WEEK 1: PSY202 INTRODUCTION TO PHYSIOLOGICAL PSYCHOLOGY

Biopsychology, Evolution and Genetics – Matthew Summers Lecture

Why and how did brain activity become conscious? Biological explanations of behaviour fall into four categories:

1. Physiological – relates to behaviour to the brain and other organs. Deals with the machinery of the body, e.g., chemical reactions influence hormones, which influence brain activity.
2. Ontogenetic - how the structure or behaviour develops across the lifespan; what is the influence of genes, nutrition, experiences and their interactions, e.g., impulse control develops gradually from childhood to teenage years as the frontal lobe matures.
3. Evolutionary – explores the evolutionary history of a behaviour or structure. Characteristics of an animal are almost always modifications of something found in ancestral species, e.g., bat wings are modified arms. Evolutionary explanations call attention to behavioural similarities among related species.
4. Functional - describes why a structure or behaviour evolved as it did, e.g., many animals have natural camouflage to help protect them against predators. Some birds (such as) Hawks fly a certain way (e.g., like a vulture) to trick their prey, so they can eat them. Functional explains why hawks behave this way.

Philosophical explanations of the mind-brain relationship

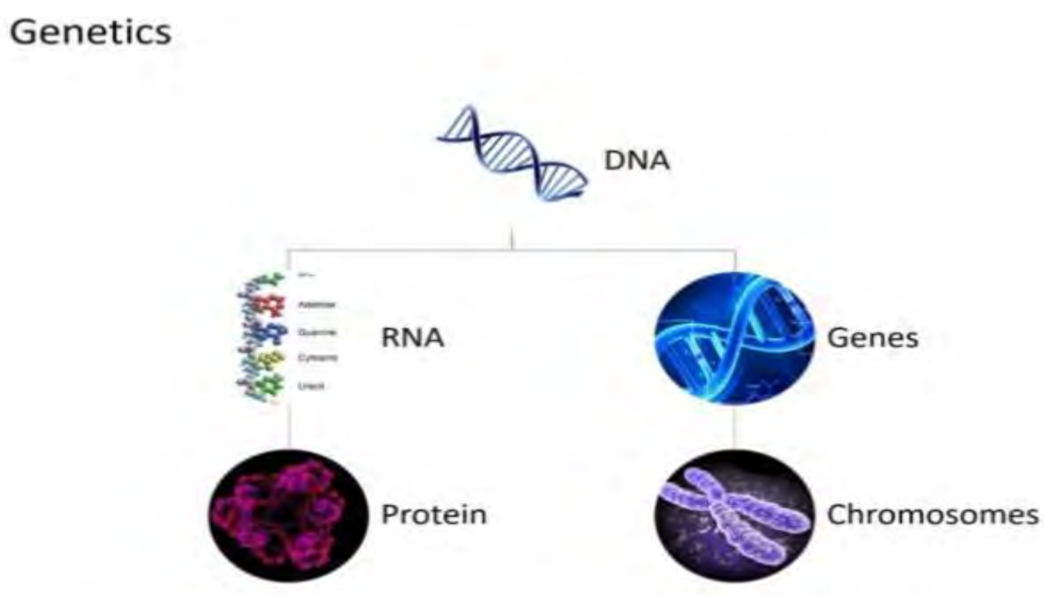
- Dualism: mind is one thing, and brain matter is a completely separate thing.
- Monoism: mental activity and brain activity are completely inseparable.

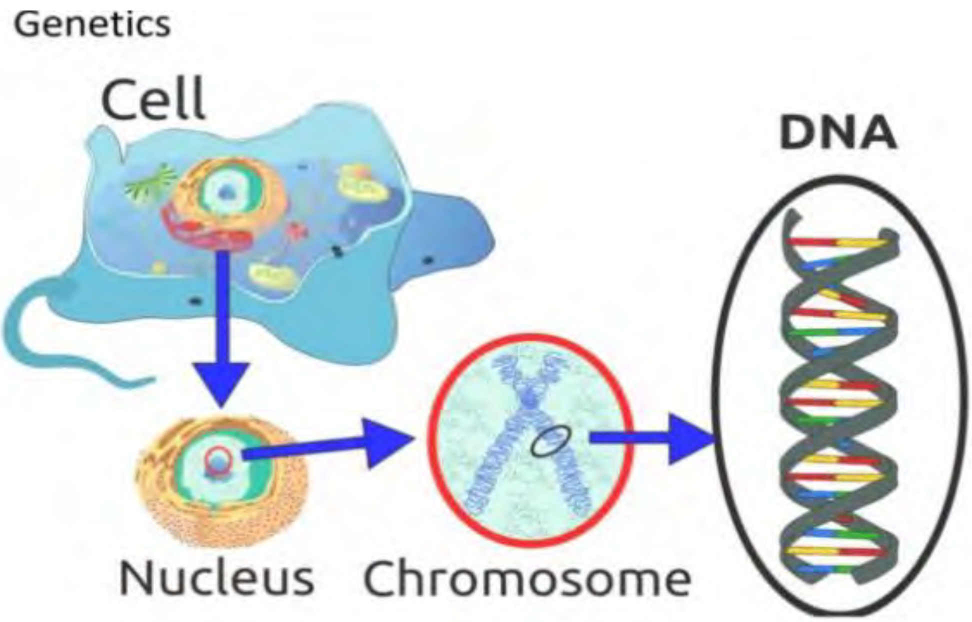
*Most Neuroscientists beliefs are consistent with monoism as they believe that there is a relationship between the mind and the brain, and you cannot have one without considering the other.

