September 6:

- Psychology is an extremely young/new field of science.
- Psychology first began in the late 1800's. So, it's just over 150 years old.
- A **soul** is an immaterial, metaphysical part of the human. As such, souls do not conform to the rules of physics, chemistry and biology.
- To pursue something scientifically, one must first assume that the behaviour of that thing conforms to some sort of natural laws, laws that can eventually be understood, specified, and used to predict future behaviour.
- Souls are spiritual entities and, as such, they do not conform to natural laws. Given this, trying to understand them via a scientific process is pure folly.
- **Animism** is the religious belief that objects, places and creatures all possess a distinct spiritual essence/soul.
  E.g. Back in the really old days, people believed that everything was made up of 4 elements: water, air, fire and earth. Furthermore, they did not know/understand the concept of gravity. Based on that, people believed that if you let go of a metal object, it fell to the earth because earth items liked to be with other earth items. Similarly, they believed that smoke from fires went up because air items like to be with other air items. In that sense, they gave every object a soul.
  E.g. Back in the really old days, people believed that if a tornado came, it was because they had offended a god and that god either took form as a tornado or sent a tornado. To appease the god, people would sacrifice a virgin by throwing the virgin in a volcano. This is known as **Volcano Bound Virgins**. Even the weather was connected with a spiritual/animism idea.
- Humans like things to make sense. As a result, some people say that animism, intelligence and magic were born out of people's ignorance and their desire for things to make sense. It's the easy way for people to make sense of something they don't understand. Magic is you not understanding what it is your eyes are seeing and how they are seeing it.
  E.g. If you see a magic trick/show, say a levitating act, and you don't know how that happened, you think that's magic. However, if you know how the magician was able to be levitated, even if you are still impressed, the magic is lost.
  E.g. If you see a tornado, but you don't know how the tornado was created, you might think that a god sent it because they were angry. In this sense, some people believe that animism was born out of people's ignorance and their desire for things to make sense.
- **Rene Descartes (1596 – 1650):**
  - Rene was very smart from a young age. He is a **polymath**, someone who makes major contributions to multiple fields. Rene made contributions in philosophy, math, etc.
  - However, like many people who were very smart, Rene had trouble fitting in with people his own age. Also had a lot of mental issues/mental health issues. He had anxiety, nervous breakdowns and was uncomfortable fitting in with other people.
  - Rene took a trip to the Palace of Versailles, Paris, to relax. At a park, he saw a statue of Diana, goddess of the hunt. He wanted to get a closer

look, so he walked towards it. While walking to the statue of Diana, a statue of Neptune comes out behind a bush and blocks his path. Rene was blown away and extremely confused by this because it seemed like the statue of Neptune intentionally moved to block him from seeing the statue of Diana. This incident messed up his mind for a long time. Prior to this moment, he thought that you could tell if something has a soul if it moves with intention. I.e. Prior to this moment, he thought "Things with a soul move with intention." After the incident, he wasn't sure of his hypothesis anymore because he just saw a statue (A soulless object) move with intention. He thought, "Does this mean that other objects that move with seeming intention also not have a soul? Maybe are they machines, too. And motion does not imply a soul." From this incident, he believed that animals DO NOT have a soul and were fancy, hydraulic machines.

- Rene endorsed animal testing and performing vivsections (Nailing animals to boards and cutting them open while they were alive) on animals because he thought that animals were machines and had no soul. When other people pointed out that the animals were screaming and were under stress, Rene said that machines also make noise and can be under stress, and that if you're concerned about the noise the animal is making, cut the vocal cords first.
- With humans, Rene believed in **Cartesian Dualism**, which is the belief that humans are part machine but we also have a soul, which connects with the body at the pineal gland. He believed that there are two distinct ways behaviour could emerge for humans. The first way is that our behaviour and actions are controlled by the machine aspect. The second way is that our behaviour and actions are controlled by our soul.
- Rene is saying that humans are not fully spirits in a material world, and that we are very much material, but we also have a soul component. From this, Rene opened up the idea for humans to view ourselves the same way we view the rest of the world, because from a scientific perspective, this means that while we can't study the metaphysical (soul) component of humans, we can study the physical (machine) component.
- During Rene's time, the Church had a lot of influence and power in Europe. So, Rene was on tricky ground. The Church had providence over the soul and Rene didn't want to challenge that. In the end, the Church did not mind Rene's idea that humans were part machines but also had a soul.

- **John Locke (1632-1704):**
  - Locke came just after Rene.
  - He thought that the "Mind is a machine", but didn't have a name for it. Later on, James Mill coined the term **Materialism** from this idea.
  - Locke coined the term **La Table Rassa**, which is a theory that humans were born a blank slate. Locke had the idea that when someone was born, they could become anything in life. He thought that a person's

experiences defined them and their future. (This idea came before the concept and understanding of genetics.) In psychology, this concept is called **The Nurture View**, which contrasts **The Natural View** which states that you are defined by your genetics. Locke started the **Nurture vs Nature debate**, which debated whether genetics or experiences define humans the most, and had a strong nurture view.

- Locke believed in **empiricism**, which is the idea that people should test their ideas by doing experiments. Philosophers used to come up with lots of ideas but did not do any experiments to verify those ideas. Locke was one of the first people to say that people should be doing experiments and gathering data to see if their hypothesis was true.

- **James Mill (1773 – 1836):**
  - Coined the term **Materialism** from Locke's "Mind is a machine" philosophy.
  - Materialism, in this connotation, is the notion that things are composed of material that follow natural laws.
  - Mill believed that humans are totally material.
  - Locke and Mill went a step further than Rene Descartes did. Rene thought that humans were machines with a soul, while Locke and Mill thought humans were completely machines.
- **Luigi Galvani (1737-1798):**
  - Back in the day, there were no "professional scientists." Science was a hobby which people did in their basement or backyard. To show off their discoveries, the scientists would meet up and tell the other people in their group what they discovered.
  - At one of these meetings, Luigi Galvani showed off that by applying electricity to a cut off frog leg, it made the leg move. He showed that by applying electricity to a muscle, it activated the muscle.
  - Rene believed our biology was hydraulically driven, but Luigi and others believed that it was electricity, not hydraulics. Luigi believed that humans were bio-electric machines.
- **Pierre Florens (1774-1867):**
  - Florens built on Luigi's idea of applying electricity to a muscle, but he was more interested in how the brain controlled functions.
  - Pierre started doing **ablation studies**, which is running an animal through a series of tasks and then doing surgery on the animal where you destroy part of the animal's brain to see how they function afterwards. If you did damage to the right side of the brain, the animal's left side would be paralyzed. If you did damage to the back of the brain, the animal would be blind. Pierre found that if you did damage to specific parts of the brain, the animal would have very specific deficits.
    The brain was starting to seem like a machine.
- **Paul Broca (1824-1880):**
  - Paul was a medical doctor who found a lot of people that had trouble producing language, but could understand it fine and asked if he could

inspect their brain when they died. After inspecting their brains, he found that they all had damage to the same part of the brain, the left, front area. This area is called **Broca's area**.

September 9:

- Most scientists such as Einstein and Darwin believed that people had a soul. However, they believe that whatever they are studying, such as the human memory, is not spiritual and that it follows natural laws.
- Many scientists and psychologists wanted to "reverse engineer" the machine aspect of humans.
- A lot of the early psychologists were from Germany. Germany during the mid to late 1800's was very economically powerful and because of this, they began to think of new ways to invest their money. One of the things they invested their money into was research and development (R&D), because they wanted to make their country and people smarter and more competitive. However, since biology, chemistry and physics had been around for a long time, they looked for other, newer places to invest and one of the places was psychology.
- **Hermann von Helmholtz (1821-1894):**
    - Measured the speed of neural impulses.
    - When scientists cut open animals, they saw a lot of nerve fibres. To the scientists, the nerve fibres were like cables transmitting information and energy from the brain to other parts and they wanted to measure how fast our body transmits information and energy.
    - Helmholtz discovered that our nerves send signals at a relatively slow rate compared to modern electronics.
    - Showed that something that seemed impossible to measure was possible if you were creative and thought about it well enough.
- **Ernst Weber (1795-1878):**
    - Studied **psychophysics**, which is the study of the relationship between the physical world and the mental representation of that world.
    - Was a colleague of Gustav Fechner and they did a lot of similar work.
    - Psyche came from the Latin word for soul.
    - Aristotle believed that there were 3 levels of life:
        1. **Plants:** All plants did was essentially grow. They turned nutrients into mass.
        2. **Animals:** While animals grew, too, they also had senses. I.e. Animals could sense the external world.
        3. **Humans:** Humans could grow, sense the external world and could think about it rationally.
    - What Weber did was that he blindfolded people and put a weight (of either different or same weight) in each hand and asked the person which weight they thought was heavier or if both weights weighed the same. (This is a very similar experiment done by Gustav Fechner.) Weber discovered that if there's at least a 10% difference between what the two weights weighed, then people could feel which weight is heavier.
      I.e. If one weight weighed 10g and the other weight weighed 11g, then

people could feel which weight is heavier.
I.e. If one weight weighed 100g and the other weight weighed 110g, then people could feel which weight is heavier. However, if one weight weighed 100g and the other weight weighed 101g, then people could not feel which weight is heavier.

- **Willhelm Wundt (1832-1920):**
  - Known as the father of psychology because he opened the first psychology lab, which was in Germany. A lot of the psychologists that followed were his students.
  - Was the first to refer to himself as a psychologist.
  - He wrote the first psychology textbook "The Principles of Physiological Psychology".
  - He liked introspection, and would teach students how to observe what's in their mind. However, this was controversial because you're relying on the person being truthful and/or the person could be describing his/her thoughts improperly.
  - Wundt was a structuralist. **Structuralism** is an attempt to analyze conscious experience by breaking it down into basic elements, and to understand how these elements work together.
- **Darwin (1809-1882):**
  - He changed everything in the sciences.
  - Biologists pre-Darwin and even Darwin himself were structuralists. They created classes of animals by their physical features. However, the scientists never considered why an animal had the physical features it had. However, Darwin pushed the idea that the physical features an animal has is there for a reason, which got people to think.
  - Also came up with the theory of "**Survival of the fittest**", which means that if you are best designed for your habitat, then you will survive.
  - Pushed for **functionalism** instead of structuralism, which meant focus on why something happens instead of what that something is.
  - Structuralism largely gave way to functionalism, a focus on the purpose of the mental world, not what it "looks" like.
- **William James (1842-1910):**
  - Was more of a philosopher than a psychologist. However, he is considered a psychologist because he thought a lot about psychological things, such as how does attention work, how does memory work, etc. He didn't do a lot of experiments.
  - His ideas/thoughts have become the hypotheses of many psychologists and a lot of his ideas turned out to be correct.
  - In the psychology world, James was one of the first functionalists.
- **Artificial selection**, also known as **selective breeding**, is the intentional reproduction of individuals in a population that have desirable traits so that their descendents would have these traits, too.
- A lot of early psychologists didn't consider themselves a psychologist. They wanted to prove that you could scientifically study the mind as a lot of scientists

back then were skeptical of that and still thought humans were spirits in a material world.

- **Herman Von Ebbinghaus (1850-1909):**
  - Was interested in memory and read a lot of William James' ideas and wanted to do experiments based on the ideas.
  - For one of his experiments, he wrote 40 CVCs (Consonant Vowel Consonant), made up words that started with a consonant, followed by a vowel and ended with a consonant on cards and tried to memorize all of them. Then, he tried to write all 40 CVCs out multiple times, with a gap in between each time and without looking at the cards at all. He found out that over time, he'd remember less and less words. This is seen below on the graph and we now call this the **Forgetting Function**.
  - After a few of these tests, Ebbinghaus relearned the words. However, he kept track of how long it took him to learn all 40 words the first time and how long it took for him to relearn it, and he found that relearning the words took way less time. He came to the conclusion that the words were gone but not forgotten.
  - This was the pinnacle of trying to show the rest of the world that this new science of psychology is a science and that we can scientifically learn/study about the mind.
- **Sigmund Freud (1856-1939):**
  - Was trained as a medical doctor (physiologist), not as a scientist.
  - Operated on the concept of the **medical model**, which is the concept of using medical ideas to treat disorders of emotions, thoughts, and behaviour.
  - Before Freud, most mentally ill people would get locked up in asylums, but Freud challenged that idea. He said that many people with mental illness were leading normal lives otherwise. He invented **psychoanalysis**, a psychological approach that attempts to explain how behaviour and personality are influenced by unconscious processes, to find the root cause of why someone has a mental illness.
  - Invented psychoanalysis, promoted cocaine, spoke a lot about sexual and aggressive urges, popularized his notion of psychology, and drove (and still does) scientists nuts!
  - Freud lived in the Victorian Era where people were very obsessed about being proper. So, they did not openly talk about sexual issues or aggression. However, Freud said that everything's about sex or aggression. Freud said that we can satisfy all of our urges except for sex or aggression, which fasciated a lot of people.
  - Freud had a notion of unconscious things playing out in little behaviours that you do. While this made Freud popular with the general public, it did not make him popular with other scientists and this almost redefined psychology.
  - Scientifically-minded psychologists hated Freud so much because they could never disprove his theories. Freud would come up with an

explanation for every behaviour and so he was never wrong. It's all about the lack of testable theories. To scientists, if something cannot be proven wrong, it's useless. Furthermore, prior to Freud, psychologists focused on average humans. However, Freud focused on people with mental illness and birthed the concept of **clinical psychology**, the field of psychology that concentrates on the diagnosis and treatment of psychological disorders. This split psychology into two types, experimental psychology and clinical psychology, and early on, there was a division between the two types because early clinicians didn't care about science and operated on the concept of the medical model.

