terms:

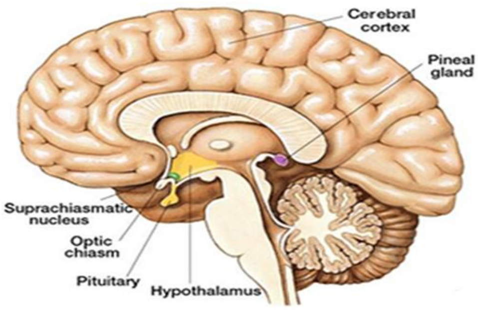
Key terms

Key Term	**Explanation**	**Example**
Circadian Rhythm		
Infradian Rhythm		
Ultradian Rhythm		
Endogenous pacemakers		
Exogenous zeitgebers		

Circadian Rhythms

Circadian rhythms are physical, mental and behavioural changes that follow a roughly 24-hour cycle, responding primarily to light and darkness in an organism's environment. Most living things [humans, animals, plants] respond to circadian rhythms

One endogenous pacemaker is the **suprachiasmatic nucleus (SCN)**. The SCN is a tiny region located in the hypothalamus, situated directly above the optic chiasm. It is responsible for controlling **circadian rhythms**. The neuronal and hormonal activities it generates regulate many different body functions in a 24-hour cycle hence why the SCN is considered the most important internal clock.



Endogenous Pacemaker [Control]

The most important internal clock in most animals has been identified as the SCN located in the hypothalamus

Evidence from Research	Support
Stephan et al [1973] damaged the SCN of rats and found that this influenced a number of circadian rhythms including drinking and being more active in the dark period	Ralph et al (1990) - took the SCN from a hamster which had a circadian rhythm mutated to a shortened 20.2 hours, and transplanted it into another hamster with a normal 24 hour circadian rhythm. On recovery, the recipient hamster exhibited a circadian rhythm very similar to that of the donor

Endogenous Control or Exogenous Influence?

Light is regarded as the primary zeitgeber for the SCN. Without this zeitgeber, cycles become ‘freerunning’, i.e. not tied to a 24 hour light/dark cycle. Thus, zeitgebers influence rather than control rhythms

Evidence from Research	Support
Aschoff (1975) – people kept in underground bunkers (eliminating zeitgebers) kept a natural cycle of activity, suggesting an internal clock	Michael Siffre (1972) – spent 205 days deep in a cave. He was free to light his work-place when he wanted but had no knowledge of the light/dark cycles in the outside world. His sleep/wake cycle adjusted over time to approximately 25 hours.

Infradian Rhythms

Infradian rhythms last longer than one day. Although Infradian means ‘less than one day’ it is used to describe biological rhythms that have a periodicity of more than one day. Examples include the human menstrual cycle, seasonal affective disorder [SAD] and hibernation in bears and squirrels. The regularity of these cycles is certainly due to endogenous pacemakers and confirms that there must be many of these body clocks controlling the variety of biological rhythms that we can identify.

The menstrual cycle in particular is under clear physiological control from hormones in the pituitary glands whose release is controlled by the hypothalamus. The regularity of the rhythm and the fact that it is independent of environmental cues [zeitgebers indicates that endogenous pacemakers are the key controlling factor.

Menstrual Cycle

Occurs once a month, and is a series of physical and hormonal changes related to fertility.

Endogenous pacemakers

The cycle is controlled by hormones released by the pineal gland in the brain. Reiberg (1967) found that a woman living in a cave showed a shortened menstrual cycle, indicating that in the absence of exogenous zeitgebers a cycle is maintained.

Exogenous zeitgebers

Many people believe that women living or working closely with one another synchronize their menstrual cycles. It has been suggested that pheromones released by the women initiate the synchrony, although there is no sound evidence for this

Evidence for exogenous influence	**Evidence against exogenous influence**
Russell et al [1980] did find evidence for an influence of zeitgebers on the menstrual cycle. They found that if sweat from one woman was rubbed on the lips of another woman, their menstrual cycles would eventually synchronise. Russell concluded that the sweat from the first woman contained pheromones, chemicals that serve as sex signals.	**Yang and Schank (2006) - 186 Chinese women living in university accommodation showed no menstrual synchrony at all.**

Hibernation

Endogenous pacemaker

It is thought that hormones control the changes in body function, allowing animals to prepare for harsh winter months

Evidence for endogenous pacemaker

Dawe et al (1968): blood from hibernating squirrels encouraged hibernation in 'awake' donors within 48 hours of the transfusion.

