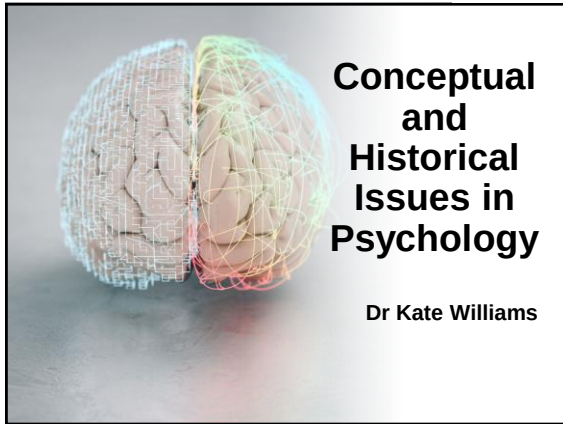




1

Session Outline:

-  **Biological Basis of Behaviour**
-  **Brief History and Background**
-  **Understanding the Nervous System**
-  **Neurons and Synaptic Transmission**
-  **Key Terminology and Organisation of the Brain**
-  **Major Structures and Functions of the Brain**
-  **Techniques for Studying the Brain**
-  **Effects of Brain Damage**

2

Core Domain: Biological Psychology

ONE OF THE BPS CORE AREAS!!!

TO EXPLORE INTRICATE RELATIONSHIP BETWEEN BRAIN, BEHAVIOUR, AND MENTAL PROCESSES

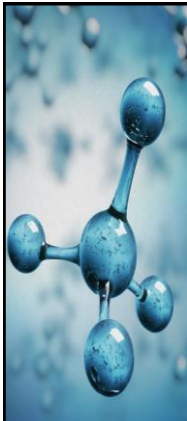
3

Question:

Why Study Biology in Psychology?



4



• Biological psychology:

- Understand how biological processes influence thoughts, feelings, and action/behaviour.
- Investigate physiological & neurological mechanisms underlying psychological processes and behaviour.
- Has implications for:
 - Treating psychological disorders
 - Developing medications
 - Enhancing overall well-being

5

Neurotransmitters:
Chemical messengers transmit signals between neurons.

Brain Structure and Function: How brain areas contribute to cognitive & emotional processes.

Genetics: How inherited traits may influence psychological processes. Typically involves twins.

Hormones and Endocrine System:
Influence mood, stress response, etc.

Brain Imaging:
Technology enabling study of living brain and connectivity (e.g., fMRI, PET).

Evolution: How psychological traits & behaviours evolved to enhance survival.

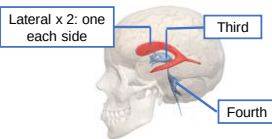
Neuroplasticity: Brain's ability to change and adapt by forming new neural connections due to experience.

Psychophysiology: Study relationship between physiological processes and psychological experiences

6

Brief History

Edwin Smith Surgical Papyrus:
Egyptian medical text detailing
effects of brain damage on
functioning (circa 1600 BCE).



**4th - 14th C: types of
behaviour mediated by
activity of ventricles:
hollow fluid-filled cavities**

7

Brief History

• **18th & 19th C: ventricle hypothesis no longer valid
due to discoveries in anatomy and
neurophysiology.**

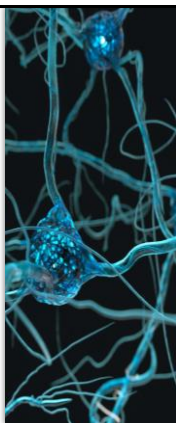
- **E.g., discovery of cells
(neurons) in the brain.**
- **Physician Camillo Golgi:
discovered way of tracing
structure of cells through
technique called staining.**



8

Brief History

- **Pathologist Santiago Ramon y Cajal:**
 - Discovered brain comprises network of communication neurons.
- **Physician Luigi Galvani:**
 - Discovered nerve cells produce electricity
 - Led to Helmholtz finding nerve cells communicated with each other using electrical signals.
- **Discovery in psychopharmacology:**
 - Surface of neurons, known as receptor sites, responsive to chemicals called neurotransmitters.