- **European scientists reacted to Freud in two ways:**
    - **Gestalt Psychology:** Trying to understand the laws underlying our amazing ability to acquire and maintain stable percepts in a noisy world.
      I.e. Looks at the human mind and behaviour as a whole.
    - **Humanistic psychology:** Born largely as a direct counter in response to Freud's focus on sex and aggression. It focused on the positive aspects of humanity.
- **North American scientists reacted to Freud in one way:**
    - **Behaviourism/S-R Psychology/Rat Psychology:** An approach that dominated the first half of the 20th century of North American psychology and had a singular focus on studying only observable behaviour, with little to no reference to mental events or instincts as possible influences on behaviour.
    - Influential psychologists included Ivan Pavlov (1849 - 1936), John B. Watson (1878 - 1958), and B.F. Skinner (1904 – 1990). Pavlov started this idea and even though he was Russian, because many North American psychologists built on his ideas, we call this the North American scientists' reaction to Freud.
    - Wanted to study things that can be measured and manipulated in objective/scientific ways. Wanted to see what the test subject does as a function of certain stimuli (certain situations we put the animal in). Only cared about the stimuli and the test subject's reaction to it.

- **The Cognitive Revolution:**
    - Getting into the 1950's to 1960's.
    - Computers were around at this time and became a model for the human mind. Computers have memory, could take input, process that input and produce an output based on the input. Since computers were physical, this made the human mind feel more concrete. Psychologists began studying the human mind and memory again.
    - An important topic psychologists began to study was attention and how they could enhance the memory of humans. In America, there were a lot of wars from the early to mid 1900's (Spanish-American War, WW1, WW2, Korean War, Vietnam War) and the army was interested in finding new ways for them to do better at wars. One of the tasks that drove the

army to embrace psychology was radar operator task (A person staring at a radar screen for 8 hours each day and sending signals if they saw any enemy vehicles on the screen). The army found out that after a few hours, the radar operator wasn't focused anymore and didn't notice when an enemy vehicle showed up on the screen. This made the army very interested in studying attention.

- **Social psychology** is the study of the influence of other people on our behaviour.

Textbook:

- **Section 1.1:**
- **The Science of Psychology:**
- One of the reasons psychology is such an exciting field is that it is easy to see how this field of study relates to your own life.
- Psychology is visceral. We feel emotions, we take in sensations, and we produce behaviours such as thoughts and actions. Psychology is you.
- **Psychology** is the scientific study of behaviour, thought, and experience, and how they can be affected by physical, mental, social, and environmental factors.
- Some of the overarching goals of psychology include:
    - To understand how different brain structures work together to produce our behaviour.
    - To understand how nature (genetics) and nurture (our upbringing and environment) interact to make us who we are.
    - To understand how previous experiences influence how we think and act.
    - To understand how groups, family, culture, and crowds affect the individual.
    - To understand how feelings of control can influence happiness and health.
    - To understand how each of these factors can influence our well-being and could contribute to psychological disorders.
    - Critically, these points are not independent of one another.
- Every topic in psychology could be examined from a biological, cognitive, or sociocultural perspective.
- **The Scientific Method:**
- A person who carefully follows a system of observing, predicting, and testing is conducting science, whether the subject matter is chemicals, physiology, human memory, or social interactions.
  I.e. Whether a field of study is a science, or a specific type of research is scientific, is based not on the subject but on the use of the scientific method.
- The **scientific method** is a way of learning about the world through collecting observations, developing theories to explain them, and using the theories to make predictions.
- **Hypotheses Making Predictions:**
- A **hypothesis** is a testable prediction about processes that can be observed and measured.
- A hypothesis can be supported or rejected. You cannot prove a hypothesis because it is always possible that a future experiment could show that it is wrong

or limited in some way. This support or rejection occurs after scientists have tested the hypothesis.

- For a hypothesis to be testable, it must be falsifiable, meaning that the hypothesis is precise enough that it could be proven false. This precision is also important because it will help future researchers if they try to replicate the study to determine if it the results were due to chance.
- Horoscopes make very general predictions, typically so much so that you could easily find evidence for them if you looked hard enough, and perhaps stretched an interpretation of events a bit. In contrast, a good scientific hypothesis is stated in more precise terms that promote testability.
- Astrology is often referred to as **pseudoscience**, an idea that is presented as science but does not actually utilize basic principles of scientific thinking or procedure.
- **Theories Explaining Phenomena:**
- A **theory** is an explanation for a broad range of observations that also generates new hypotheses and integrates numerous findings into a coherent whole.
- Theories are built from hypotheses that are repeatedly tested and confirmed.
- An essential quality of scientific theories is that they can be supported or proved false with new evidence.
- If a hypothesis is supported, it provides more support for the theory. In turn, good theories can be used to generate new hypotheses.
- However, if the hypothesis is not supported by the results of a well-designed experiment, then researchers may have to rethink elements of the theory.
- Theories are not the same as opinions or beliefs.
- All theories are not equally plausible.
- A good theory can explain previous research and can lead to even more testable hypotheses.
- The quality of a theory is not related to the number of people who believe it to be true.
- Testing hypotheses and constructing theories are both part of all sciences.
- **The Biopsychosocial Model:**
- The **biopsychosocial model** is a means of explaining behaviour as a product of biological, psychological, and sociocultural factors.
- Biological influences on our behaviour involve brain structures and chemicals, hormones, and external substances such as drugs.
- Psychological influences involve our memories, emotions, and personalities, and how these factors shape the way we think about and respond to different people and situations.
- Social factors such as our family, peers, ethnicity, and culture can have a huge effect on our behaviour.
- Importantly, none of these levels of analysis exists on its own. These levels influence each other. Almost every moment of your life is occurring at all three levels.

- **Building Scientific Literacy:**
- **Scientific literacy** is the ability to understand, analyze, and apply scientific information.
- Scientific literacy involves gathering knowledge about the world, explaining it using scientific terms and concepts, thinking critically, and applying this knowledge to relevant, real-world situations.
- We have to examine whether the ideas being presented were scientifically tested, and whether those studies were designed properly. Doing so allows us to separate the information that we should find convincing from the information that we should view with caution. It will also allow you to better analyze the information. Finally, we want to generalize the results. Generalization shows us that the studies conducted in universities and hospitals can provide insight into behaviours that extend far beyond the confines of the lab.
- **Critical Thinking, Curiosity, and a Dose of Healthy Skepticism:**
- Critical thinking involves exercising curiosity and skepticism when evaluating the claims of others, and with our own assumptions and beliefs.
- Critical thinking does not mean being negative or arbitrarily critical. Rather, it means that you intentionally examine knowledge, beliefs, and the means by which conclusions were obtained. Critical thinking involves cautious skepticism.
- To improve your ability to think critically, you should develop the following habits and skills:
    - **Be curious.** Simple answers are sometimes too simple, and common sense is not always correct.
    - **Examine the nature and source of the evidence.** Not all research is of equal quality.
    - **Examine assumptions and biases.** This includes your own assumptions as well as the assumptions of those making the claims.
    - **Avoid overly emotional thinking**. Emotions can tell us what we value, but they are not always helpful when it comes to making critical decisions.
    - **Tolerate ambiguity.** Most complex issues do not have clear-cut answers.
    - **Consider alternative viewpoints and alternative interpretations of the evidence.**
- Scientific and critical thinking involves the use of the **principle of parsimony**, which states that the simplest of all competing explanations of a phenomenon should be the one we accept.
- **Section 1.2:**
- **Psychology's Philosophical and Scientific Origins:**
- Science is more than a body of facts to memorize or a set of subjects to study. Science is actually a philosophy of knowledge that stems from two fundamental beliefs: empiricism and determinism.
- **Empiricism** is a philosophical tenet that knowledge comes through experience. In the scientific sense, empiricism means that knowledge about the world is based on careful observation, not on common sense or speculation.
- **Determinism** is the belief that all events are governed by lawful, cause-and-effect relationships. This is easy enough when we discuss natural

laws such as gravity. But does the lawfulness of nature apply to the way we think and act? Does it mean that we do not have control over our own actions? This interesting philosophical debate is often referred to as **free will versus determinism**.

- Psychological science is both empirical and deterministic.
- **Influences from the Ancients Philosophical Insights into Behaviour:**
- In ancient Greece, the physician Hippocrates (460–370 BCE) developed the world's first personality classification scheme. The ancient Greeks believed that four humours or fluids flowed throughout the body and influenced both health and personality. These four humours included blood, yellow bile, black bile, and phlegm. Different combinations of these four humours were thought to lead to specific moods and behaviours.
- Galen of Pergamon (127–217), arguably the greatest of the ancient Roman physicians, refined Hippocrates's more general work and suggested that the four humours combined to create temperaments, or emotional and personality characteristics that remained stable throughout the lifetime. Galen's four temperaments (each related to a humour) included:
    - Sanguine (blood), a tendency to be impulsive, pleasure-seeking, and charismatic.
    - Choleric (yellow bile), a tendency to be ambitious, energetic, and a bit aggressive.
    - Melancholic (black bile), a tendency to be independent, perfectionistic, and a bit introverted.
    - Phlegmatic (phlegm), a tendency to be quiet, relaxed, and content with life.
- Although such a classification system is primitive by modern standards, the work of Hippocrates and Galen moved the understanding of human behaviour forward by attempting to categorize different types of personalities.
- Psychology also did not immediately benefit from the scientific revolution of the 1500s and 1600s. Once the scientific method started to take hold around 1600, physics, astronomy, physiology, biology, and chemistry all experienced unprecedented growth in knowledge and technology. But it took psychology until the late 1800s to become scientific. One of the reasons is zeitgeist, a German word meaning "spirit of the times."
- **Zeitgeist** refers to a general set of beliefs of a particular culture at a specific time in history.
- The power of zeitgeist can be very strong, and there are several ways it prevented psychological science from emerging in the 1600s. Perhaps most important is that people were not ready to accept a science that could be applied to human behaviour and thought. To the average person of the 1600s, viewing human behaviour as the result of predictable physical laws was troubling. Doing so would seem to imply the philosophy of **materialism**: the belief that humans, and other living beings, are composed exclusively of physical matter. Accepting this idea would mean that we are nothing more than complex machines that lack a self-conscious, self-controlling soul. The opposing belief, that there are

properties of humans that are not material (a mind or soul separate from the body), is called **dualism**.

- **Influences from Physics Experimenting with the Mind:**
- The initial forays into scientific psychology were conducted by physicists and physiologists.
- One of the earliest explorations was made by Gustav Fechner (1801–1887), who studied sensation and perception.
- Fechner coined the term **psychophysics**, which is the study of the relationship between the physical world and the mental representation of that world.
- **Influences from Evolutionary Theory The Adaptive Functions of Behaviour:**
- Around the same time Fechner was doing his experiments, Charles Darwin (1809–1882) was studying the many varieties of plants and animals found around the world. Darwin noticed that animal groups that were isolated from one another often differed by only minor variations in physical features. These variations seemed to fine-tune the species according to the particular environment in which they lived, making them better equipped for survival and reproduction.
- Darwin's theory of evolution by natural selection was based on his observations that the genetically inherited traits that contribute to survival and reproductive success are more likely to flourish within the breeding population. These specific traits differ across locations because different traits will prove beneficial in different environments. This theory explains why there is such a diversity of life on Earth.
- Darwin's theory also helps to explain human and animal behaviour. As Darwin pointed out in The Expression of the Emotions in Man and Animals, behaviour and physical traits are shaped by natural selection.
- **Influences from Medicine: Diagnoses and Treatments:**
- Medicine contributed a great deal to the biological perspective in psychology. It also had a considerable influence on the development of **clinical psychology**, the field of psychology that concentrates on the diagnosis and treatment of psychological disorders. A research topic that impacted both fields was the study of localization of brain function, the idea that certain parts of the brain control specific mental abilities and personality characteristics.
- In the mid-1800s, localization was studied in two different ways:
    1. **Phrenology:**
        a. Franz Gall (1758–1828), Johann Spurzheim (1776–1832) and their followers believed that the brain consisted of 27 "organs," corresponding to mental traits and dispositions that could be detected by examining the surface of the skull.
        b. They believed that different traits and abilities were distributed across different regions of the brain.
        c. If a person possessed a particular trait or ability, then the brain area related to that characteristic would be larger. The larger brain areas would cause bumps on a person's head, so, by measuring the bumps on a person's head, proponents of phrenology believed that

it would be possible to identify the different traits that an individual possessed.

2. **The study of brain injuries and the ways in which they affect behaviour:**
    a. Had a scientific grounding that phrenology lacked.
    b. Physician Paul Broca found that a patient who had difficulties producing spoken language had brain damage in an area of the left frontal lobes of the brain (near his left temple).
    c. Prussian physician Karl Wernicke found that damage to another area in the left hemisphere led to problems with speech comprehension.
    d. Doctors in Vermont described a railroad employee who became impulsive and somewhat childlike after suffering damage to his frontal lobes.