Terms & Definitions

- Males: X & Y chromosomes.
- Females: – X & X chromosomes.

- DNA: Deoxyribonucleic acid. DNA is the genetic instructions, or blueprints, that a living organism must follow to exist. Every cell in our body has the same DNA and consequently the same genes, however not every gene is expressed in every cell.
- RNA: Ribonucleic acid. RNA helps carry out the instructions or blueprint. Based on what the DNA instructions are, RNA leads to the creation of amino acids, which leads to the creation of protein.
- Proteins: are important to all functioning.
- Genes: are the basic unit of heredity. A gene is a specific sequence of DNA which directs specific protein creation.
- Chromosomes: made up of strands of DNA.





Genetics of Behaviour

- Both genes and environment interact to shape human behaviour (interact of genetics 50% and environment 50%).
- The fundamental issue is how much a role genetics play in shaping human behaviour.
- Examples: mental health disorders, weight gain, personality and sexual orientation.

Mendelian genetics

Homozygous (Homo = same)

- Identical pair of genes on the two chromosomes (the person is homozygous for that gene).
- E.g., TT or tt

Heterozygous (Hetero = different)

- Different or unmatched pair of genes on the two chromosomes (the person is heterozygous for that gene).
- E.g., Tt

Genes are either dominant, recessive or intermediate

- Dominant = strong effect in either the homozygous or heterozygous condition (e.g., TT or Tt).
- Recessive = shows its effects only in the homozygous condition (e.g., tt).
- Intermediate = phenotype falls somewhere in between.

Phenotype

- The observable expression of genes, e.g., actual hair or eye colour.

Epigenetics

- The changes in gene expression within the individual over time.
- Every cell has the same DNA, but the activity of a gene can vary (e.g., the genes active in your brain are not the same as the genes active in your kidneys).
- Experiences can "turn a gene on or off," e.g., a malnourished mother rat's offspring may have altered gene expression to adjust to a world where there's not much food, so they store energy and are more likely to be overweight rats when they grow up if food is available.

Sex linked genes (usually refer to X linked)

- Sex linked genes = genes located on the sex chromosomes, whereas autosomal = all other genes.
- In mammals, sex chromosomes have X and Y. So child always gets an X chromosome from the mother and depends on what they get from the farther as to whether the child is male (XY) or female (XX).
- Sex-linked = usually refers to X linked.
- Humans have 46 chromosomes in pairs = 23 pairs... So 1 pair of sex-linked chromosomes (XX or XY) and 22 autosomal chromosome pairs.

Sex limited genes

- Sex limited genes are present in both sexes but mainly influence just one sex (e.g., genes that control chest hair and breast size).

Genetics and behaviour

- Sex linked recessive gene. So, any male with this gene on his X chromosome is red-green colour blind because he has no other X chromosome. So, the effect will show. A woman is only RG colour blind if she receives this recessive gene in both of her X chromosomes (one from her mother and one from her father.
- Not having the gene is dominant to having the gene.

Kleinfelter syndrome

- XXY (47 chromosomes, not 46).
- Genetically male but phenotype may be male, female or intersex.

May have

- Genetically taller than average height
- Less testosterone

- Less muscle control than other males their age
- Less facial and body hair
- Broader hips
- May develop breast tissue
- Often infertility
- Hypogonadism

Turner syndrome

- X only (45 chromosomes, not 46).

Can manifest as:

- Short stature
- Broad chest
- Low hairline
- Ovaries not functional
- Congenital heart disease
- Hypothyroidism
- Diabetes
- Vision and hearing difficulty
- Cognitive (e.g. memory) difficulties

Down syndrome (Trisomy 21)

- Presence of all, or part, of a third copy of chromosome 21

May show

- Growth delay
- Intellectual disability
- Low muscle tone
- Obstructive sleep apnoea (due to airway changes)
- Hearing and vision difficulties etc
- Congenital heart defect common (hole in heart valves)

Genetics of behaviour

Monozygotic (identical, fertilisation of one egg that splits) vs dizygotic (not identical, two sperm, two eggs) twins allow study of genetic versus environmental influences.

Heritability: a statistic used in the fields of breeding and genetics that estimates the degree of variation in a phenotypic trait in a population that is due to genetic variation between individuals in that population.

Problems and errors associated with estimating heritability:

- Distinguishing between the effects of genes and parental influences.
- Multiplier effect: genetic tendencies that guide behaviour will result in a change in the environment that magnifies the original tendency.
- Traits with a strong hereditary influence can be modified by environmental intervention.
- Essentially, heritable = unmodifiable.

Animals in research

- Animal research is an important source of information for biological psychology but remains a highly controversial topic.