9



Key figures in understanding brain damage (19th C)

- Pierre Paul Broca
- Carl Wernicke.

Anthropological society meeting (1861) on **equipotentiality**:

- Any part of intact piece of brain can carry out function from damaged part.

Versus **localisation theory**:

- Only that part of the brain can deal with a certain function.
- Localisation theory prevailed based on evidence from brain damage patients



10

Broca's Aphasia (expressive):

- Patients have slow non-fluent speech.
- Poor ability producing syntactically correct sentences (many grammatical errors).
- *But* sentence comprehension is intact.

<https://www.youtube.com/watch?v=JWC-cVQmEmY>



11

Wernicke's Aphasia (receptive):

- Can speak fluently with apparent grammar
- But severely lacks meaning
- Many key words missing
- Severe problems with speech comprehension.

<https://www.youtube.com/watch?v=3oe168YabD0>



12

The Nervous System

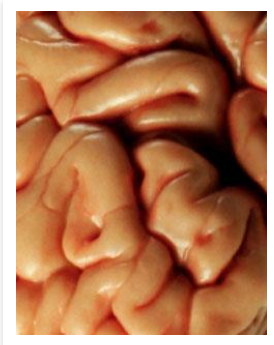
- Produce movement & control behaviour
- Communication network consisting of nerve cells.
- Transmits nerve impulses around the brain and between parts of the body.
- Comprises approx. 100 billion neurons arranged in complex array of around 100 trillion connections.
- Approx. 80% of these are in the brain.



13

Most neurons are in the Cerebral Cortex

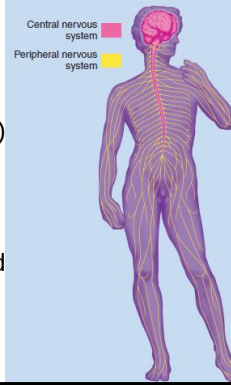
The outer layer of the brain.



14

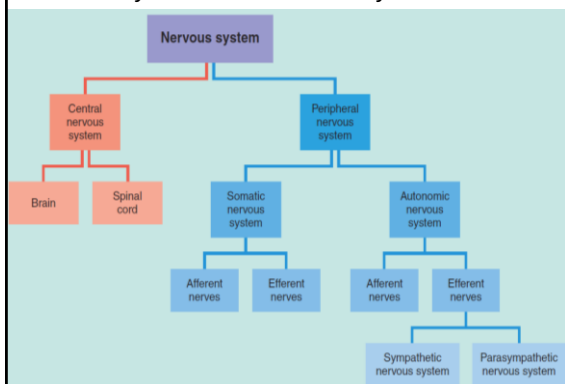
General Layout of the Nervous System

- Central Nervous System (CNS)
 - Brain (in the skull)
 - Spinal Cord (in the spine)
- Peripheral Nervous System (PNS)
 - Located outside skull and spine
 - Brings info to and carry signals out of CNS



15

General Layout of the Nervous System



16

Autonomic Nervous System

Opposite effects.

SYMPATHETIC	PARASYMPATHETIC
Project from CNS in Thoracic (chest) and lumbar (bottom of back) areas of spinal cord.	Project from the Cranial (brain) and sacral (lower back area of spinal cord).
“Fight or flight”: stimulate, organize, & mobilize energy resources when in threat.	“Rest and restore”: conserve energy
	

17



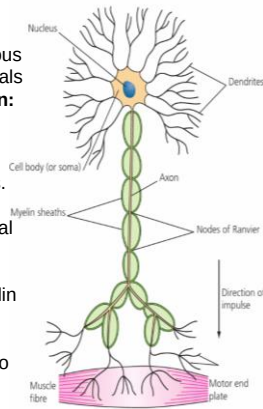
Interactive Task:

Complete the Worksheet to identify whether the sympathetic or parasympathetic system would be involved in the presented scenarios