- **Psychosomatic medicine** is the branch of medicine that studies and treats disorders in which physical symptoms are influenced by psychological factors.
- Sigmund Freud (1856–1939) began to use hypnosis to treat his own patients.
- Freud was particularly interested in how hypnosis seemed to have cured several patients of hysterical paralysis, a condition in which an individual loses feeling and control in a specific body part, despite the lack of any known neurological damage or disease. These experiences led Freud to develop his famous theory and technique called psychoanalysis.
- **Psychoanalysis** is a psychological approach that attempts to explain how behaviour and personality are influenced by unconscious processes.
- Freud acknowledged that conscious experience includes perceptions, thoughts, a sense of self, and the sense that we are in control of ourselves. However, he also believed in an unconscious mind that contained forgotten episodes from early childhood as well as urges to fulfill self-serving sexual and aggressive impulses. Freud proposed that because these urges were unconscious, they could exert influence in strange ways, such as restricting the use of a body part. Freud believed hypnosis played a valuable role in his work. When a person is hypnotized, dreaming, or perhaps medicated into a trance-like state, he thought, the psychoanalyst could have more direct access into the individual's unconscious mind. Once Freud gained access, he could attempt to determine and correct any desires or emotions he believed were causing the unconscious to create the psychosomatic conditions.
- Although Freud did not conduct scientific experiments, his legacy can be seen in some key elements of scientific psychology.
    1. Many modern psychologists make inferences about unconscious mental activity, just as Freud had advocated, although not all of them agree with the specific theories proposed by Freud.
    2. The use of medical ideas to treat disorders of emotions, thought, and behaviour, an approach known as the **medical model**, can be traced to Freud's influence.

3. Freud incorporated evolutionary thinking into his work. He emphasized how physiological needs and urges relating to survival and reproduction can influence our behaviour.
4. Freud placed great emphasis on how early life experiences influence our behaviour as adults.

- **The Influence of Social Sciences Measuring and Comparing Humans:**
- A fifth influential force came out of the social sciences of economics, sociology, and anthropology. These disciplines developed statistical methods for measuring human traits, which soon became relevant to the emerging field of psychology. An early pioneer in measuring perception and in applying statistical analyses to the study of behaviour was Sir Francis Galton.
- Galton noticed that great achievement tended to run in families; as a result, he came to believe that heredity (genetics) could explain the physical and psychological differences found in a population.
- To support his beliefs, Galton developed ways of measuring what he called **eminence**, a combination of ability, morality, and achievement. One observation supporting his claim for a hereditary basis for eminence was that the closer a relative, the more similar the traits.
- Galton was one of the first investigators to scientifically take on the question of **nature and nurture relationships**, the inquiry into how heredity (nature) and environment (nurture) influence behaviour and mental processes. Galton came down decidedly on the nature side, seemingly ignoring the likelihood that nurturing influences such as upbringing and family traditions, rather than biological endowments, could explain similarities among relatives.
- Galton's beliefs and biases led him to pursue scientific justification for **eugenics**, the science of improving a human population by controlled breeding to increase the occurrence of desirable heritable characteristics.
- Galton promoted the belief that social programs should encourage intelligent, talented individuals to have children, whereas criminals, those with physical or mental disability, and non-White races should not receive such encouragement.
- Ultimately, Galton's beliefs in eugenics led to disastrous consequences.
- In modern times, biological and genetic approaches to explaining behaviour are thriving and with the advent of new brain-imaging techniques. This area of psychology, biological psychology, is poised to provide new and important insights into the underlying causes of our behaviour.
- **The Beginnings of Contemporary Psychology:**
- By the late 1800s, the zeitgeist had changed so that the study of human behaviour was acceptable. Ideas flourished. Most importantly, researchers began to investigate behaviour in a number of different ways.
- **Structuralism and Functionalism The Beginnings of Psychology:**
- Most contemporary psychologists agree that Wilhelm Wundt (1832–1920) was largely responsible for establishing psychology as an independent scientific field.
- Wundt established the first laboratory dedicated to studying human behaviour in 1879 at the University of Leipzig, where he conducted numerous experiments on how people sense and perceive.

- His primary research method was **introspection**, meaning “to look within.”
- Introspection required a trained volunteer to experience a stimulus and then report each individual sensation he or she could identify.
- Wundt also developed reaction time methods as a way of measuring mental effort.
- What made Wundt’s work distinctly psychological was his focus on measuring mental events and examining how they were affected by his experimental manipulations.
- Edward Titchener, a student of Wundt, adopted the same method of introspection used by Wundt to devise an organized map of the structure of human consciousness. His line of research, **structuralism**, was an attempt to analyze conscious experience by breaking it down into basic elements, and to understand how these elements work together.
- Titchener chose the term elements deliberately as an analogy with the periodic table in the physical sciences. He believed that mental experiences were made up of a limited number of sensations, which were analogous to elements in physics and chemistry. The challenge for psychologists was to determine which elements were grouped together during different conscious experiences and to figure out what caused these specific groupings to occur.
- William James, a trained physician, developed the theory of **functionalism** by building on Darwin’s evolutionary principles. **Functionalism** is the study of the purpose and function of behaviour and conscious experience. This contrasts structuralism.
- According to functionalists, in order to fully understand a behaviour, one must try to figure out what purpose it may have served over the course of our evolution. These principles are found today in the modern field of **evolutionary psychology**, an approach that interprets and explains modern human behaviour in terms of forces acting upon our distant ancestors.
- **The Rise of Behaviourism:**
- **Behaviourism** is an approach that dominated the first half of the 20th century of North American psychology and had a singular focus on studying only observable behaviour, with little to no reference to mental events or instincts as possible influences on behaviour.
- The credit for discovering classical conditioning typically goes to a Russian physiologist named Ivan Pavlov (1849–1936). Pavlov noticed that the dogs in his laboratory began to salivate when the research technician entered the room and turned on the device that distributed the food. Importantly, salivation occurred before the delivery of food, suggesting that the dogs had learned an association between the technician and machine noises and the later appearance of food.
- **Radical Behaviourism:**
- Edward Thorndike (1874–1949) showed that the frequency of different behaviours could be changed based on whether or not that behaviour led to positive consequences.
- In Skinner’s view, the foundation of behaviour was how an organism responded to rewards and punishments. This is known as **radical behaviourism**.

- **Humanistic Psychology Emerges:**
- Psychology, by the mid-20th century, was dominated by two perspectives, behaviourism and Freudian psychoanalytic approaches, which had almost entirely removed free will from the understanding of human behaviour.
- To the behaviourists, human experience was the product of a lifetime of rewards, punishments, and learned associations. To the psychoanalysts, human experience was the result of unconscious forces at work deep in the human psyche. From both perspectives, the individual person was merely a product of forces that operated on her, and she had little if any control over her own destiny or indeed, even her own choices, beliefs, and feelings.
- In contrast to these disempowering perspectives, a new movement of psychologists arose, which emphasized personal responsibility, free will, and the universal longing for growth, meaning and connection, and which highlighted the power that individuals possessed to shape their own consciousness and choose their own path through life. This new perspective, **humanistic psychology**, focuses on the unique aspects of each individual human, each person's freedom to act, his or her rational thought, and the belief that humans are fundamentally different from other animals.
- Humanistic psychologists sought to understand the meaning of personal experience. They believed that people could attain mental well-being and satisfaction through gaining a greater understanding of themselves, rather than by being diagnosed with a disorder or having their problems labelled.
- **The Brain and Behaviour:**
- Donald Hebb (1904–1985), a Canadian neuroscientist, observed that when a brain cell consistently stimulates another cell, metabolic and physical changes occur to strengthen this relationship.
- This theory, now known as Hebb's Law, demonstrated that memory is actually related to activity occurring at the cellular level. It also reinforced the notion that behaviour can be studied at a number of different levels ranging from neurons (brain cells) to the entire brain.
- Wilder Penfield (1891–1976) was able to map out to the functions of various brain regions. To do this, Penfield electrically stimulated each patient's brain while the patient was awake and conscious. The patient was then able to report the sensations he experienced after each burst of electricity. Based on several patients' reports, Penfield was able to create precise maps of the sensory and motor (movement) cortices in the brain.
- **The Cognitive Revolution:**
- Although behaviourism dominated psychology in the United States and Canada throughout the first half of the 20th century, the view that observable behaviours were more important than thoughts and mental imagery was not universal.
- In Europe, psychologists retained an emphasis on thinking, and ignored the North Americans' cries to study only what could be directly observed.
- It was the work of European psychologists that formed the basis of the cognitive perspective.

- Early evidence of an emerging cognitive perspective concerned the study of memory. British psychologist Frederick Bartlett (1886–1969) found that our memory was not like a photograph.
- Another precursor to cognitive psychology is **Gestalt psychology**, an approach emphasizing that psychologists need to focus on the whole of perception and experience, rather than its parts. This contrasts with the structuralist goal of breaking experience into its individual parts.
- **Cognitive psychology** is a modern psychological perspective that focuses on processes such as memory, thinking, and language.
- **Social and Cultural Influences:**
- **Social psychology** is the study of the influence of other people on our behaviour.
- **Personality psychology** is the study of how different personality characteristics can influence how we think and act.
- Although it's easy to think of social psychology (the effect of external factors) and personality psychology (the effect of internal traits) as being distinct, in reality, your personality and the social situations you are in interact. This relationship was most eloquently described by Kurt Lewin (1890–1947), the founder of modern social psychology. Lewin suggested that behaviour is a function of the individual and the environment. What Lewin meant was that all behaviours could be predicted and explained through understanding how an individual with a specific set of traits would respond in a context that involved a specific set of conditions.
- **Comparing Cultures:**
- **Cross-cultural psychology** is the field of psychology that draws comparisons about individual and group behaviour among cultures.
- **The Neuroimaging Explosion:**
- Although it has been possible to detect brain activity using sensors attached to the scalp since the late 1920s, the use of brain imaging to study behaviour became much more common in the early 1990s.
- It was at this time that a technique known as functional magnetic resonance imaging (fMRI) was developed. fMRI allows us to reliably detect activity throughout the entire brain and to depict this activity on clear three-dimensional images.
- Initially, fMRI was used to examine relatively straightforward behaviours such as visual perception. However, it quickly became the "go to" tool for researchers interested in understanding the neural mechanisms for cognitive behaviours such as memory, emotion, and decision-making. This field, which combines elements of cognitive psychology and biopsychology is known as **cognitive neuroscience**. Cognitive neuroscience examines how different brain areas are involved with different cognitive abilities.
- As fMRI became accessible, researchers in other fields of psychology began to incorporate it into their studies. Psychologists studying social behaviours ranging from racism to relationships use fMRI in their experiments. This new field is known as **social neuroscience**.

- **The Search for the Positive:**
- Another rapidly growing area of psychology involves promoting human strengths and potentials. Rather than focusing on pathologies or negative events such as rejection, the goal of **positive psychology** is to help people see the good in their lives by promoting self-acceptance and improving social relationships with others. The eventual goal of this field is to help people experience feelings of happiness and fulfillment.

Definitions:

- **Behaviourism:** An approach that dominated the first half of the 20th century of North American psychology and had a singular focus on studying only observable behaviour, with little to no reference to mental events or instincts as possible influences on behaviour.
- **Biopsychosocial model:** A means of explaining behaviour as a product of biological, psychological, and sociocultural factors.
- **Cartesian Dualism:** The belief that humans are part machine but we also have a soul, which connects with the body at the pineal gland.
- **Clinical psychology:** The field of psychology that concentrates on the diagnosis and treatment of psychological disorders.
- **Cognitive neuroscience:** Examines how different brain areas are involved with different cognitive abilities.
- **Cognitive psychology:** A modern psychological perspective that focuses on processes such as memory, thinking, and language.
- **Cross-cultural psychology:** The field of psychology that draws comparisons about individual and group behaviour among cultures.
- **Determinism:** The belief that all events are governed by lawful, cause-and-effect relationships.
- **Empiricism:** A philosophical tenet that knowledge comes through experience.
- **Evolutionary psychology:** An approach that interprets and explains modern human behaviour in terms of forces acting upon our distant ancestors.
- **Functionalism:** The study of the purpose and function of behaviour and conscious experience. This contrasts structuralism.
- **Gestalt psychology**: An approach to psychology emphasizing that psychologists need to focus on the whole of perception and experience, rather than its parts. This contrasts with the structuralist goal of breaking experience into its individual parts.
- **Hypothesis:** A testable prediction about processes that can be observed and measured.
- **Humanistic psychology**: A field of psychology that focuses on the unique aspects of each individual human, each person's freedom to act, his or her rational thought, and the belief that humans are fundamentally different from other animals.
- **Medical model:** The use of medical ideas to treat disorders of emotions, thought, and behaviour.
- **Personality psychology:** The study of how different personality characteristics can influence how we think and act.

- **Principle of parsimony:** A theory that the simplest of all competing explanations of a phenomenon should be the one we accept.
- **Psychoanalysis:** A psychological approach that attempts to explain how behaviour and personality are influenced by unconscious processes.
- **Psychology:** The scientific study of behaviour, thought, and experience, and how they can be affected by physical, mental, social, and environmental factors.
- **Psychophysics:** The study of the relationship between the physical world and the mental representation of that world.
- **Psychosomatic medicine:** The branch of medicine that studies and treats disorders in which physical symptoms are influenced by psychological factors.
- **Scientific literacy:** The ability to understand, analyze, and apply scientific information.
- **Scientific method:** A way of learning about the world through collecting observations, developing theories to explain them, and using the theories to make predictions.
- **Social psychology:** The study of the influence of other people on our behaviour.
- **Structuralism:** An attempt to analyze conscious experience by breaking it down into basic elements, and to understand how these elements work together.
- **Theory:** An explanation for a broad range of observations that also generates new hypotheses and integrates numerous findings into a coherent whole.
- **Zeitgeist:** A general set of beliefs of a particular culture at a specific time in history.