Reasons for studying animals include:

- The underlying mechanisms of behaviour are similar across species and often easier to study in nonhuman species.
- We are interested in animals for their own sake.
- What we learn about animal's sheds light on human evolution
- Some experiments cannot use humans because of legal or ethical reasons.
- Justification for research considers the amount of benefit gained compared to the amount of distress caused to the animal (no clear dividing line exists).

It is a legal requirement that all research using animals in Australia is approved by an accredited Animal Research Ethics Committee operating in accordance with the NHMRC (National Health and Medical Research Council of Australia) *Australian Code for the Care and Use of Animals for Scientific Purposes.* It required that these ethics committees comprise a minimum of 4 persons, one must be a qualified Veterinary Surgeon, one must be a person with experience in animal welfare (not involved in animal research), and one must be a general lay person.

Heredity Crash Course Biology #9

Polygenic trait: a trait that’s phenotypes are influenced more than one gene. Traits that display a continuous distribution such as height or skin colour are polygenic. The inheritance of polygenic traits does not show the phenotypic ratios characteristic of Mendelian inheritance, though each of the genes contributing to the trait is inherited as described by Gregor Mendel. Many polygenic traits are also influenced by the environment and are called multifactorial.

Week 3 Lecture: The Synapse & Research Methods in Biological Psychology

The Concept of a Synapse

- Late 1800s – Cajal demonstrated that neurons communicate by transmitting chemicals at junctions called synapses.
- The neuron that delivers the transmission = presynaptic neuron/terminal.
- The neuron that receives the transmission = postsynaptic terminal.
- Chemicals (neurotransmitters) are the main way your neurons communicate.
- Neurotransmitters: how one neuron communicates with another neuron.

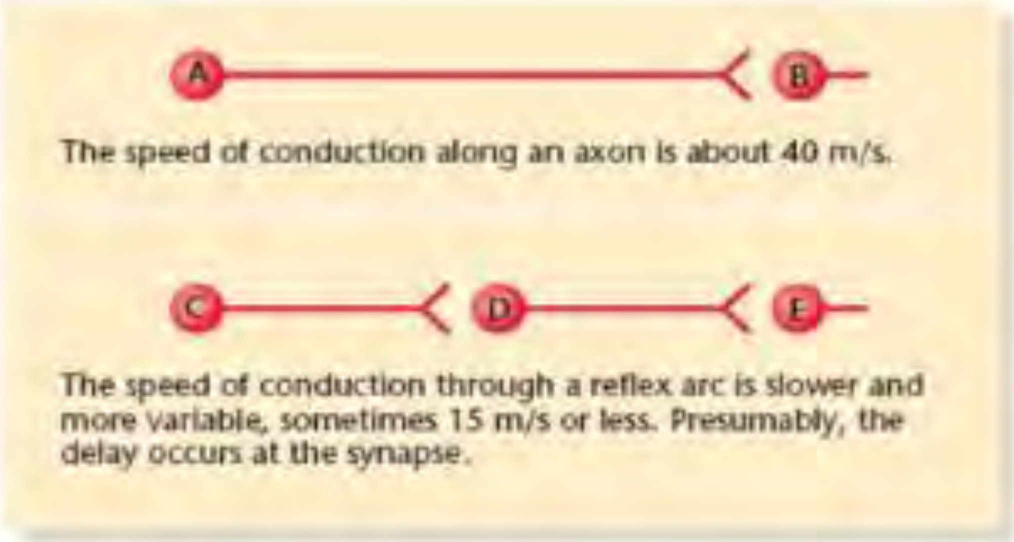
Sherrington: The Great Dog Pincher

- In the late 1800s, Ramon Cajal anatomically demonstrated a narrow gap that separated neurons.
- Not long after, in 1906, Sherrington found that when he pinched a dog’s foot, the dog flexed that leg after a short delay (impulse travelled from skin, to spinal cord, and back to muscle).
- Sherrington *Physiologically* demonstrated that communication between two neurons is different to communication along a single axon. He inferred a specialised gap between neurons, and called it a synapse.
- Sherrington’s work opened the way for people to explore the wiring of the nervous system.

Sherrington's 1906 observations

Sherrington and his dogs

- Studied reflexes (automatic muscle responses to stimuli) to inform our knowledge about synapses.
- Reflex arc = skin receptor neuron in spinal cord to motor neuron in leg.
- Reflexes (15m/s) are slower than conduction along an axon (40m/s). Therefore the delay occurs at a gap, or a synapse.



Sherrington's evidence for synaptic delay
An impulse traveling through a synapse in the spinal cord is slower than one traveling a similar distance along an uninterrupted axon.

Temporal Summation

- A light pinch did not evoke a reflex, but a few rapid pinches did.
- Repeated pinches in a brief period had a cumulative effect (one single light pinch was not enough to reach threshold, it was subthreshold excitation or a graded potential).
- Summation of input over time = temporal summation.

*When hearing temporal think time.