Support

Myers et al (1981) - substance from the plasma of hibernating squirrels injected into the brain of the macaque monkey (an animal that does not normally hibernate) encouraged heart and temperature changes related to hibernation

Exogenous zeitgeber

External indicators like harsher weather and shorter days indicate to animals that they should begin to hibernate. For example, black bears normally hibernate in the wild. In captivity, where there is regular food and shelter, they do not. This suggests that the food and shelter cues (external) are important for hibernation to occur

Seasonal Affective Disorder (SAD)

Seasonal affective disorder (SAD)

Some people suffer annual bouts of depression during the winter months. The problem appears to be related to levels of light

Endogenous pacemakers

Many researchers point to a key role played by melatonin – levels increase during darkness and release is suppressed by light. It has been suggested that SAD occurs because of increased melatonin secreted by the pineal gland during the darker winter months.

Exogenous zeitgebers

Because a lack of light seems related to the onset of SAD, treating people with light may be helpful.

Evidence for exogenous influence

Eastman et al (1998): exposure to bright light as a treatment significantly helps those who suffer SAD, with a partial or full remission of their symptoms.

Evidence against endogenous control of SAD

Postolache et al (1998) - full remission of the kind that happens in the summer does not occur with light treatment. This may be due to a number of things such as the UV content of the light. Other external issues influencing SAD may be personal finance issues experienced during the winter and reduced social contact. Some research suggests that people with SAD secrete melatonin normally.

Ultradian Rhythms

The different stages of sleep are collectively an ultradian rhythm, as is the 'basic rest activity cycle (BRAC)'.

Stages of Sleep

Sleep largely consists of several 90 minute cycles of REM and NREM sleep. NREM (stages 1 to 4 of sleep) differs from REM in terms of physical and brain activity. Stages 3 and 4 are known as slow wave sleep (SWS). REM (rapid eye movement sleep, also known as dream sleep) occurs after stage 4

Evidence for endogenous control	**Support**
Jouvet (1972) – damaging the brain stem of cats in the area of the locus coeruleus removed REM sleep	**Webster et al (1985):** The quantity of destroyed cells sensitive to the neurotransmitter acetylecholine was related to the amount of REM lost

Evidence for exogenous influence

Although there is no ***direct*** evidence of exogenous influence certain studies have indicated that although the basic rhythm is controlled by an endogenous pacemaker [body clock] it may require the input of an exogenous zeitgeber [external influence]: Think about it – summer nights/can't sleep too light whereas in the December you may begin to feel tired about 4pm when it becomes dark.

Siffre (1975)	**Aschoff et al (1976)**
Spent 6 months in an underground cave in Texas, with no natural light. Biological rhythms became free running. The cave was artificially lit and he could use a telephone to ask for the lights off when he slept. He could eat/sleep when he wanted.	Placed participants in an underground World War II bunker in the absence of environmental and social time cues. They found that most people displayed circadian rhythms between 24 and 25 hours, though some rhythms were as long as 29 hours.
A variety of physiological functions were recorded including body temperature, heart rate, blood pressure and sleeping-waking pattern. They found his sleep-waking cycle extended from 24 hours to between 25 and 32 hours. His body temperature circadian rhythm was more stable and extended slightly to 25 hours but remained consistent	These studies show that circadian rhythms persist despite isolation from natural light, which demonstrates the existence of an endogenous 'clock'. However this research also shows that external cues are important because the clock was not perfectly accurate: it varied from day to day.

Disruption of Biological Rhythms

Further evidence regarding the relationship between endogenous pacemakers and exogenous zeitgebers can be found by looking at situations where the normal synchronised relationship breaks down. Two key examples of this are:

- Jet Lag
- Shift Work

Jet lag

Jet lag is caused by flying across time zones. e.g. because it is five hours behind the UK, flying from London at 1pm means that you would arrive in New York at 3.30pm, even though the flight time is 7.5 hours. This causes a conflict between zeitgebers, which tell us one time, and our biological clocks, which are telling us it is another.