PSYA01 List of Psychologists

Name/Date	Accomplishments and Achievements
Rene Descartes (1596 - 1650)	- Originally believed that things with a soul move with intention, but after being blocked by a statue of Neptune as he tried to walk towards a statue of Diana, he no longer believed that. - After the statue incident, Rene believed animals were fancy hydraulic machines and did not have a soul. As such, he endorsed animal testing and performing vivsections on them. - With humans, Rene believed in **Cartesian Dualism**, the belief that humans are part machine, but we also have a soul, which connects with the body at the pineal gland. - Believed that humans' biology were hydraulically driven.
John Locke (1632 - 1704)	- Thought that the **Mind is a machine** - Coined the term **La Table Rassa**, which is a theory that humans are born a blank slate and that their experiences would define them and their future. Hence, he strongly supported the Nurture View in the Nurture vs Nature debate. - Believed in **empiricism**, the idea that people should test their ideas by doing experiments. - Believed that humans are completely machines.
Luigi Galvani (1737 - 1798)	- Showed that by applying electricity to a severed frog leg, it made the frog leg move. - Believed that humans are bio-electric machines.
Franz Gall (1758 - 1828)	- A proponent of **phrenology**, which involves the measurement of bumps on the skull to predict mental traits. - Believed that the brain consisted of 27 organs corresponding to mental traits and dispositions could be detected by examining the surface of the skull. If a person possessed a particular trait, then the brain area related to that characteristic would be larger. The larger brain areas would cause bumps on a person's head, so by measuring the bumps on a person's head, it would be possible to identify the different traits that an individual possesses.
James Mill (1773 - 1836)	- Coined the term **Materialism** from Locke's mind is a machine. - Believed that humans are completely machines.
Pierre Florens (1774 - 1867)	- Did ablation studies on animals to see what part of the brain controlled what functions.
Johann Spurzheim (1776 - 1832)	- A proponent of **phrenology**, which involves the measurement of bumps on the skull to predict mental traits.

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	- Believed that the brain consisted of 27 organs corresponding to mental traits and dispositions could be detected by examining the surface of the skull. If a person possessed a particular trait, then the brain area related to that characteristic would be larger. The larger brain areas would cause bumps on a person's head, so by measuring the bumps on a person's head, it would be possible to identify the different traits that an individual possesses.
Ernst Weber (1795 - 1878)	- Studied **psychophysics**, the study of the relationship between the physical world and the mental representation of that world. - Did an experiment where he blindfolded people and put an object (of either the same or different weight) in each hand and asked the person which object was heavier. He noticed that if there's at least a 10% difference in the weight of the objects, the person could feel which object is heavier.
Gustav Fechner (1801 - 1887)	- Studied psychophysics. - Was a close associate with Weber.
Charles Darwin (1809 - 1882)	- Changed everything in the sciences. - Biologists pre-Darwin and Darwin himself were structuralists. They classes animals by their physical features. However, Darwin pushed them to think why an animal had the physical features it has. This led to **functionalism**, which focuses on why something happens as opposed to what that something is. - Coined the term "Survival of the fittest".
Hermann Von Helmholtz (1821 - 1894)	- Measured the speed of neural impulses and discovered that our nerves send signals at a relatively slow rate compared to modern electronics.
Francis Galton (1822 - 1911)	- Was a strong supporter of the **nature view**. - Believed and pushed for eugenics.
Paul Broca (1824 - 1880)	- Discovered that people who had trouble producing speech, but no trouble with understanding speech had damage to the left, front part of their brain. This area is known as **Broca's area**.
Willhelm Wundt (1832 - 1920)	- Known as the father of psychology because he opened the first psychology lab. - Was the first person to refer to himself/herself as a psychologist. - Wrote the first psychology textbook "The Principles of Physiological Psychology". - Liked introspection. However, introspection was controversial because you're relying on the person being truthful and describing his/her thoughts properly.

PSYA01 List of Psychologists

	- Was a **structuralist**. **Structuralism** is an attempt to analyze conscious experience by breaking it down into basic elements and to understand how these elements work together.
William James (1842 - 1910)	- More of a philosopher than a psychologist and didn't do a lot of experiments. - However, he is considered a psychologist because he thought a lot about psychological things like memory, attention, etc. - A lot of his theories have become the hypotheses for many psychologists and they turned out correct. - One of the first functionalists.
Ivan Pavlov (1849 - 1936)	- Credited as the inventor of **behaviourism**. - He noticed that his test dogs would salivate when his lab assistants simply turned on the machine that distributed food. Importantly, the dogs salivated before the delivery of food.
Herman Von Ebbinghaus (1850 - 1909)	- Was interested in memory. - For one of his experiments, he wrote 40 CVC (Consonant Vowel Consonant) made-up words and tried to memorize them. Then, he tried to rewrite all 40 CVCs multiple times with a gap in between each attempt. He found out that over time, he'd remember less and less words. This is now known as the **forgetting function**. He also discovered that relearning something takes less time than learning it originally. This was the pinnacle of trying to show the rest of the world that psychology is a science and that we can scientifically study the mind.
Sigmund Freud (1856 - 1939)	- Was trained as a physiologist, not a scientist. - Operated on the **medical model**, the concept of using medical ideas to treat disorders of emotions, thoughts and behaviour. - Argued that mental ill people should not be locked in asylums. - Invented **psychoanalysis**, a psychological approach that attempts to explain how behaviour and personality are influenced by unconscious processes, to find the root cause of why someone has a mental illness. - Used hypnosis to treat his patients. Freud believed that if someone was hypnotized, then he could enter their unconscious mind and diagnose the problem. - Said that everything is about sex or aggression as we can satisfy all of our urges except for those 2. - Freud was hated by scientists because they could never disprove his theories. Freud would come up with an explanation for every behaviour, so he was never wrong. To scientists, if something is not falsifiable, it's useless.

PSYA01 List of Psychologists

	- Birthed the concept of **clinical psychology**, the field of psychology that concentrates on the diagnosis and treatment of psychological disorders. This split psychology into 2 types, experimental psychology and clinical psychology. Early on, there was a division between the 2 branches as clinical psychology did not care about science and operated on the medical model. - European scientists reacted to Freud in two ways, **Gestalt psychology** and **Humanistic psychology**. - North American scientists reacted to Freud in one way, **behaviourism**.
Edward Titchener (1867 - 1927)	- A student of Wundt and a proponent of structuralism. - Devised an organized map of the structure of the human brain.
Edwin Twitmyer (1873 - 1943)	- An American psychologist in reflexes. - His work helped shape **behaviourism**. - Did an experiment where a bell would ring right before he used his reflex mallet on a patient. After several times, he noticed that if the bell rang, but he did not use the mallet, the patient's leg kicked anyways.
Edward Thorndike (1874 - 1949)	- Was a proponent of **radical behaviourism**, the concept that one's behaviour changes based on whether or not that behaviour led to positive consequences.
Fredrick Bartlett (1886 - 1969)	- Discovered that human's memory is not like a photograph.
Kurt Lewin (1890 - 1947)	- The founder of modern social psychology. - Suggested that behaviour is a function of the individual and the environment. All behaviour could be predicted and explained through understanding how an individual with a specific set of traits would respond in a context that involved a specific set of conditions.
Wilder Penfield (1891 - 1976)	- Mapped out functions of various brain regions by electrically stimulating parts of a patient's brain while the patient was alive. After each shock, the patient would describe the sensations felt.
Donald Hebb (1904 - 1985)	- Observed that when a brain cell consistently stimulates another cell, metabolic and physical changes occur to strengthen this relationship. This theory is known as Hebb's Law and it reinforced the notion that behaviour can be studied.
Ulrich Neisser (1928 - 2012)	- Coined the term "Cognitive psychology" in 1968.

September 13:

- Sometimes, you may see a study say something one day and the next day, another study says the opposite. This is because each study uses different methodologies. Unless you're very careful to think about the study and understand it, it's very hard to interpret it. This is called **scientific literacy**.
- **Outliers** are data that are very far away from the others.
- The first step in the scientific process is to come up with a hypothesis. To get to the hypothesis, we start with **observational research**, which is when the researcher observes ongoing behaviour and notes them down. However, one of the challenges with doing observational research is the **Hawthorne effect**.
- The **Hawthorne effect** is when a person's behaviour changes as a result of being observed.
- The **placebo effect** is when you're led to believe that something will help you, it will often help you.
- While psychologists want to observe people without them knowing to eliminate the Hawthorne effect, there is an ethical code of conduct that states psychologists cannot watch people without their knowledge and consent.
- A **third variable/confound variable/mediator variable** is something that influences both dependent and independent variables.
- In order to know what's going on in some situations, we begin with observations and we get a suspicion of certain things that might be going on. Then, we follow that with correlational research. While correlational research helps us see that there is something going on, it doesn't really tell us how things are working. It doesn't give us **causal explanations**. That's where experiments are going to come in.
- A **positive correlation** occurs when one variable increases, the other variable also increases. Furthermore, the points lie close to a straight line which has a positive gradient.
- A **negative correlation** occurs when one variable increases, the other variable decreases. Furthermore, the points lie close to a straight line which has a negative gradient.
- A **no correlation** occurs when there is no pattern to the points.
- **Ordinate** is the y-axis.
- **Abscissa** is the x-axis.
- Correlations range from -1 to +1, inclusive. -1 is a perfect negative correlation. +1 is a perfect positive correlation. 0 means no correlation exists.
- Correlation does not imply causation. Correlation just says that there's something going on between the 2 variables. Experiments will prove that there is something going on between the 2 variables.

September 18:

- **Random assignment** is a technique for dividing samples into two or more groups in which participants are equally likely to be placed in any condition of the experiment.
- A **confound variable** is a variable outside of the researcher's control that might affect or provide an alternative explanation for the results. We want to ignore this.

- Your hypothesis must be specific.
- You have to operationally define things to do an experiment. However, there's usually a third variable, so we want to see **convergence** in experiments. **Convergence** is when a theory's predictions hold up to dozens of tests using a variety of operational definitions.
- We also like seeing **replication**, which is when another person or team does the experiment but with a slight difference, especially in random selection. If a bias snuck into one random selection, it shouldn't be able to sneak into other random selections.
- **Internal Validity** is concerned with if the experiment was performed well. It looks at issues that are related to potential confounds and/or poor measurement. This is where the role of peer-review comes in. When you write a scientific paper and submit it to a journal, the editor of that journal submits it to 3 other scientists that are doing similar research and they read your paper very carefully. One of the things they look for is internal validity.
- **External Validity** is concerned with if the experiment really maps onto the concepts it is intended to be studying. It looks at the validity of the operational definitions.
  I.e. External validity is concerned if the experiment supports the hypothesis and the theory.
  This is where replication and **manipulation checks** are important.
  We hope that people will replicate the experiment, but change the operational definitions and get similar results.
  A **manipulation check** is when the researcher debriefs the test subject at the end of the experiment and asks how the "manipulation part" made him/her feel. This is to check if your manipulation did what you think it did.
- **Cultural Validity** is concerned with if the findings are only applicable to some specific group of humans. The importance of representative samples and randomness is shown here.
- There are some very stringent rules on what we can do in ethical context.
- **APA Ethical Guidelines for Human Research:**
  - All research goes before an institution review board (IRB) for approval.
  - Research involving humans must meet the following standards:
    - **Coercion:** Participants cannot be forced in any way to participate in the study.
    - **Informed Consent:** Participants must know that they are involved in research and give their consent or permission.
    - **Anonymity/Confidentiality:** The identities and actions of the participants must not be revealed in any way by the researcher.
    - **Risk:** Participants cannot be placed at significant mental or physical harm.
    - **Debriefing:** Participants must be told of the purpose of the study and provided with ways to contact the researchers about the results after the research is complete.

        - **Deception:** If the participants are deceived in any way about the nature of the study, the participants must be debriefed after the study is over.
- **APA Ethical Guidelines for Animal Research:**
    - **Justification:** The proposed research must have a clear scientific purpose.
    - **Care:** Must care for and house animals in a humane way.
    - **Source:** Must acquire animals legally.
    - **Minimize Suffering:** Must design procedures that involve minimum suffering to the animals.
- **The 3 R's in Animal Testing:**
    - **Replacement:** Use alternative, non-animal methods to achieve the same scientific aim.
    - **Reduction:** Use statistical methods so that a smaller number of animals are required.
    - **Refinement:** Improve the experiments so that animals don't suffer.
- When you expose animals to a mirror, at first the animal will get excited, thinking that the reflection is another animal, but will lose interest later on. Researchers also discovered that some animals, like chimpanzees, will use the mirror to look at themselves.

Textbook:

- **Section 2.1:**
- **Five Characteristics of Quality Scientific Research:**
- Quality scientific research meets the following criteria:
    1. It is based on measurements that are objective, valid, and reliable.
    2. It can be generalized.
    3. It uses techniques that reduce bias.
    4. It is made public.
    5. It can be replicated.
- **Scientific Measurement Objectivity:**
- The foundation of scientific methodology is the use of **objective measurements**, the measure of an entity or behaviour that, within an allowed margin of error, is consistent across instruments and observers.
- A **variable** is the object, concept, or event being measured.
- Regardless of the specific experimental question being asked, any method used by a researcher to measure a variable needs to include carefully defined terms. **Operational definitions** are statements that describe the procedures and specific measures that are used to record observations.
- **Scientific Measurement: Reliability, and Validity:**
- The behavioural measurements that psychologists make must be valid and reliable. **Validity** refers to the degree to which an instrument or procedure actually measures what it claims to measure. A measure demonstrates **reliability** when it provides consistent and stable answers across multiple observations and points in time.