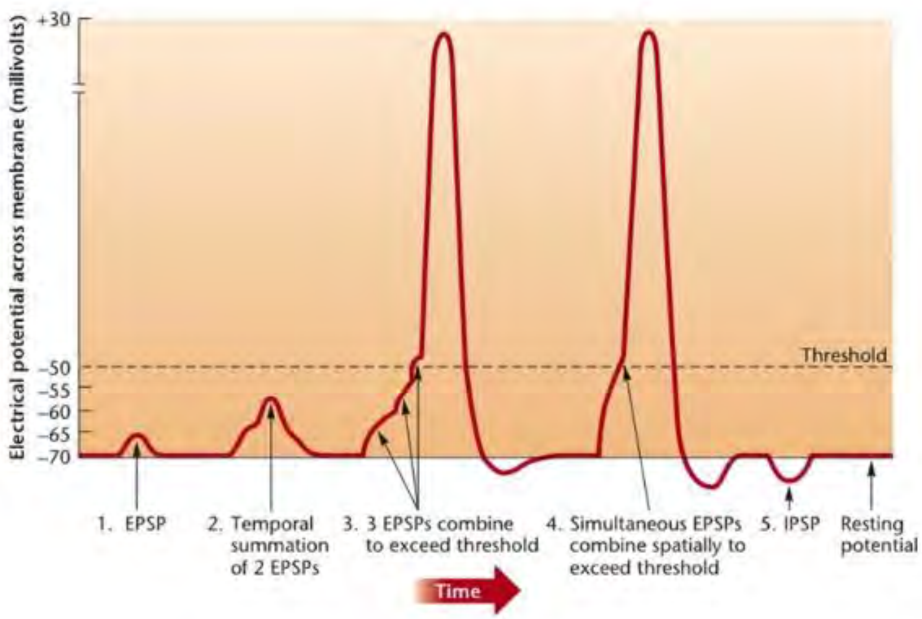
Spatial Summation

- Sherrington also demonstrated that pinching two points at once evoked a reflex, when either one alone would not. Input from several locations can have a cumulative effect and trigger a nerve impulse.
- Summation of input from multiple sources/across space = spatial summation.
- Temporal and spatial summation ordinarily occur together for neurons to fire.

*When you hear spatial, think several space, and synchronised.

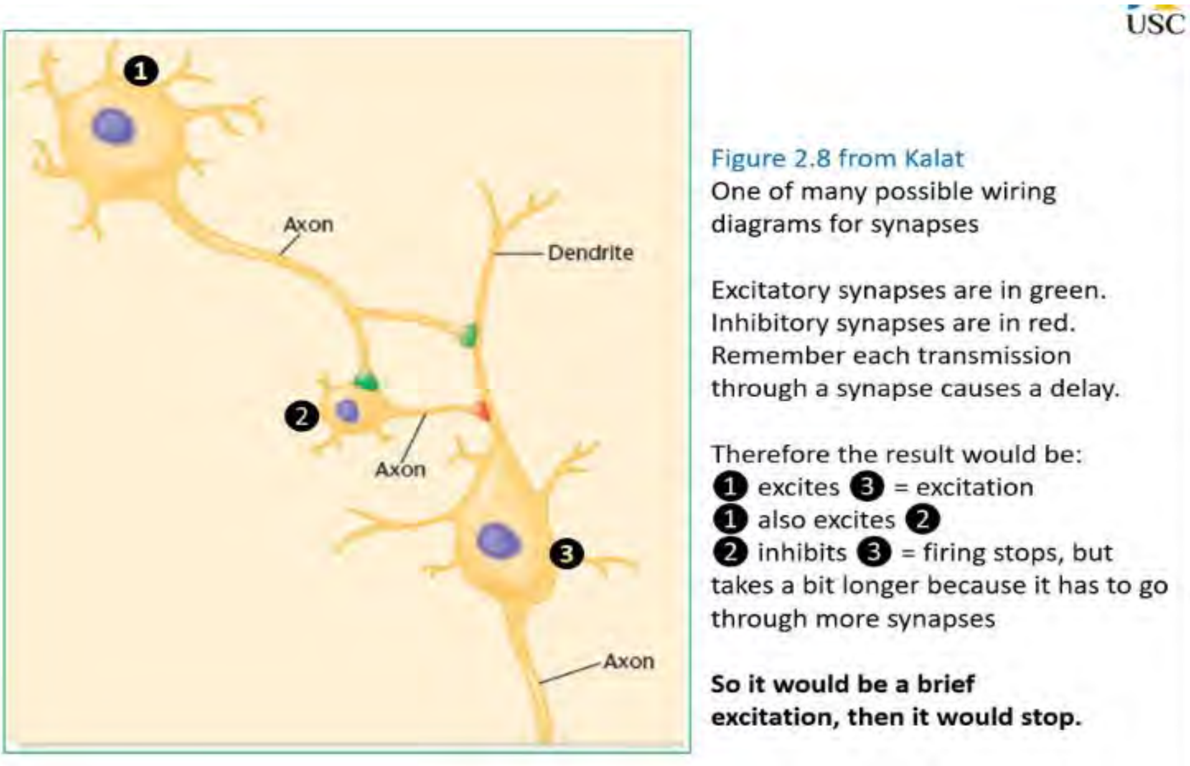
Graded Potentials: EPSP

- Years later, another researcher (Eccles, 1964) struck electrodes into cells and noted existence of graded potentials. These may be depolarisations (less polarised, closer to 0 = excitatory) or hyperpolarisation (more polarised, further away from 0 = inhibitory).
- Excitatory postsynaptic potential = ESPP. Sodium ions enter neuro. Brief excitation.
- Enough EPSPs in a short enough time = exceed threshold and an action potential occurs.