- Flying from Heathrow to New York takes 8 hours so you would arrive in NY at 8pm. However because of the time difference [NY is 5 hours behind] you will arrive at 3pm in the afternoon. Your endogenous pacemaker is therefore 5 hours ahead of local time and has to wait for zeitgebers to catch up; this is known as **phase delay**
- Returning from NY your endogenous pacemaker is therefore 5 hours behind; this is known as **phase advance**

Effects of jet lag - evidence from research	**Evidence for consequences of jet lag - sporting performance**
Spitzer et al (1997): Jet lag shows itself as cognitive disturbances including reduced alertness, clumsiness, memory problems and general tiredness **Rafnsson et al (2001):** 1500 female flight attendants, those flying for over 5 years had double the risk of breast cancer	Sasaki et al (1980) – a Russian volleyball team flying east into the Japanese time-zone for a tournament performed badly for the first few games but then improved. This was put down to west-east jet lag and the difficult phase advance correction. The research, however, ignored individual differences and variations in team performance as well as ability of opponents

Shift Work

Shift work is any work outside normal daytime hours (i.e. between 7am and 7pm). Biological clocks are not designed for activity outside these times and so are disrupted. The most disruptive kinds of shift work are those that include night work. There is evidence to suggest that night shift work can be harmful to health, and it has been linked to diabetes, cancer, and hypertension and gastric and immune system problems.

Evidence of consequences of shift work - accidents and heart disease

Czeisler et al (1985): US police officers on night shift had 4 times as many accidents as those on day shift. This was improved hugely by changing shift patterns, i.e. how many night shifts a person worked before moving onto day shifts, and how the day/night hours were allocated

Knutson et al (1999): Night shift increased the risk of heart attack by 30% in men and women who had been doing night shifts for 16 to 20 years

Evidence of consequences of shift work – risk of cancer

Kubo et al (2006): Men in Japan who worked any kind of night shift (either regular or with rotating day/night schedules) were 4 times more likely to develop prostate cancer than other workers

Shernhammer et al (2001): US nurses, the risk of breast cancer increased significantly with the number of years spent working nights

Research on possible causal mechanisms

Swerdlow (2003)

Reduced levels of melatonin cause increased levels of hormones associated with breast cancer

Schernhammer et al (2003):

Blind women who do not have melatonin suppressed by light have lower incidence of breast cancer

Spiegel et al (2002)

Disagree with melatonin being a cause and suggest that cancer is due to disruptions in the release of cortisol

Exam Questions

0 8 The human female menstrual cycle is an example of one type of biological rhythm; it is called a:

A circadian rhythm ⬭

B infradian rhythm ⬭

C ultradian rhythm ⬭

[1 mark]

0 9 Outline the structures and processes involved in synaptic transmission.

[6 marks]

Extra space

1 0 Split brain patients show unusual behaviour when tested in experiments. Briefly explain how unusual behaviour in split brain patients could be tested in an experiment.

[2 marks]

1 1 Briefly evaluate research using split brain patients to investigate hemispheric lateralisation of function.

[4 marks]

Turn over for the next section

1 0 Split brain patients show unusual behaviour when tested in experiments. Briefly explain how unusual behaviour in split brain patients could be tested in an experiment.

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[2 marks]

1 1 Briefly evaluate research using split brain patients to investigate hemispheric lateralisation of function.

[4 marks]

Turn over for the next section

1 The body's response to stress includes the pituitary-adrenal system and the sympathomedullary pathway. The following are all features of this stress response.

A Adrenal medulla
B Noradrenaline
C Adrenal cortex
D Adrenaline
E Cortisol/Corticosteroids
F Adrenocorticotrophic hormone (ACTH)

Select **two** from the above list that are linked to the pituitary-adrenal system and **two** from the list that are linked to the sympathomedullary pathway.

Put **one** letter in each box.

Pituitary-adrenal system		
Sympathomedullary pathway		

(4 marks)

1. With reference to neurotransmitters, explain what is meant by excitation and inhibition [4]

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2. Distinguish between a sensory neuron and a relay neuron [2]

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Section A Biological Psychology

Answer **all** questions in the spaces provided.

Total for this question: 6 marks

1 (a) Outline the pituitary-adrenal system.

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(3 marks)

Extra space ....

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1 (b) Outline the sympathomedullary pathway.

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(3 marks)

Extra space ....

....

6