- There are actually a number of different types of reliability that affect psychological research:
    - **Test-retest reliability** examines whether scores on a given measure of behaviour are consistent across test sessions. If your scores on a test of depression vary widely each time you take the test, then it is unlikely that your test is reliable.
    - **Alternate-forms reliability** examines whether different forms of the same test produce the same results.
    - A third type of reliability takes place when observers have to score or rate a behaviour or response. Having more than one rater allows you to have **inter-rater reliability**, meaning that the raters agree on the measurements that were taken. If you design an experiment with clear operational definitions and criteria for the raters, then it is likely that you will have high inter-rater reliability.
- **Generalizability of Results:**
- **Generalizability** refers to the degree to which one set of results can be applied to other situations, individuals, or events.
- While it would be ideal to study an entire **population**, the group that researchers want to generalize about, the task of finding all population members, persuading them to participate, and measuring their behaviour is impossible in most cases. Instead, psychologists typically study a **sample**, a select group of population members. Once the sample has been studied, then the results may be generalized to the population as a whole.
- If researchers want to generalize the results to the entire population, they use a **random sample**, a sampling technique in which every individual of a population has an equal chance of being included. If researchers don't want to generalize the results to the entire population, they use a **convenience sample**, samples of individuals who are the most readily available.
- In addition, research should ideally have high **ecological validity**, meaning that the results of a laboratory study can be applied to or repeated in the natural environment.
- Although generalizability and ecological validity are important qualities of good research, we need to be careful not to over-generalize.
- **Sources of Bias in Psychological Research:**
- While creating objective, reliable, and valid measures is important in quality research, various types of bias can be unintentionally introduced by the researchers. This is known as a **researcher bias**.
- It is also possible for the participants, including animals, to introduce their own bias. This is known as **subject biases** or **participant biases**.
- The **Hawthorne effect** is when a person's behaviour changes as a result of being observed.
- In most psychological research, the participants are aware that they are being observed. This presents a different form of problem. Participants may respond in ways that increase the chances that they will be viewed favourably by the

experimenter and/or other participants, a tendency known as **social desirability/socially desirable responding**.

- This type of bias is particularly relevant when the study involves an interview in which the researcher has face-to-face contact with the volunteers. In these situations, the participants can look for feedback and then adapt their responses to be consistent with what they think is expected of them. The potential biasing effects of social desirability show us a challenge faced by many psychologists: the need to limit the effect that they have on the results of their own study so that the results are due to the variables being studied rather than to the participants responding to cues from the researcher. This challenge is not as simple as it appears. As a result, many researchers now collect data using computers; this allows the participants to respond with relative anonymity, thereby reducing the desire to appear likeable.
- The demand effect that we know the most about is the **placebo effect**, a measurable and experienced improvement in health or behaviour that cannot be attributable to a medication or treatment. It usually comes from drug studies.
- **Working the Scientific Literacy Model Demand Characteristics and Participant Behaviour:**
- Results of psychological studies should provide uncontaminated views of behaviour. In reality, however, people who participate in psychological studies typically enter the research environment with a curiosity about the subject of the study. Researchers need to withhold as much detail as possible,while still being ethical, to get the best, least biased results possible.
- When studying human behaviour, a major concern is **demand characteristics**, inadvertent cues given off by the experimenter or the experimental context that provide information about how participants are expected to behave.
- This issue of bias in research is very difficult to overcome. Very few researchers intentionally manipulate their participants, but many times these influences are subtle and accidental.
- In most cases, experimenters complete rigorous training and follow careful scripts when explaining experimental procedures to participants. These precautions help reduce experimenter effects.
- Additionally, many studies include interviews or questionnaires at the end of the study asking participants what they thought the experiment was about. This information can then be used by the experimenters to determine if the data from that participant are due to the experimental manipulation or to demand characteristics.
- One way to evaluate whether participants' expectations are influencing the results is to create an additional manipulation in which the researchers give different groups of participants different expectations of the results. If the groups then differ when performing the same task, then some form of demand characteristic, in this case from the participant, might be influencing performance. Of course, it is not always practical to include an additional group in a study, and, when doing clinical research, manipulating expectations might not be ethical.

But when researchers begin performing research on new topics or with new research methods, testing for demand characteristics would be a wise decision.

- Demand characteristics and other sources of bias all have the potential to compromise research studies. Given the time, energy, and monetary cost of conducting research, it is critical that results are as free from contamination as possible.
- Furthermore, the science of psychology involves the study of a number of very sensitive topics and the results are often used to help policymakers make better-informed decisions. Producing biased results will therefore have negative effects upon society as a whole.
- Demand effects are particularly problematic when studying clinical populations or when performing experiments with different types of clinical treatments. The results of these studies affect what we know about different patient populations and how we can help them recover from their different conditions. Biased results could therefore affect the health care of vulnerable members of our society.
- **Techniques That Reduce Bias:**
- One of the best techniques for reducing subject bias is to provide anonymity and confidentiality to the volunteers. Ensuring anonymity and confidentiality are important steps toward gathering honest responses from research participants. Participants are much more likely to provide information about sensitive issues like their sexual history, drug use, or emotional state if they can do so confidentially and anonymously.
- **Anonymity** means that each individual's responses are recorded without any name or other personal information that could link a particular individual to specific results.
- **Confidentiality** means that the results will be seen only by the researcher.
- Another source of bias in psychological research involves participants' expectations of the effects of a treatment or manipulation. We saw this tendency in the discussion of the placebo effect earlier. The critical element of the placebo effect is that the participants believe the pill or liquid they are consuming is actually a drug. If they knew that they were receiving a sugar pill instead of a pain medication, they would not experience any pain relief. Therefore, it is important that experiments involving drugs utilize what are known as **blind procedures**.
- In a **single-blind study**, the participants do not know the true purpose of the study, or else do not know which type of treatment they are receiving. However, the researcher might unintentionally introduce bias. To solve this issue, researchers often use a technique known as a **double-blind study**, a study in which neither the participant nor the experimenter knows the exact treatment for any individual.
- **Sharing The Results:**
- Psychology's primary mode of communication is through academic journals. However, only a fraction of the journal articles that are written eventually get published. Rather, before research findings can be published, they must go through **peer review**, a process in which papers submitted for publication in scholarly journals are read and critiqued by experts in the specific field of study.

- In the field of psychology, peer review involves two main tasks. First, an editor receives the manuscript from the researcher and determines whether it is appropriate subject matter for the journal. Second, the editor sends copies of the manuscript to a select group of peer reviewers. These reviewers critique the methods and results of the research and make recommendations to the editor regarding the merits of the research.
- **Replication:**
- **Replication** is the process of repeating a study and finding a similar outcome each time. As long as an experiment uses sufficiently objective measurements and techniques, and if the original hypothesis was correct, then similar results should be achieved by later researchers who perform the same types of studies.
- **Five Characteristics of Poor Research:**
- Poor evidence comes most often in one of five varieties: untestable hypotheses, anecdotes, a biased selection of available data, appeals to authority, and appeals to common sense.
- Perhaps the most important characteristic of science is that its hypotheses are testable. For a hypothesis to be testable, it must be **falsifiable**, meaning that the hypothesis is precise enough that it could be proven false.
- A second characteristic of poor research is the use of **anecdotal evidence**, an individual's story or testimony about an observation or event that is used to make a claim as evidence.
- A third characteristic of poor research is the **biased selection of data**. We still need to be careful even if a scientific claim is backed up by published data. It is possible that some individuals, particularly politicians and corporations, might present only the data that support their views.
- The fourth kind of questionable evidence is the **appeal to authority**, the belief in an "expert's" claim even when no supporting data or scientific evidence is present. Expertise is not actually evidence; "expert" describes the person making the claim, not the claim itself. It is entirely possible that the expert is mistaken, dishonest, or misquoted.
- Finally, the evidence may consist of an **appeal to common sense**, a claim that appears to be sound, but lacks supporting scientific evidence.
- **Section 2.2:**
- Psychologists always begin their research with a research question. In most cases, they also make a prediction about the outcome they expect, the hypothesis. Psychologists then create a **research design**, a set of methods that allows a hypothesis to be tested.
- Research designs influence how investigators:
    1. Organize the stimuli used to test the hypothesis.
    2. Make observations.
    3. Evaluate the results.
- All research designs share the following characteristics:
    1. **Variables**. A variable is a property of an object, organism, event, or something else that can take on different values. How frequently you laugh is a variable that could be measured and analyzed.

2. **Operational definitions**. Operational definitions are the details that define the variables for the purposes of a specific study.
3. **Data**. When scientists collect observations about the variables of interest, the information they record is called data.

- **Descriptive Research:**
- **Descriptive research** describes the characteristics of the phenomenon that is being studied.
- These descriptions can be performed in different ways:
    1. **Qualitative research** involves examining an issue or behaviour without performing numerical measurements of the variables. In psychology, qualitative research often takes the form of interviews in which participants describe their thoughts and feelings about particular events or experiences.
    2. **Quantitative research**, involves the examination of an issue or behaviour by using numerical measurements and/or statistics. The majority of psychological studies are quantitative in nature. These designs can involve complex manipulations, but it is also possible to perform more descriptive studies using numbers.
- To answer the research questions, researchers usually gather data using one or more of the following designs:
    1. Case studies
    2. Naturalistic observation
    3. Surveys and questionnaires
- **Case Studies:**
- A **case study** is an in-depth report about the details of a specific case.
- Rather than developing a hypothesis and then objectively testing it on a number of different individuals, scientists performing a case study describing an individual's history and behaviour in great detail.
- Generally reserved for individuals who have a very uncommon characteristic or have lived through a very unusual experience.
- **Naturalistic observation:**
- **Naturalistic observations** are observations that unobtrusively observe and record behaviour as it occurs in the subject's natural environment.
- **Surveys and questionnaires:**
- Another common method of descriptive research used by psychologists is **self-reporting**, a method in which responses are provided directly by the people who are being studied, typically through face-to-face interviews, phone surveys, paper and pencil tests, and web-based questionnaires.
- The creation of objective survey and questionnaire items is extremely challenging. Care must be taken not to create biased questions that could affect the results one way or another.
- Researchers can determine if their questions are valid in multiple ways:
    1. For clinical questionnaires, the researchers can compare the results to a participant's clinical diagnosis.

2. For questionnaires examining other phenomena, researchers perform a large amount of pretesting in order to calculate norms or average patterns of data.

- **Correlational Research:**
- **Correlational research** involves measuring the degree of association between two or more variables.
- Correlations can be visualized when presented in a graph called a scatterplot.
- Two main characteristics that describe correlations are:
    1. **Direction**: The pattern of the data points on the scatterplot will vary based on the relationship between the variables. If correlations are **positive**, it means that the two variables change values in the same direction. If correlations are **negative**, it means that the two variables change values in the opposite direction.
    2. **Magnitude/strength**: This refers to how closely the changes in one variable are linked to changes in another variable. This magnitude is described in terms of a mathematical measure called the **correlation coefficient**. A correlation coefficient of zero means that there is no relationship between the two variables. Furthermore, 1.0 is the most positive correlation coefficient possible and -1.0 is the most negative correlation coefficient possible. 1.0 and -1.0 coefficients have an equal magnitude or strength, but they have a different direction.
- The correlation coefficient is a measure of association only. It is not a measure of causality. I.e. Correlation does not equal causation.
- The **third variable problem** is the possibility that a third, unmeasured variable is actually responsible for a well-established correlation between two variables.
- **Illusory correlations** are relationships that really exist only in the mind, rather than in reality.
- **Experimental Research:**
- Experimental designs improve on descriptive and correlational studies because they are the only designs that can provide strong evidence for cause-and-effect relationships.
- There are two key differences between correlational research and experiments:
    1. The random assignment of the participants.
    2. The experimenter's control over the variables being studied.
- **The Experimental Method:**
- A critical element of experiments is **random assignment**, a technique for dividing samples into two or more groups in which participants are equally likely to be placed in any condition of the experiment.
- Random assignment allows us to assume the two groups will be roughly equal.
- A **confound variable** is a variable outside of the researcher's control that might affect or provide an alternative explanation for the results.
- Randomly assigning participants to the different experimental conditions also allows the researcher to assume that other sources of variability such as mood and personality are evenly spread across the different conditions. This allows you

to infer that any differences between the two groups are because of the variable you are testing.

- The **independent variable** is the variable that the experimenter manipulates to distinguish between two or more groups. The participants cannot alter these variables, as they are controlled by the researcher.
- The **dependent variable** is the observation or measurement that is recorded during the experiment and subsequently compared across all groups. The levels of this variable are dependent upon the participants' responses or performance.
- A **between-subjects design** is an experimental design in which we compare the performance of participants who are in different groups. One of these groups is the **experimental group** which is the group in the experiment that receives a treatment or the stimuli targeting a specific behaviour. The experimental group always receives the treatment. The other group is the **control group** which is the group that does not receive the treatment or stimuli targeting a specific behaviour. This group serves as a baseline to which the experimental group is compared.
- A between-subjects design allows the researcher to examine differences between groups, but what if the two groups were different from each other simply by chance? In order to reduce this possibility, researchers often use **within-subjects designs**, an experimental design in which the same participants respond to all types of stimuli or experience all experimental conditions.
- **The Quasi-Experimental Method:**
- Random assignment and manipulation of a variable are required for experiments. They allow researchers to make the case that differences between the groups originate from the independent variable. In some cases, though, random assignment is not possible.
- **Quasi-experimental research** is a research technique in which the two or more groups that are compared are selected based on predetermined characteristics, rather than random assignment.
- Quasi-experiments can point out relationships among pre-existing groups, but they cannot determine what it is about those groups that lead to the differences.
- **Converging Operations:**
- When a theory's predictions hold up to dozens of tests using a variety of designs, a perspective known as **converging operations**, we can be much more confident of its accuracy, and are one step closer to understanding the many mysteries of human and animal behaviour.