The Concept of the Synapse

- Neurons can have many synapses.
- The likelihood of an action potential depends on the ratio of IPSPs to EPSPs at a given moment.
- Temporal and spatial summation are also involved in all this too. Basically, it gets messy. Quickly.



Relationships among EPSP, IPSP, and action potentials

- Sherrington assumed that synapses produce on and off responses, but the relationship is complex.
- Synapses vary enormously in their duration of effects.
- The spontaneous firing rate refers to the periodic production of actions potentials despite synaptic input.
- EPSPs increase the number of action potentials above the spontaneous firing rate.
- IPSPs decrease the number of action potentials below the spontaneous firing rate.
- For example, if the neuron's spontaneous firing rate is 10 action potentials/second, a stream of EPSPs might increase the rate to 15/second, whereas a stream of IPSPs may decrease it to 5/second.

Chemical Events at the Synapse

- Sherrington assumed that synaptic transmission was **electrical**. He was wrong. Loewi (1921) was the first to convincingly demonstrate that communication across the synapse **occurs via chemical means.**
- In 1920, Loewi slowed one frog's (frog 1) heart rate, by stimulating a particular nerve. Fluid taken from the Frog 1 heart decreased the heart rate in a second frog's (Frog 2) heart. Then he did it the other way: stimulated another nerve and sped up Frog 1 heart, and transferred the fluid from Frog 1 heart into Frog 2, resulting in an increase in Frog 2 heart rate,
- Neurotransmitters are the chemicals that travel across the synapse and allow communication between neurons. Most synapses rely on chemical processes.

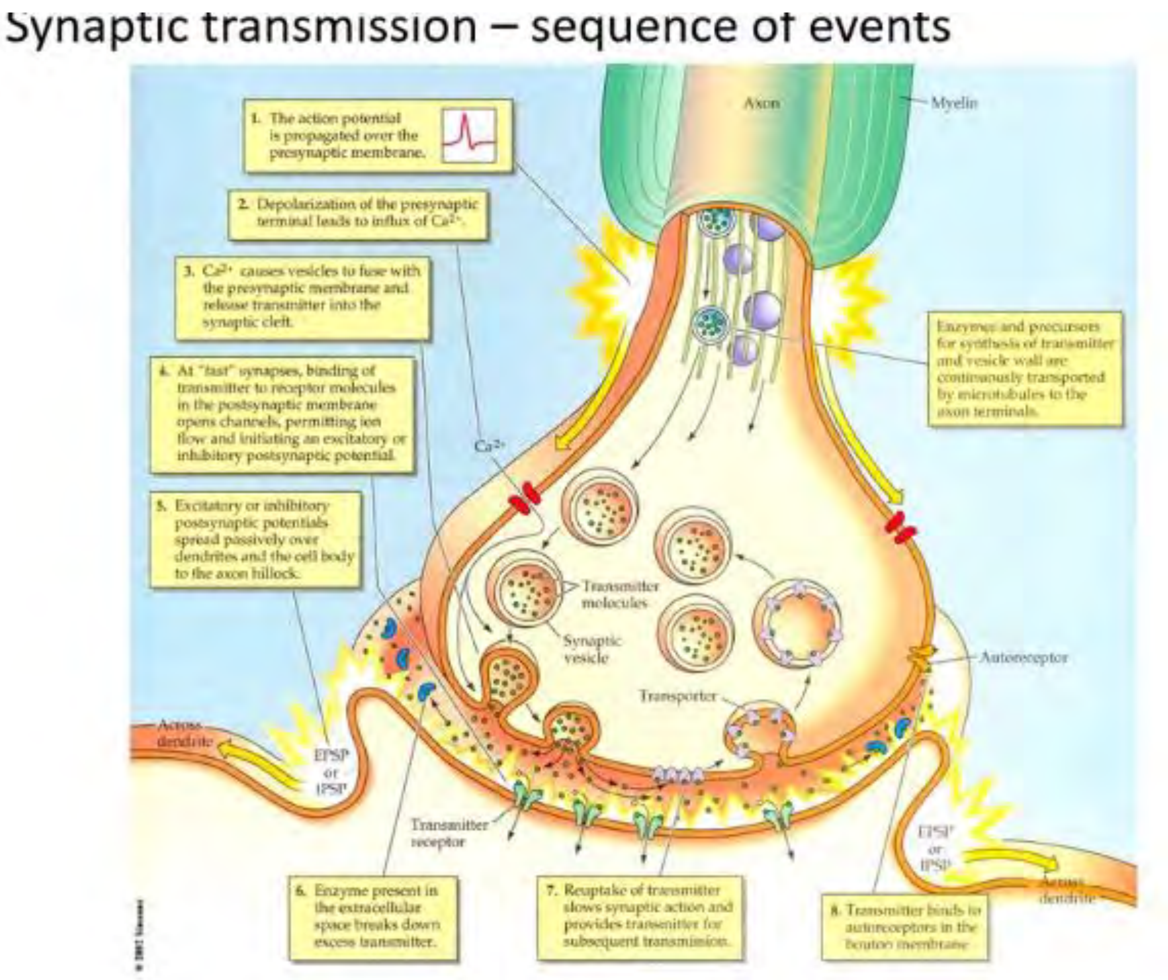
Major types of NTs (neurotransmitters)

- Amino Acids: e.g., glutamate, GABA, aspartate.
- A Modified Amino Acids: e.g., acetylcholine.