18

Neuron Anatomy

- Messages passed around Nervous System via electrochemical signals between neurons down the **Axon**:
 - **Action Potential**.
- **Neurotransmitters**: chemical substances that carry messages.
- **Myelin Sheath**: speeds up neural transmission
- **Nodes of Ranvier**: gaps in Myelin Sheaths around axon.
- **Synaptic Cleft**: gap between two neurons

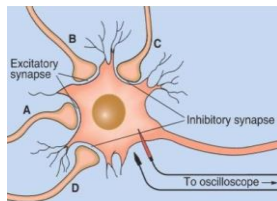


19

How are signals made in a neuron?

- Through **Membrane potential**:

- Difference in electrical charge between inside and outside of cell.
 - Inside is negative

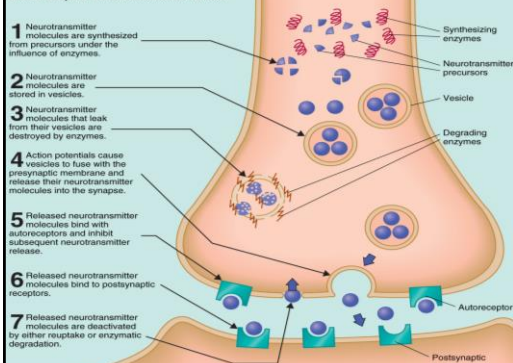


- Resting potential = **minus 70 millivolts (-70mV)**
- Membrane is said to be *polarized*: carries a charge

20

Pharmacology of Synaptic Transmission

Seven Steps in Neurotransmitter Action



21

Neurotransmitters

Dopamine:

- Role in motor function, pleasure, reward, motivation, and learning. Dysregulation linked to Parkinson's, schizophrenia, and addiction.

Serotonin:

- Influences mood regulation, appetite, sleep, memory, and social behaviour. Imbalances connected to mood disorders of depression and anxiety.

Norepinephrine:

- "Fight-or-flight" response, regulating arousal, attention, focus, stress. Important in attention-related disorders (ADHD).

GABA:

- Inhibitory neurotransmitter, promoting relaxation. Low GABA = anxiety, insomnia, & epilepsy. Drugs to increase activity, (benzodiazepines) used to treat anxiety/stress.

Glutamate:

- Excitatory neurotransmitter, crucial for learning, memory, and brain development. Excessive activity linked to Alzheimer's.

Acetylcholine:

- Muscle activation, attention, memory, learning, neuroplasticity. Deficiencies = cognitive impairments.

Endorphins:

- Natural painkillers and promote feelings of euphoria. Released during exercise, stress, and pain.

Endocannabinoids:

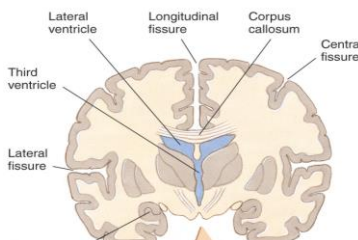
- Regulating mood, appetite, memory, and pain sensation. Role in managing stress and anxiety.

22

Key terminology

Brain can be divided into left and right hemispheres.

- Left side of brain controls right side of body
- Right side of brain controls left side of body



Corpus Callosum joins hemispheres allowing info exchange.

Evidence from Split-Brain patients (corpus callosum is cut, Sperry, 1968) suggests separate functioning

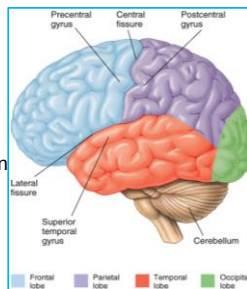
But recent evidence suggest they play different parts in integrated performance.

23

Key terminology

• Within each hemisphere there are four lobes:

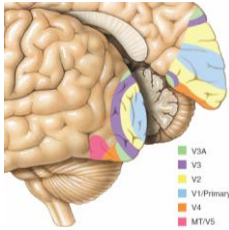
- **Frontal:** complex cognitive and motor functions
- **Parietal:** body sensations, attention, perceive object location
- **Temporal:** hearing, language, identifying complex visual patterns
- **Occipital:** analyse visual info
- Not separate functioning units!!