Method	**Strengths**	**Limitations**
Case studies	Yields detailed information, often of rare conditions or observations	Focus on a single subject limits generalizability
Naturalistic observation	Allows for detailed descriptions of subjects in environments where behaviour normally occurs	Poor control over possibly influential variables

Surveys and questionnaires	Quick and often convenient way of gathering large quantities of self-report data	Poor control; participants may not answer honestly, written responses may not be truly representative of actual behaviour
Correlational study	Shows strength of relationships between variables	Does not allow researchers to determine cause-and-effect relationships
Experiment	Tests for cause-and-effect relationships; offers good control over influential variables	Risk of being artificial with limited generalization to real-world situations

- **Section 2.3:**
- **Promoting the Welfare of Research Participants:**
- In Canada, all institutions that engage in research with humans, including colleges and universities, are required to have a **research ethics board (REB)**, a committee of researchers and officials at an institution charged with the protection of human research participants.
- REBs help ensure that researchers abide by the ethical rules set out in the **Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (2nd edition)**, a set of requirements created by the Government of Canada's Panel of Research Ethics.
- The REBs are intended to protect individuals in two main ways:
    1. The committee weighs potential risks to the volunteers against the possible benefits of the research.
    2. It requires that volunteers agree to participate in the research.
- **Weighing the Risks and Benefits of Research:**
- Some examples of measures that involve possible cognitive and emotional stress are:
    1. **Mortality salience.** In this situation, participants are made more aware of death, which can be done in a number of ways. For example, participants may be asked to read or write about what happens to a human body after death.
    2. **Writing about upsetting or traumatic experiences.**
- Another source of risk is related to the fact that some studies ask participants to provide the experimenter with sensitive and/or personal information. Disclosing this information is a potential threat to a person's reputation, friends, and family. Psychologists must find ways to minimize these risks so that participants do not suffer any unintended consequences of participating in psychological research.
- Indeed, everyone involved in the research process, the researcher, the REB, and the potential volunteer, must determine whether the study's inherent risks are worth what can potentially be learned if the research goes forward.
- Today, it is mandatory that research participants be informed of any risks to which they may be exposed and willfully volunteer to take part in a study.

- **Obtaining Informed Consent:**
- Before any experimental procedures begin, all participants must provide **informed consent**: A potential volunteer must be informed and give consent without pressure.
- To be truly informed about the study, volunteers should be told, at minimum, the following details:
    1. The topic of the study.
    2. The nature of any stimuli to which they will be exposed.
    3. The nature of any tasks they will complete.
    4. The approximate duration of the study.
    5. Any potential physical, psychological, or social risks involved
    6. The steps that the researchers have taken to minimize those risks.
- Sometimes, researchers use **deception**, misleading or only partially informing participants of the true topic or hypothesis under investigation. In psychological research, this typically amounts to a white lie of sorts. The participants are given enough information to evaluate their own risks.
- In medical research situations, deception can be much more serious.
- Importantly, in both cases, the deception is only short-term. Once the experiment is over, the participants are informed of the true nature of the study and why deception was necessary. Additionally, if a treatment was found to be effective for the experimental group, it will often be made available to participants in the control group at the end of the experiment.
- Once participants are informed, they must also be able to give consent.
- Modern psychological research includes the following elements in determining whether full consent is given:
    1. **Freedom to choose.** Individuals should not be at risk for financial loss, physical harm, or damage to their reputation if they choose not to participate.
    2. **Equal opportunities.** Volunteers should have choices.
    3. **The right to withdraw.** Volunteers should have the right to withdraw from the study, at any time, without penalty. The right to give informed consent stays with the participants throughout the entire study.
    4. **The right to withhold responses.** Volunteers responding to surveys or interviews should not have to answer any question that they feel uncomfortable answering.
- Usually, these criteria are sufficient for ensuring full consent. Sometimes, psychologists are interested in participants who cannot give their consent that easily. In this case, a parent or next-of-kin must give consent on behalf of the participant. All the rules of informed consent still apply.
- After participating in the research study, participants must undergo a full **debriefing**, which means that the researchers should explain the true nature of the study, and especially the nature of and reason for any deception.
- **The Right to Anonymity and Confidentiality:**
- **Anonymity** means that the data collected during a research study cannot be connected to individual participants.

- **Confidentiality** includes at least two parts:
    1. Researchers cannot share specific data or observations that can be connected with an individual.
    2. All records must be kept secure so that identities cannot be revealed unintentionally.
- **REBS for Animal-Based Research:**
- Three main areas of ethical treatment are emphasized by researchers and animal welfare committees:
    1. Basic care of laboratory animals. This means providing appropriate housing, feeding, and sanitation for the species.
    2. Minimization of any pain or discomfort experienced by the animals.
    3. Although it is rare for a study to require discomfort, when it is necessary, the researchers must ensure that the pain can be justified by the potential benefits of the research.
- The same standards apply if animals are to be sacrificed for the research.
- **Ethical Collection, Storage, and Reporting of Data:**
- Once data are reported in a journal or at a conference, they should be kept for a reasonable amount of time, generally, three to five years is acceptable. The purpose of keeping data for a lengthy period relates to the public nature of good research. Other researchers may request access to the data to reinterpret it, or perhaps examine the data before attempting to replicate the findings.
- While it might seem as though the confidentiality requirement conflicts with the need to make data public, but this is not necessarily true. For example, if the data are anonymous, then none of the participants will be affected if and when the data are shared.
- In addition to keeping data safe, scientists must be honest with their data. Unfortunately, cases of **scientific misconduct** sometimes arise when individuals fabricate or manipulate their data to fit their desired results. The chances of fraudulent data being published can also be decreased by requiring researchers to acknowledge any potential conflicts of interest.
- **Section 2.4:**
- **Descriptive Statistics:**
- **Descriptive statistics** are a set of techniques used to organize, summarize, and interpret data.
- In most research, the statistics used to describe and understand the data are of three types: frequency, central tendency, and variability.
- **Frequency:**
- The **frequency** is the number of observations that fall within a certain category or range of scores
- A **histogram** is a type of bar graph. The vertical axis of histograms shows the frequency.
- A **normal distribution/bell curve** is a symmetrical distribution with values clustered around a central, mean value.
- A **negatively skewed distribution** is a distribution in which the curve has an extended tail to the left of the cluster.

- A **positively skewed distribution** is a distribution in which the long tail is on the right of the cluster.
- **Central Tendency:**
- The **central tendency** is a measure of the central point of a distribution.
- There are three different measures of central tendency used in psychology:
    1. The **mean** is the arithmetic average of a set of numbers.
    2. The **median** is the 50th percentile. The point on the horizontal axis at which 50% of all observations are lower, and 50% of all observations are higher.
    3. The **mode** is the category with the highest frequency.
- If the data are normally distributed, researchers generally use the mean, but, if the data is skewed in some way, then researchers need to think about which measure is best.
- The measure used the least is the mode, because it provides less information than the mean or the median. The mode is typically only used when dealing with categories of data.
- When the data is not a perfectly symmetrical curve, the mean, median, and mode will produce different values. If the histogram spreads out in one direction, we are usually better off calculating central tendency by using the median, because extreme values will have a large effect on the mean, but not the median.
- **Variability:**
- **Variability** is the degree to which scores are dispersed in a distribution.
- High variability means that there are a larger number of cases that are closer to the extreme ends of the continuum for that set of data.
- Low variability means that most of the scores are similar.
- Variability can be caused by measurement errors, imperfect measurement tools, differences between participants in the study, or characteristics of participants on that given day.
- All data sets have some variability, but, if information about variability is not provided by the researcher, it is impossible to understand how well the measure of central tendency reflects the entire data set. Therefore, whenever psychologists report data from their research, their measures of central tendency are almost always accompanied by measures of variability.
- The **standard deviation** is a measure of variability around the mean.
  I.e. The standard deviation is the average distance from the mean.
- A large standard deviation would indicate that there is a lot of variability in the data and that the values are quite spread out from the mean. A small standard deviation would indicate the opposite.
- Step 1 of statistics is creating a graph and reporting two numbers, the measure of central tendency and standard deviation, so that you can provide a summary of your data that almost anyone can understand.
  Step 2 uses these measures to test whether or not your hypothesis is supported by your data.

- **Hypothesis Testing Evaluating the Outcome of a Study:**
- A **hypothesis test** is a statistical method of evaluating whether differences among groups are meaningful, or could have been arrived at by chance alone.
- If the means differ between groups and there is little overlap in the distribution of scores, the groups are much more likely to be significantly different. If the means differ between groups, but there is much overlap between the distributions of scores, it is unlikely that these two groups would be significantly different.
- **Working the Scientific Literacy Model Statistical Significance:**
- **Statistical significance** is a concept that implies that the means of the groups are farther apart than you would expect them to be by random chance alone. It was first proposed in 1925 by Ronald Fisher.
- Statistical significance testing is based on the researcher making two hypotheses, the **null hypothesis** and the **experimental hypothesis**.
- The **null hypothesis** assumes that any differences between groups or conditions are due to chance.
- The **experimental hypothesis** assumes that any differences are due to a variable controlled by the experimenter.
- The goal of researchers is to find differences between groups that are so large that it is virtually impossible for the null hypothesis to be true.
- The probability of the results being due to chance is known as a **p-value**. Lower p-values indicate a decreased likelihood that your results were a fluke, and therefore an increased likelihood that you had a great idea and designed a good experiment.
- When Fisher first presented the idea of significance testing, he noted that scientists needed to establish a fairly conservative threshold for rejecting the null hypothesis. He correctly thought that if it were quite easy for researchers to find a significant result, it would increase the likelihood that results labelled as being significant were actually due to chance. If enough of these false positives occurred, then the entire idea of significance would soon become meaningless. Fisher therefore recommended that researchers use $p < 0.05$ as the cut-off point. If a p-value were less than 0.05, then there was less than a 5% chance that the results were due to chance. This p-value quickly became the standard in a number of fields, including psychology.
- There are at least two concerns related to significance testing:
    1. The first is the problem of multiple comparisons. If a fluke result can occur approximately 5% of the time, the more tests you perform for your experiment, the greater the likelihood that one of them is due to chance. In order to cope with this problem, researchers generally use a stricter acceptable p-value; as the number of comparisons increases, researchers decrease the p-value. This makes it more difficult to produce significant results, but does help ensure that the results are not due to chance.
    2. A second problem is the fact that as you increase the number of participants in your study, it becomes easier to find significant effects. If you sample thousands of people extremely small differences will still be statistically significant.

- As an alternative to significance testing, Jacob Cohen developed a technique known as **power analysis**, whose goal is to calculate **effect sizes**. Rather than saying that a difference is significant, which is essentially a yes or no decision, effect sizes tell the researcher whether the difference is statistically small or large. So, instead of an experiment supporting or disproving a theory, effect sizes allow the researcher to adjust how much they believe that their hypothesis is true.

Definitions:

- **Anecdotal evidence:** An individual's story or testimony about an observation or event that is used to make a claim as evidence.
- **Appeal to authority:** The belief in an "expert's" claim even when no supporting data or scientific evidence is present.
- **Appeal to common sense:** A claim that appears to be sound, but lacks supporting scientific evidence.
- **Between-subjects design:** An experimental design in which we compare the performance of participants who are in different groups.
- **Case study:** An in-depth report about the details of a specific case.
- **Central tendency:** A measure of the central point of a distribution.
- **Confounding variable:** A variable outside of the researcher's control that might affect or provide an alternative explanation for the results.
- **Control group:** The group that does not receive the treatment or stimuli targeting a specific behaviour; this group therefore serves as a baseline to which the experimental group is compared.
- **Convenience samples:** Samples of individuals who are the most readily available.
- **Correlational research:** Involves measuring the degree of association between two or more variables.
- **Debriefing:** When researchers explain the true nature of the study, and especially the nature of and reason for any deception.
- **Deception:** Misleading or only partially informing participants of the true topic or hypothesis under investigation.
- **Demand characteristics:** Inadvertent cues given off by the experimenter or the experimental context that provide information about how participants are expected to behave.
- **Dependent variable:** The observation or measurement that is recorded during the experiment and subsequently compared across all groups.
- **Descriptive statistics:** A set of techniques used to organize, summarize, and interpret data.
- **Double-blind study:** A study in which neither the participant nor the experimenter knows the exact treatment for any individual.
- **Ecological validity:** The results of a laboratory study can be applied to or repeated in the natural environment.
- **Experimental group:** The group in the experiment that receives a treatment or the stimuli targeting a specific behaviour.

- **Experimental hypothesis:** Assumes that any differences are due to a variable controlled by the experimenter.
- **Falsifiable:** The hypothesis is precise enough that it could be proven false.
- **Frequency:** The number of observations that fall within a certain category or range of scores.
- **Generalizability:** The degree to which one set of results can be applied to other situations, individuals, or events.
- **Hawthorne effect:** Behaviour change that occurs as a result of being observed.
- **Hypothesis test:** A statistical method of evaluating whether differences among groups are meaningful, or could have been arrived at by chance alone.
- **Illusory correlations:** Relationships that really exist only in the mind, rather than in reality.
- **Independent variable:** The variable that the experimenter manipulates to distinguish between two or more groups.
- **Informed consent:** A potential volunteer must be informed (know the purpose, tasks, and risks involved in the study) and give consent (agree to participate based on the information provided) without pressure.
- **Mean:** The arithmetic average of a set of numbers.
- **Median:** The 50th percentile—the point on the horizontal axis at which 50% of all observations are lower, and 50% of all observations are higher.
- **Mode:** The category with the highest frequency (that is, the category with the most observations).
- **Naturalistic observations:** Observations that unobtrusively observe and record behaviour as it occurs in the subject's natural environment.
- **Negatively skewed distribution:** A distribution in which the curve has an extended tail to the left of the cluster.
- **Normal distribution:** A symmetrical distribution with values clustered around a central, mean value.
- **Null hypothesis:** Assumes that any differences between groups (or conditions) are due to chance.
- **Objective measurements:** The measure of an entity or behaviour that, within an allowed margin of error, is consistent across instruments and observers.
- **Operational definitions:** Statements that describe the procedures or operations and specific measures that are used to record observations.
- **Peer review:** A process in which papers submitted for publication in scholarly journals are read and critiqued by experts in the specific field of study.
- **Placebo effect:** A measurable and experienced improvement in health or behaviour that cannot be attributable to a medication or treatment.
- **Population:** The group that researchers want to generalize about.
- **Positively skewed distribution:** A distribution in which the long tail is on the right of the cluster.
- **Qualitative research:** Examining an issue or behaviour without performing numerical measurements of the variables.
- **Quantitative research:** Examining an issue or behaviour by using numerical measurements and/or statistics.