- Monoamines: indoleamines (e.g., serotonin), catecholamines (e.g., dopamine, norepinephrine).
- Peptides (chains of amino acids): e.g., endorphins, neuropeptide.
- Purines: e.g., ATP, adenosine.
- Gases: e.g., nitric oxide (not nitrous oxide...).

Chemical Events at the Synapse

- Neurons synthesise (create) neurotransmitter (NTs) and other chemicals from substances provided by the diet.
- Acetylcholine: is created from things in milk, eggs, and nuts. Tryptophan (found in chocolate and peanuts) serves as a precursor for serotonin.
- Most NTs are created in the presynaptic terminal and are stored in packages called vesicles. Cells release a combination of NTs.
- The action potential opens gate in the presynaptic terminal, and calcium enters.
- The causes exocytosis (release of NTs from presynaptic neurons into synaptic cleft).



Neurotransmitters: what happens to stop the process?

- Broken down and reabsorbed (process called reuptake) by presynaptic neurons via transporters. Individual differences, e.g. anxiety.
- Broken down into inactive chemicals and diffused away.

- Many presynaptic neurons have auto receptors sensitive to the neurotransmitter that they release.
- Many postsynaptic neurons have chemicals that inhibit the presynaptic neurons.
- Main point = postsynaptic neurons have ways to control or limit their own input.

Post-synaptic receptors

Metabotropic (G-protein coupled) receptor

- Slower to activate but longer lasting than ionotropic receptor.
- Mostly relies on dopamine, norepinephrine, and serotonin.
- Useful for hunger, pain, smell etc where exact timing does not really matter.
- Influences a G protein which sends secondary messenger throughout post-synaptic cell which can exert secondary effects (e.g., protein modification).

Chemical events at the synapse: Neuropeptides and neuromodulators

- Neuropeptides are another way cells can communicate with each other but have a wider impact across many regions of the brain.
- Can after release, they just "diffuse away".
- Mainly released by dendrites and cell body (not axon terminal, like NTs).
- Need repeated simulation. But when they do release, it is in large amounts and long lasting (e.g., 20+ minutes).
- Important for hunger, thirst, and longer lasting changes in behaviour.

Main differences between NTs & neuropeptides

	Neuropeptides	Other neurotransmitters
Place created	Cell body	Presynaptic terminal
Place released	Dendrites, cell body, sides of axon	Axon terminal
Released by	Repeated depolarisation	Single action potential
Effect on neighbouring cells	Neighbours release it too	No effect on neighbours
Spread of effects	Diffuse to wide area	Receptors of the adjacent postsynaptic cell
Duration of effects	Many minutes	Generally less than a few seconds

Electrical synapses

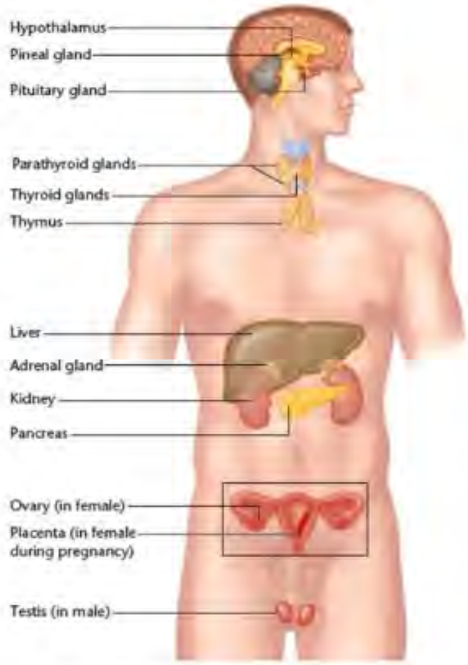
- A few special-purpose synapses operate electrically for when synchrony is super important (e.g., breathing).

- Faster than all chemical transmissions.
- Gap junction: the direct contact of the membrane of one neurone with the membrane of another.
- Depolarisation occurs in both cells, resulting in the two neurons acting as if they were one.

*The nervous system has a huge variety of synapse types that serve a variety of functions.

Hormones

- A hormone is a chemical that is released by cells in one part of the body, and conveyed by blood to influence other cells
- Endocrine *(hormone producing)* glands are responsible for the production of hormones
- Hormones are important for triggering long-lasting changes in multiple parts of the body
- Many chemicals serve as both neurotransmitters and hormones



Location of some major endocrine glands
(Source: Starr & Taggart, 1989)

Useful Analogies

- Neurotransmitter: conveys message to intended receiver.
- Hormone: convey message via blood to any receiver tuned into the right channel.
- Neuropeptide: in between the above two; they are like a hormone, but only within the brain, and not carried by blood.