24

Anatomical modularity

Evidence of this within the visual processing system



Functional Specialisation:
Zeki (1993, 2001)

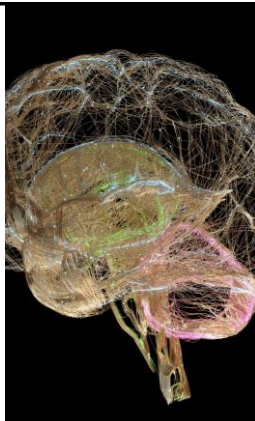
V1 & V2 = Initial processing
V3 & V3A = Form processing
V4 = Colour processing
V5/MT = Motion processing

25

Organisation

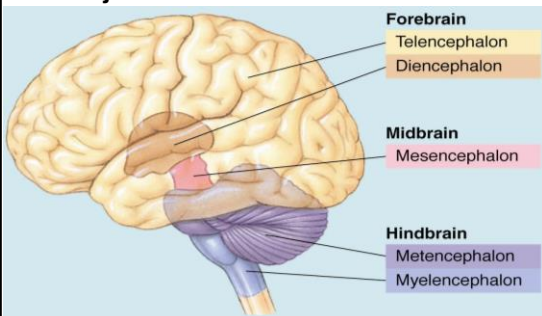
• Brodman's Cytoarchitectonic map:

- Atlas according to types of cells and density of cells in specific brain regions.
- Assigns number (52 in total) to areas of brain distinguished by cellular arrangement.
- High correlation between Brodman's areas and underlying function.



26

Five Major Divisions of the Brain



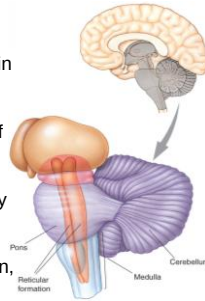
Telencephalon goes through most growth during development.
Other regions may be referred to as brain stem

27

Major Brain Structures

Medulla

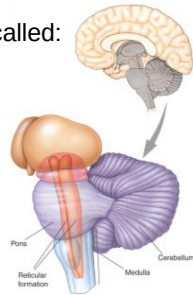
- Controls vital life functions such as breathing and heart rate.
- Many tracts carry signals between brain and body.
- Includes reticular formation: network of ~100 very small nuclei.
- Reticular activating system = parts play role in arousal.
- Other nuclei involved in sleep, attention, and cardiac reflexes.



28

Major Brain Structures

- Many tracts that create bulge called:
– **The Pons** (ventral surface)
- **Cerebellum:**
 - Deals with balance, coordination of voluntary movement, sensorimotor function, and cognitive functioning.



29

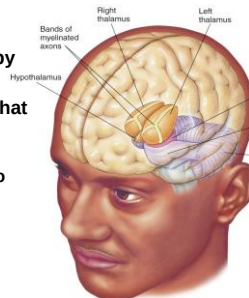
Major Brain Structures

Thalamus:

- Two blobbed structure joined by mass intermedia.
- Many different pairs of nuclei that project to cortex.
 - Processes and transmits movement and sensory info
 - Sensory relay nuclei

Hypothalamus

- Role in motivation behavior
- Regulates release of hormones
- Controls hunger, thirst, body temp



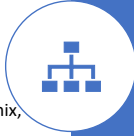
30

Subcortical Structures

Several large subcortical nuclear groups considered part of either Limbic or Basal Ganglia system.

• Limbic system:

- Process and regulate emotion, memory, motivational behaviour
- Circuit of midline structures circle thalamus include hypothalamus, mammillary bodies, hippocampus, amygdala, olfactory bulbs, fornix, cingulate cortex, and septum.