- **Quasi-experimental research:** A research technique in which the two or more groups that are compared are selected based on predetermined characteristics, rather than random assignment.
- **Random assignment:** A technique for dividing samples into two or more groups in which participants are equally likely to be placed in any condition of the experiment.
- **Random sample:** A sampling technique in which every individual of a population has an equal chance of being included.
- **Reliability:** Consistent and stable answers across multiple observations and points in time.
- **Replication:** The process of repeating a study and finding a similar outcome each time.
- **Research design:** A set of methods that allows a hypothesis to be tested.
- **Research ethics board (REB):** A committee of researchers and officials at an institution charged with the protection of research participants.
- **Sample:** A select group of population members.
- **Self-reporting:** A method in which responses are provided directly by the people who are being studied, typically through face-to-face interviews, phone surveys, paper and pencil tests, and web-based questionnaires.
- **Single-blind study:** A study in which participants do not know the true purpose of the study, or else do not know which type of treatment they are receiving (for example, a placebo or a drug).
- **Social desirability/Socially desirable responding:** Research participants respond in ways that increase the chances that they will be viewed favourably.
- **Standard deviation:** A measure of variability around the mean.
- **Statistical significance:** The means of the groups are farther apart than you would expect them to be by random chance alone.
- **Third variable problem:** The possibility that a third, unmeasured variable is actually responsible for a well-established correlation between two variables.
- **Within-subjects designs:** An experimental design in which the same participants respond to all types of stimuli or experience all experimental conditions.
- **Validity:** The degree to which an instrument or procedure actually measures what it claims to measure.
- **Variable:** The object, concept, or event being measured.
- **Variability:** The degree to which scores are dispersed in a distribution.

Frequency Tables:

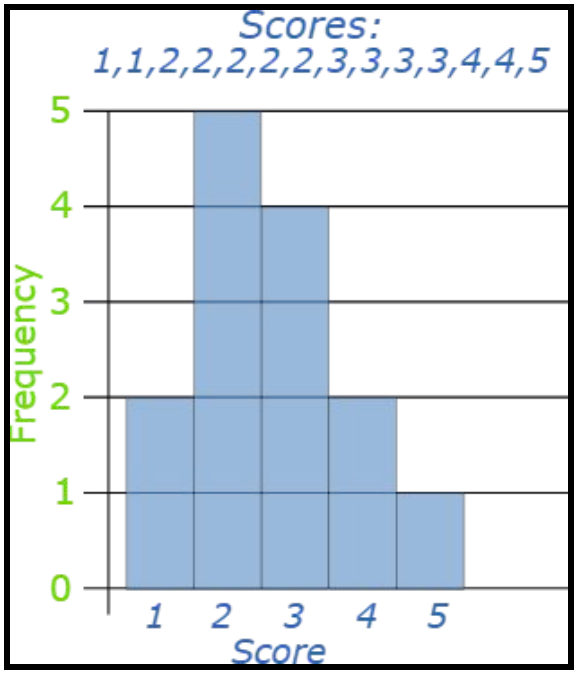
- **Frequency** is a measure of the number of occurrences of a particular score in a given set of data.
- A **frequency table** is a method of organizing raw data in a compact form by displaying a series of scores in ascending or descending order, together with their frequencies, the number of times each score occurs in the respective data set.
- This is an example of a frequency table.

Scores:
1,1,2,2,2,2,2,3,3,3,3,4,4,5

Score	Frequency
1	2
2	5
3	4
4	2
5	1

Histograms:

- A **histogram** is a graphical representation of the distribution of numerical data.
- This is an example of a histogram.



- When we have a histogram, we can see the distribution of data. In that distribution, we're usually looking for 2 things:

1. How spread out is the distribution. (**Variability**)
2. Where's the middle. (**Central tendency**)

Measures of Central Tendency (Mean, Median, Mode):

- **Mean:** The sum of a collection of numbers divided by the count of numbers in the collection. The problem with the mean is that outliers can distort it. It is the most commonly used measure.
- **Median:** The value separating the higher half from the lower half of a data set. It may be thought of as the "middle" value. The median can't be distorted by outliers.
- **Mode:** The value that appears most often in a data set. It is the least commonly used measure.

Measures of Variability (MAD, Variance, Standard Deviations):

- **Chance variation** is the difference between the predicted value of a variable and the actual value of the variable. For a fairly large sample size, these errors are seen to be uniformly distributed above and below the mean and cancel each other out, resulting in an expected value of zero.
- **Mean Absolute Distribution (MAD):** The average of the positive differences of each of the given data and the mean of that data set.
- **Variance:** The average of the squared differences of each of the given data and the mean of that data set.
- **Standard Deviation:** The square root of the variance.

Definitions:

- **Chance variation:** The difference between the predicted value of a variable and the actual value of the variable. For a fairly large sample size, these errors are seen to be uniformly distributed above and below the mean and cancel each other out, resulting in an expected value of zero.
- **Descriptive Statistics:** One of the two main branches of statistics. Descriptive statistics are brief descriptive coefficients that summarize a given data set, which can be either a representation of the entire or a sample of a population. Descriptive statistics are broken down into measures of central tendency and measures of variability.
- **Frequency:** A measure of the number of occurrences of a particular score in a given set of data.
- **Frequency table:** A method of organizing raw data in a compact form by displaying a series of scores in ascending or descending order, together with their frequencies, the number of times each score occurs in the respective data set.
- **Histogram:** A graphical representation of the distribution of numerical data.
- It differs from a bar graph, in the sense that a bar graph relates two variables, but a histogram relates only one.
- **Inferential Statistics:** One of the two main branches of statistics.
- Inferential statistics use a random sample of data taken from a population to describe and make inferences about the population. Inferential statistics are valuable when examination of each member of an entire population is not convenient or possible.

- **Mean:** The sum of a collection of numbers divided by the count of numbers in the collection. The problem with the mean is that outliers can distort it. It is the most commonly used measure.
- **Mean Absolute Distribution (MAD):** The average of the positive differences of each of the given data and the mean of that data set.
- **Median:** The value separating the higher half from the lower half of a data set. It may be thought of as the "middle" value. The median can’t be distorted by outliers.
- **Mode:** The value that appears most often in a data set. It is the least commonly used measure.
- **Standard Deviation:** The square root of the variance.
- **T-Tests:** A type of inferential statistic used to determine if there is a significant difference between the means of two groups.
- **Variance:** The average of the squared differences of each of the given data and the mean of that data set.

September 25:

- The critical part of the Central Nervous System is the brain. The brain is where a lot of the primary decision making happens. The rest of the nervous system connects the brain to the rest of the body.
- We have brain-like tissue in our spine and that brain-like tissue can make very simple decisions, like reflexive behaviour.
- The Peripheral Nervous System is the nerve fibres that connect the brain to the rest of the body.
- Your body has 2 modes, one for when it's under threat and one for when there's no threat. When our body is under threat, we go into **fight or flight mode**. When our body is not under threat, we go into **long-term survival mode**.
- Both parts of the autonomic nervous system, the sympathetic and parasympathetic nervous systems work involuntarily. Sympathetic is responsible for the response commonly referred to as "fight or flight," while parasympathetic is referred to as "rest and digest." Both originate in the spinal cord and branch out from there. You cannot have both systems simultaneously active. The action of one inhibits the action of the other.
- The **sympathetic nervous system** is the part of the autonomic nervous system that prepares the body to react to stresses such as threat or injury. It causes muscles to contract and heart rate to increase.
  In addition to the diagram above, when the sympathetic nervous system is on, blood drains from our frontal lobes.
- The **parasympathetic nervous system** is the part of the autonomic nervous system that controls functions of the body at rest. It helps maintain homeostasis in the body. It causes muscles to relax and heart rate to decrease.
- Since you can't have both the sympathetic nervous system and the parasympathetic nervous system on at the same time, if you're feeling stressed or anxious, instead of trying not to be nervous, try to turn on the parasympathetic system.
- While the sympathetic nervous system is usually worried about the present, it also wants to make sure that you're not in this situation in the future. We have a part of our brain, called the **amygdala**, which is responsible for emotions, survival instincts, and memory. It kicks in the sympathetic system and sends signals to the hippocampus when it senses danger. The hippocampus stores the memory. When the amygdala sends signals to the hippocampus, it is telling the hippocampus to remember anything associated with the threat/danger, so the next time you encounter those same things, the amygdala will kick in right away.
- The amygdala sending signals to the hippocampus is a reason why people get PTSD. To help overcome PTSD, doctors/psychiatrists will sometimes give patients **beta blockers**, pills that prevent your sympathetic systems from engaging, to help calm them down and then get them to talk about their experience. If you allow someone to relive traumatic experiences on beta blockers enough times, they'll start to form a memory of that experience that won't trigger their PTSD.

September 27:

- The **cerebral cortex** is the place where high level perception of the world occurs, and is also the place where controlled motor activities originate. This contrasts with a number of more basic brain regions (the **midbrain parts**) which are more devoted to monitoring and controlling internal behaviours and automatic responses to external stimuli. The midbrain parts are very old and primitive.
- Humans are the most complex animals. While most animals only have the midbrain parts, humans also have the cerebral cortex.
- The **primary cortex** deals with direct sensory or motor connections. It deals with raw input. The primary cortex is towards the center of the lobes.
- The **association cortex** deals with memory, analyzation of the input and understanding what the input is. Some of the things the association cortex does include recognition of shape, form, textures of objects, awareness of body image, and relationships of body parts to each other and their location. The association cortex is around the border of the lobes.
- The 4 lobes of the cortex are:
    1. **Frontal Lobe:** The parietal, occipital and temporal lobes are primarily responsible for getting information and that information goes to the frontal lobe. The frontal lobe combines that information with our memory and goals and guide our actions. As a result, the frontal lobe is mostly about output and behaving in the world.
    2. **Parietal Lobe:** The left parietal appears to keep track of the spatial location of our body parts, **proprioception**. The primary sensory function involves perception of the body. Damage is often associated with poor motor movements. The right parietal appears to keep track of the spatial location of things in our external world. Damage can lead to problems of neglect and spatial integration of parts. The association cortex is involved in complex spatial functions that differ across the hemispheres.
    3. **Occipital Lobe:** The occipital and lower part of the temporal lobes are responsible for vision. The primary visual cortex is directly related to sight, and damage to it produces a hole in a person's visual field, a **scotoma**. An interesting fact about people with scotomas is that even though they can't see that part, they can usually guess it correctly. The association visual cortex in this area performs the function of providing an interface between visual input and memory. Damage to this part can lead to **agnosia**, the inability to name common objects. This lobe is the furthest away from the eyes.
    4. **Temporal Lobe:** Most of the temporal lobe is responsible for audition. The primary auditory cortex is mostly hidden from view, lying on the inside to the upper temporal lobe. Damage to this leads to hearing problems. The association auditory cortex is located on the lateral surface of the upper temporal lobe. Damage to left leads to severe language deficits. **Broca's area** is responsible for production of speech.

Wernicke's area is responsible for the comprehension of speech. Damage to the right affects the patient's ability to properly perceive non-speech sounds, like the rhythm in music.

- **Contralateral organization** is the property that the left side of the brain relates to the right side of the body and vice versa for many functions.
- **Lateralization of function** refers to the notion that the brain is composed of separate hemispheres creating left and right sides of all cortical tissue, and sometimes the left and right have different priorities.
- In between the 2 hemispheres of the brain is the **corpus callosum**. It connects the two hemispheres of the brain using a bundle of neuronal fibers that allows the two hemispheres to talk to one another.
- A lot of what we know about the brain came from **neuropsychology**, the study and characterization of the behavioral modifications that follow a neurological trauma or condition.

September 30:

- A **frontal lobotomy** is a surgical procedure that severs, sometimes completely, the frontal lobe from the rest of the brain.
- Before modern medicine, when a person was violent and aggressive because of a disease or condition, doctors would perform a frontal lobotomy to calm the person down. However, after the surgery, the person would be a zombie. They also used to restrain patients by tying them down. Nowadays, drugs are used to calm the patients.
- Lobotomies started in 1935 by António Egas Moniz. He won a nobel prize in 1949. Lobotomies are now considered one of medicine's biggest mistakes. Many people now regret awarding Moniz with a nobel prize.
- The premotor cortex controls complex movements, like reaching or grasping with the hands. It also helps control posture. In the spinal cord, signals from the premotor cortex combine with signals from primary motor cortex to create unified and intentional motions. The premotor cortex also plays a role in decision making, similar to the prefrontal cortex. It is the primary cortex of the frontal lobe.
- The pre-frontal cortex is responsible for:
    - Planning complex cognitive behavior
    - Personality expression
    - Decision making
    - Moderating social behaviour
    - Pushing us to do new things
- Damage to the pre-frontal cortex causes:
    - The slowing of thoughts and loss of spontaneity
    - Perseveration errors
    - Loss of self-awareness and flat affect, especially empathy
    - Deficiencies in foresight and planning
    - Tendency to confabulate
- The **limbic system** is a large group of brain structure responsible for motivation, emotion, learning and memory. Structures in the limbic system include the **olfactory bulb** (smell), **hippocampus** (memory), **amygdala** (fear and reward),

hypothalamus (hormones and sleep), **basal ganglia** (motivation and voluntary movement), and **cingulate gyrus** (gateway to the limbic system from the cerebral cortex).