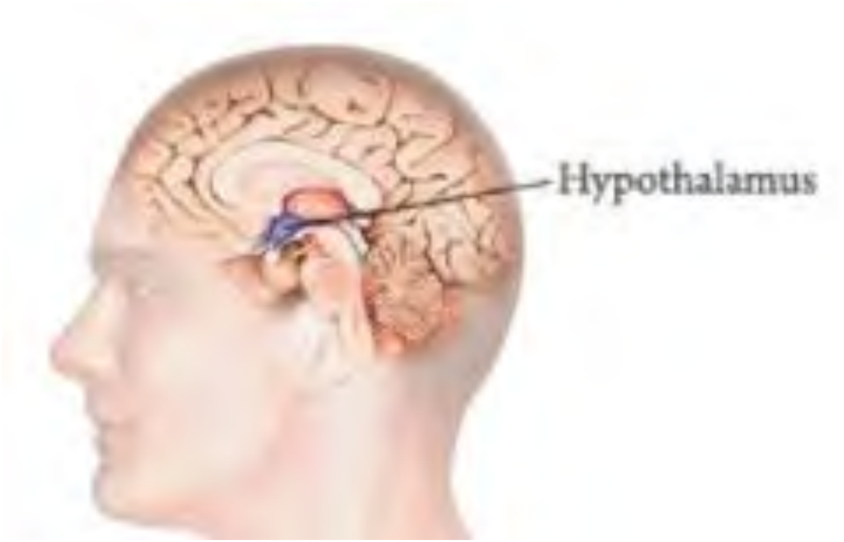
Some examples of hormones & their effects

Organ	Hormone	Function
Pineal gland	Melatonin	Increases sleepiness, influences sleep-wake cycle, onset of puberty
Pancreas	Insulin	Entry of glucose to cells and increases storage as fats
Thyroid	Thyroxine	Increases metabolic rate, growth, and maturation

Hormones & hypthalamus

- Hormones secreted by the brain can control the release of other hormones.
- Hypothalamus = region of the brain that has a role in many behaviours, including the "four f's". Hypothalamus creates hormones like oxytocin:

1. Fighting
2. Fleeing
3. Feeding
4. Reproduction



Hormones & Pituitary Glands

- The pituitary gland is attached to the hypothalamus and consists of two distinct glands that each release a different set of hormones.
- Anterior pituitary - (glandular tissue) synthesises 6 hormones, but ultimately hypothalamus controls their release.
- Posterior pituitary - (neural tissue), considered extension of hypothalamus. Oxytocin (feel good hormone) and vasopressin (antidiueretic hormone) are created in the hypothalamus and travel down to the posterior pituitary gland, and from there are released into the blood.

Synapses, drugs and addiction

- The study of the influences of various kinds of drugs has provided us with knowledge about many aspects of neural communication at the synaptic level.

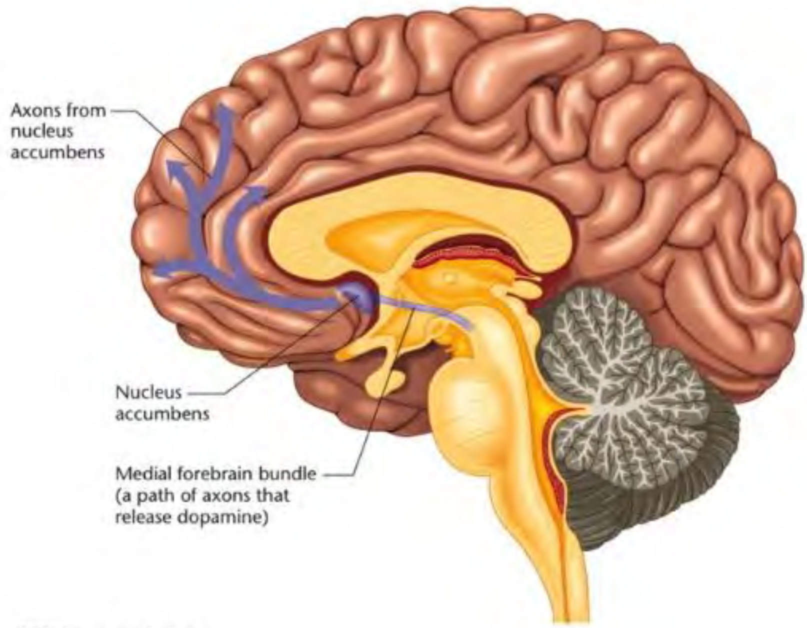
Drugs work by doing one or more of the following to neurotransmitters:

- Increasing synthesis/creation
- Causing vesicles to leak
- Increasing release
- Decreasing uptake
- Blocking its breakdown
- Directly stimulating or blocking receptors.

Drugs either facilitate the activity at the synapse:

- Antagnostic: drugs block the effects of neurotransmitters.
- Agonist: drugs mimic or increase the effects of neurotransmitters.