• Basal ganglia:

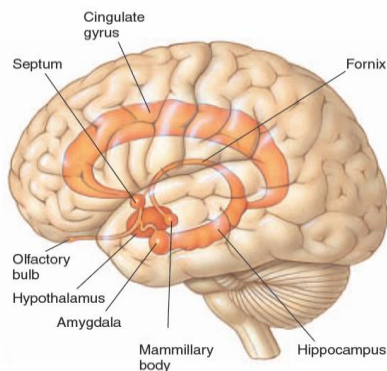
- Motor control, motor learning, executive functioning.
- Amygdala, striatum (caudate nucleus + putamen), globus pallidus

31

The Limbic System

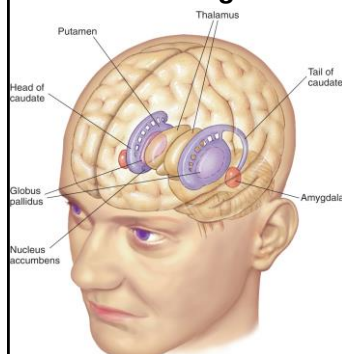
Major structures:

Hypothalamus
Amygdala
Hippocampus
Olfactory bulbs
Cingulate gyrus
Fornix
Septum
Mammillary body



32

The Basal Ganglia

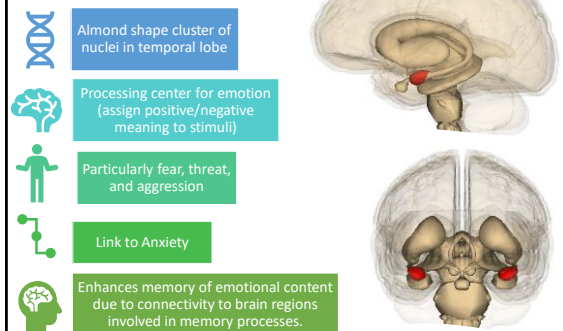


Structures in forebrain that help control movement

- Allow us to perform movements to obtain rewards.
- Damage to basal ganglia contributes to Parkinson's disease.

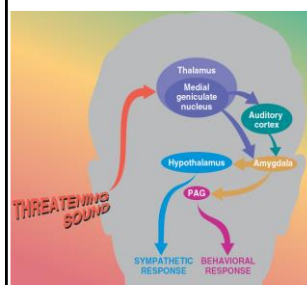
33

Key Brain Area in Psychology: Amygdala



34

Amygdala and Fear Conditioning

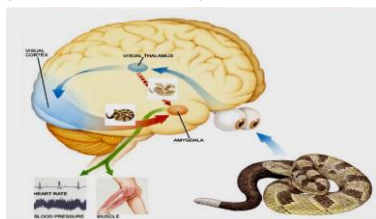


- LeDoux et al.
 - Lesions of amygdala block fear conditioning.
- Receives input from all sensory systems.
- Responsible for adding emotional significance to other stimuli.
- Projects to brainstem regions that control emotional behavior output.

35

Amygdala and Fear Conditioning

- LeDoux (1998): two pathways in processing of fear
 - Fast, quick, inaccurate, life saving:
 - Sight → Thalamus → Amygdala
 - Slow, precise, complex, sluggish:
 - Sight → Thalamus → Visual cortex → Amygdala
- One allows instant action but inaccurate and liable to false positives
- Other is precise and reduce fear response if situation deemed safe



36

Techniques to study the brain

- Technological advances mean we can obtain detailed information about brain structure **AND** functioning.
- We can work out where and when specific processes occur.
- We can determine order different parts become active when completing a task.
- We can investigate whether two different tasks involve the same parts in the same way or whether they differ.



37

Techniques to study the brain

Typically divided into:

1. Invasive vs. Non-invasive method
2. Examine Structure (image) vs. Activity (function) of the brain

Examples Include:

- Single-unit recordings (single-cell recordings)
- Electroencephalogram (EEG)
- Event related potentials (ERPs)
- X-ray Computerised Tomography (CT)
- Positron emission tomography (PET)
- Magnetic resonance imaging (MRI),
- Functional magnetic resonance imaging (fMRI),
- Event-related functional magnetic resonance imaging (efMRI)
- Magneto-encephalography (MEG)
- Transcranial magnetic stimulation (TMS)

38





Which is best?