Location of the nucleus accumbens



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*The nucleus accumbens in the brain area most often linked to drug addiction

Recap of learning objectives

The concept of a synapse

- Reflexes
- Synapse structure
- Temporal & spatial summation
- Excitatory & inhibitory postsynaptic potentials

Chemical events at the synapse

- Neurotransmitters
- The sequence of events at synapses
- Ionotropic and metabotropic effects
- Neuropeptides
- Hormones
- Electrical synapses
- Synapses and drugs (more to come in final lecture)

LECTURE READING

- Kalat, Biological Psychology – Chapter 2

Assessments

- What's the editorial board look like?
- Is there two peer reviews and
- Google scholar does not separate peer-reviewed from non-peer-reviewed.
- Library Guides
- Databases (under the letter P PsychNet - APA- + under Web of science)

Web of science - can mark list + abstract. Just articles.

Current field of research less than 10 years.

- Use gov webs & peer reviewed journal articles.

Endnote.

Quiz 1

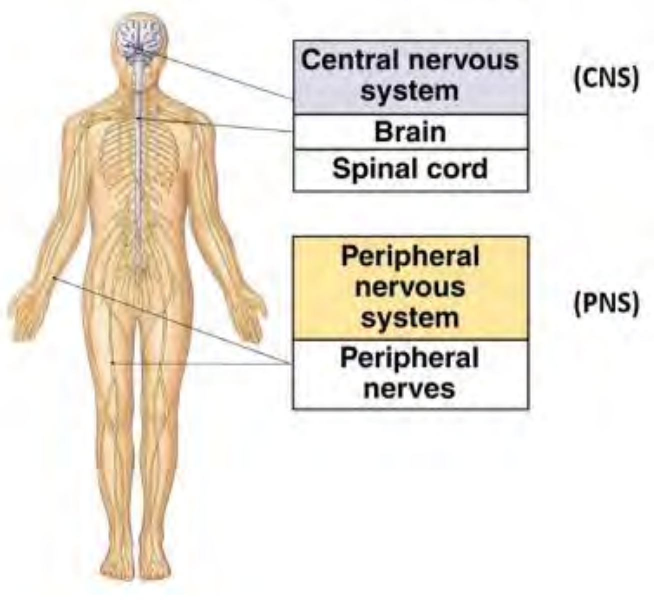
Weeks 1-3 PSY202 online content material and readings 1, 2 & 4.1

PSY202 Week 4 Lecture: Neuroanatomy, neurodevelopment, and Injury

Central and Peripheral Nervous System

There are 2 types of nerve pathways in the nervous system (CNS + PNS)

1. Afferent pathways = feed signals (input) into the brain
2. Efferent pathways = carry signals (output) to the body (from the brain)

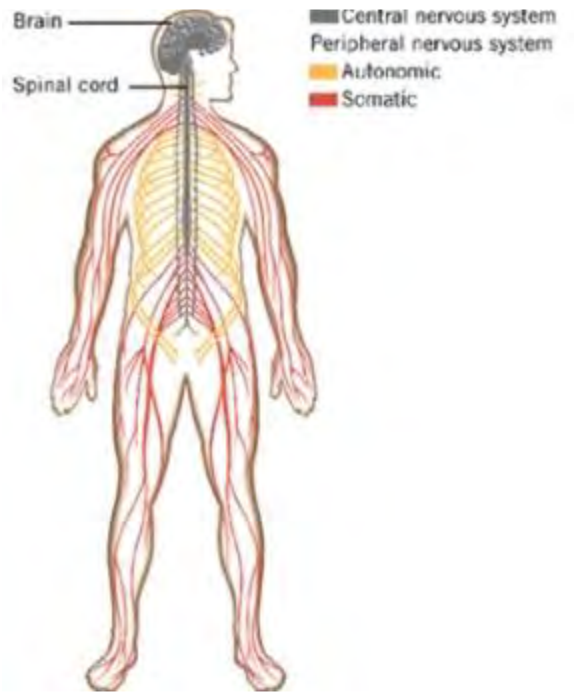


Both the CNS and PNS are integrated and both systems have afferent and efferent pathways emanating through and from them.

Peripheral Nervous System (PNS)

The PNS can be divided into two subdivisions:

- Somatic nervous system: transmits commands to the voluntary skeletal muscles (everything to do with posture control) and receives information from the muscles and skin.
- Autonomic nervous system: sends to and receives information from the glands and organs of the body. Think automatic; the automatic organs of the body refer to the orans and glands such as the heart. The autonomic nervous system connects the brain to glands and organs and receives information from those glands and organs as well.



The Autonomic Nervous System

The autonomic nervous system sends and receives messages to regulate the automatic behaviours of the body (heart rate, blood pressure, respiration, digestion, etc) in two separate systems:

1. Sympathetic branch: increases arousal in the organism.
2. Parasympathetic branch: decreases arousal in the organism.

The Sympathetic Nervous System

A network of nerves that prepares the organs for rigorous activity:

- Increases heart rate, breathing blood pressure.
- Decreases digestive activity.

*This combination is known as the “Fight or flight” response.