- No simple answer – each have strengths and limitations.
- Best technique will depend on research question.
- High spatial and temporal resolutions are better when detailed account of brain functioning is required.
- Low resolution techniques are useful when an overview of brain activity throughout the duration of a whole task is required.

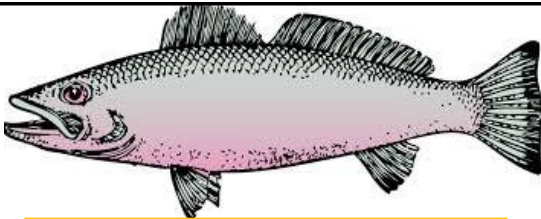
39

Does brain imaging tell us anything about Psychology?

- Difficult to find bridge between psychological process and physical activation of brain (Harley, 2012).
- E.g., prefrontal cortex is active during reasoning task –
 - But what does this mean?
- Imaging only reveals **association** between patterns of brain activation and behaviour.
- This association shows a **correlation** –
 - As one thing happens something else happens.
 - Not necessarily brain regions are needed for task.
- Area may be activated because person decided to use strategy or is worrying about performance.



40

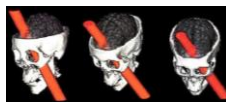
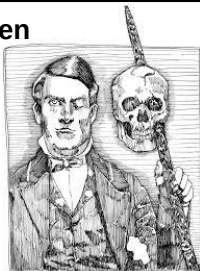


- Bennett et al. (2009):
 - fMRI of **dead** salmon showed brain activity when presented with pictures.
 - Voxel/Statistics issue
- When a brain region is activated, it is active relative to baseline.
- But what is a suitable baseline?
 - Brain is never resting - always processing.

41

Understanding link between brain and behaviour

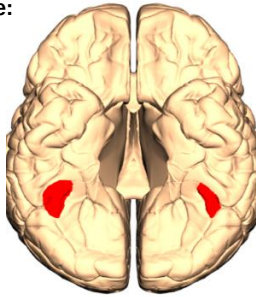
- Famous case study: Phineas Gage
 - Iron rod went through face, skull and brain when laying train tracks.
- After accident, personality changed:
 - Lost sense of responsibility and disregarded acceptable social conventions.
- Damasio (1994) examined his skull and estimated the rod must have produced lesions to left frontal lobe.



42

Effects of Brain Damage: Prosopagnosia

- Damage to fusiform face area (FFA)
 - Ventral temporal cortex
- Severe impairment of face recognition
- Report seeing a jumble of faces
 - Difficulty with holistic processing
- May not recognise themselves



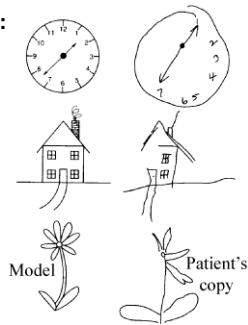
• <https://www.youtube.com/watch?v=vwCrXomPbUY>

43

43

Effects of Brain Damage: Visual Neglect

- Damage to right hemisphere leading to visual neglect of left side of visual space.
- Also, object-centred neglect:
 - Lack of awareness of one side of objects regardless of location in visual field.

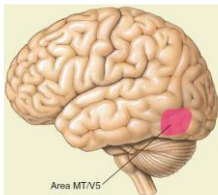


• <https://www.youtube.com/watch?v=ymKvS0XstM4w>

44

44

Effects of Brain Damage: Akinetopsia



- Severe impairment of motor perception despite stationary objects being perceived well.
- Bilateral damage to area MT/V5 in occipital lobe.
- <https://www.youtube.com/watch?v=gHA0QxGSqr4>

45

Interactive Activity

Use the Brain Structures Diagram handout to complete worksheet on Identifying injured brain structures