- The sensory strip is a part of the brain located in the parietal lobe, near the border of the frontal lobe. The sensory strip is involved in registering sensation that are connected to specific body parts or body functions. The sensory strip is the primary cortex of the parietal lobe.
- Motor strips, which are located in the frontal lobe is what controls all muscle movement including the ones that are necessary for speech.
- The amount of brain tissue tells you how sensitive that area is. The more brain tissue there is, the more sensitive the area is and vice versa.
- **Phantom limb pain** refers to ongoing painful sensations that seem to be coming from the part of the limb that is no longer there.

Textbook:

- **Section 3.1:**
- **The Genetic Code:**
- **Genes** are the basic units of heredity. Genes are responsible for guiding the process of creating the proteins that make up our physical structures and regulate development and physiological processes throughout the lifespan.
- Genes are composed of segments of **DNA (deoxyribonucleic acid)**, a molecule formed in a double-helix shape that contains four nucleotides: adenine, cytosine, guanine, and thymine. These nucleotides are typically abbreviated using the first letter of their names, A, C, G, and T. Each gene is a unique combination of these four nucleotides.
- These genes represent the instructions used to create the thousands of different proteins found in the human body. These proteins specify which types of molecules to produce and when to produce them. Genes also contain information about which environmental factors might influence whether the genes become active or not. Together, this information makes up an individual's **genotype**, the genetic makeup of an organism. The result is an organism's **phenotype**, the physical traits and behavioural characteristics that show genetic variation, such as eye colour, the shape and size of facial features, intelligence, and even personality. This phenotype develops because of differences in the nucleotide sequencing of A, C, G, and T as well as through interactions with the environment.
- Genes are organized in pairs along **chromosomes**, structures in the cellular nucleus that are lined with all of the genes an individual inherits. Humans have approximately 20 000–25 000 genes distributed across 23 pairs of chromosomes, half contributed by the mother and half by the father. Sometimes, an extra chromosome, a trisomy, is present, thus altering the genetic make-up as well as the phenotype of the individual. The most common chromosomal abnormality is Down Syndrome, a trisomy on the 21st chromosome.
- Human DNA is aligned along 23 paired chromosomes. Numbers 1–22 are common to both males and females. Chromosome 23 is sex linked, with males having the XY pattern and females the XX pattern.

- If two corresponding genes at a given location on a pair of chromosomes are the same, they are **homozygous**. If the two genes differ, they are **heterozygous**.
- Whether a trait is expressed depends on which combination of pairs is inherited. E.g. Researchers have shown that the ability to taste a very bitter substance called phenylthiocarbamide (PTC) is based on which combination of genes we inherit from either parent. The test for whether you can taste PTC is typically performed by placing a small tab of paper soaked in the substance on the tongue. Those who report tasting PTC are either homozygous dominant (TT) or heterozygous dominant (Tt). Non-tasters are homozygous recessive (tt).
- **Behavioural Genomics The Molecular Approach:**
- **Behavioural genomics** is the study of DNA and the ways in which specific genes are related to behaviour.
- The **Human Genome Project** resulted in the identification of approximately 20 000–25 000 genes. While the Human Genome Project did not directly provide a cure for a disease or an understanding of any particular behaviour, it has led to an abundance of new techniques and information about where genes are located, and it opened the door for an entirely new era of research.
- However, we must be cautious in our interpretation of such discoveries. Like any approach to answering scientific questions, behavioural genomic research does have its limitations. For example, although a single gene has been identified as a risk factor for Alzheimer's disease, not everyone who inherits it develops the disease.
- **Behavioural Genetics Twin and Adoption Studies:**
- **Behavioural genetics** is the study of how genes and the environment influence behaviour. Behavioural genetic methods applied to humans typically involve comparing people of different levels of relatedness and measuring resemblances for a specific trait of interest. The group that has provided the most insight into the genetic effects on behaviour is twins.
- **Monozygotic twins/Identical twins** come from a single egg, which makes them genetically identical (almost 100% genetic similarity).
- **Dizygotic twins/Fraternal twins** come from two separate eggs fertilized by two different sperm cells that share the same womb. These twins have approximately 50% of their genetics in common.
- Researchers have also examined these different groups in **longitudinal studies**, studies that follow the same individuals for many years, often decades.
- Behavioural geneticists use twin studies to calculate **heritability**, a statistic, expressed as a number between zero and one, that represents the degree to which genetic differences between individuals contribute to individual differences in a behaviour or trait found in a population. A heritability of 0 means that genes do not contribute to individual differences in a trait, whereas a heritability of 1 indicates that genes account for all individual differences in a trait.
- Heritability scores fall between 0 and 1, inclusively. However, heritability estimates are rarely ever 0 or 1. Instead, genetics and environmental factors both account for some of the differences in our behaviour.
- Heritability estimates for behaviours change as we age.

- In a **family study**, researchers would measure individuals from a large number of families on some particular behavioural trait of interest. The researchers would then correlate the scores on the trait between family members. Higher correlations between more genetically similar relatives (family members who are closely related and share many genes) versus less genetically similar relatives provide some evidence that the trait is influenced by genes.
- In an **adoption study**, researchers track the presence or absence of traits in adopted children as well as their biological and adoptive parents. If there's a higher correlation for a trait between the adopted children and their biological parents, it suggests a genetic contribution to that trait. If there's a higher correlation for a trait between adopted children and their adoptive parents, then environmental factors may play a more significant role for that trait than genetics.
- In a **twin study**, researchers compare the frequency of traits in identical twins with the frequency of the same traits in fraternal twins. If two twins share the same trait, they are described as **concordant** for that trait. A **concordance rate** is the percentage of twins in a study who share a particular trait.
- **Gene Expression and Behaviour:**
- The fact that heritability estimates change over time based on our different experiences shows us that nature and nurture interact to produce behaviour.
- Almost every cell in our bodies contains the same genes, but only some of these genes are active. Of the approximately 20 000–25 000 genes in the human genome, between 6000 and 7000 are active in the human brain. These genes influence the development of different brain structures, the production of chemicals that allow brain cells to communicate with each other, and the refinement of connections between cells that allow large-scale brain networks to form. The expression of these genes is influenced by genetics, environmental factors or a combination of the two.
- If some genes fail to be activated properly, people may be at a greater risk for developing brain-related disorders.
- Gene expression is a lifelong process. Factors such as diet, stress level, and sleep can influence whether genes are turned on or off. This study of changes in gene expression that occur as a result of experience and that do not alter the genetic code is known as **epigenetics**.
- **Evolutionary Insights into Human Behaviour:**
- **Natural selection** is the process by which favourable traits become increasingly common in a population of interbreeding individuals, while traits that are unfavourable become less common. This term was developed by Charles Darwin.
- When animals mate, each parent provides half of the offspring's genetic material. The genes of some animals would combine in such a way to produce traits favourable to that setting and the genes of other animals would combine in less useful ways. Because the adaptive animals were more likely to survive and reproduce, these traits and genes would be more likely to be passed onto future generations. This process is known as **evolution**, the change in the frequency of genes occurring in an interbreeding population over generations.

- **Evolutionary Psychology:**
- A modern branch of psychology known as **evolutionary psychology** attempts to explain human behaviours based on the beneficial functions they may have served in our species' development.
- The **hunter-gatherer theory** is a theory that links performance on specific tasks to the different roles performed by males and females over the course of our evolutionary history.
- **Sexual Selection and Evolution:**
- **Intrasexual selection** is when members of the same sex compete in order to win the opportunity to mate with members of the opposite sex. Intrasexual selection is evolutionarily advantageous because the animals most likely to become dominant are the strongest and/or smartest, and therefore the most fit for that time and place. If this trend continues across many generations, the species as a whole will become stronger and smarter.
- **Intersexual selection** is when members of one sex select a mating partner based on their desirable traits.
- **Section 3.2:**
- **The Neuron:**
- The primary purpose of neurons is to receive input from one group of neurons and then to transmit that information to other neurons. Neurons are designed in such a way that there are parts of the cell specialized for receiving incoming information from other neurons and parts of the cell specialized for transmitting information to other neurons.
- All neurons have a **cell body/soma**, the part of a neuron that contains the nucleus that houses the cell's genetic material. Genes in the cell body synthesize proteins that form the chemicals and structures that allow the neuron to function. The activity of these genes can be influenced by the input coming from other cells. This input is received by **dendrites**, small branches radiating from the cell body that receive messages from other cells and transmit those messages toward the rest of the cell. At any given point in time, a neuron will receive input from several other neurons. These impulses from other cells will travel across the neuron to the base of the cell body known as the **axon hillock**. If the axon hillock receives enough stimulation from other neurons, it will initiate a chemical reaction that will flow down the rest of the neuron. This chemical reaction is the initial step in a neuron communicating with other cells. The activity will travel from the axon hillock along the **axon**. The **axon** transports information in the form of electrochemical reactions from the cell body to the end of the neuron. When the activity reaches the end of the axon, it will arrive at axon terminals, bulb-like extensions filled with vesicles. These vesicles contain **neurotransmitters**, the chemicals that function as messengers allowing neurons to communicate with each other. The impulse travelling down the axon will stimulate the release of these neurotransmitters, thus allowing neural communication to take place.
- Although all neurons are designed to transmit information, not all neurons perform the same function. **Sensory neurons** receive information from the bodily senses and bring it toward the brain, often via the spinal cord. In contrast, **motor**

neurons carry messages away from the brain and spinal cord and toward muscles in order to control their flexion and extension.

- For decades, neuroscience taught us that nerves do not regenerate. However, in the past 15 years or so, advances in brain science have challenged this belief. Researchers have observed **neurogenesis**, the formation of new neurons, in a limited number of brain regions, particularly in a region critical for learning and memory. The growth of a new cell, including neurons, starts with **stem cells**, a unique type of cell that does not have a predestined function. When a stem cell divides, the resulting cells can become part of just about anything. The deciding factor seems to be the stem cell's chemical environment.
- **Glial Cells:**
- **Glial cells** are specialized cells of the nervous system that are involved in mounting immune responses in the brain, removing waste, and synchronizing the activity of the billions of neurons that constitute the nervous system.
- Glial cells outnumber neurons in the brain by a ratio of approximately 10 to 1.
- A critical function served by certain glial cells is to insulate the axon of a neuron. These glial cells form a white substance called **myelin**, a fatty sheath that insulates axons from one another, resulting in increased speed and efficiency of neural communication. In an unmyelinated axon, the neural impulse decays quickly and needs to be regenerated along the axon; the myelin protects the impulse from this decay, thus reducing how often the impulse needs to be regenerated.
- When the myelin sheath is damaged, the efficiency of the axon decreases substantially. For instance, multiple sclerosis is a disease in which the immune system does not recognize myelin and attacks it, a process that can devastate the structural and functional integrity of the nervous system.
- **The Neuron's Electrical System: Resting and Action Potentials:**
- Neural activity is based on changes in the concentrations of charged atoms called **ions**. When a neuron is not transmitting information, the outside of the neuron has a relatively high concentration of positively charged ions, particularly sodium and potassium, while the interior of the axon has fewer positively charged ions as well as a relatively high concentration of negatively charged chloride ions. This relatively stable state during which the cell is not transmitting messages is known as its **resting potential**.
- The resting state involves a great deal of tension. This is because of two forces, the **electrostatic gradient** and the **concentration gradient**. **Electrostatic gradient** means that the inside and outside of the cell have different charges. **Concentration gradient** means that different types of ions are more densely packed on one side of the membrane than on the other. However, most substances have a tendency to move from areas of high concentration to areas of low concentration whenever possible.
- When a neuron is stimulated, a surge of positive ions into the cell changes the potential of the neuron. These charges flow down the dendrites and cross the cell body to the axon hillock, where the cell body meets the axon. If enough positively charged ions reach the axon hillock to push its charge past that cell's firing

threshold, the neuron will then initiate an **action potential**, a wave of electrical activity that originates at the beginning of the axon near the cell body and rapidly travels down its length. When an action potential occurs, the charge of that part of the axon changes from approximately –70 mV to approximately +35 mV. This change does not occur along the entire axon at once, but rather as one part of the axon becomes depolarized, it forces open the ion channels ahead of it, thus causing the action potential to move down the length of the axon as positively charged ions rush through the membrane pores. This pattern continues until the action potential reaches the axon terminal.

- There are mechanisms in place to help our neurons return to their resting state (–70 mV) so that they can fire again. At each point of the axon, the ion channels slam shut as soon as the action potential occurs. The sodium ions that had rushed into the axon are then rapidly pumped back out of the cell, returning it to a resting state. This process of removing the sodium ions from the cell often causes the neuron to become **hyperpolarized**. This means that the cell is more negative than its normal resting potential. This additional negativity makes the cell less likely to fire. It normally takes 2–3 milliseconds for the membrane to adjust back to its normal resting potential. This brief period in which a neuron cannot fire is known as a **refractory period**.
- When the action potential reaches the axon terminal, it triggers the release of that cell's neurotransmitters into the **synapses**, the microscopically small spaces that separate individual nerve cells. The cell that releases these chemicals is known as the **presynaptic cell** whereas the cell that receives this input is known as the **postsynaptic cell**.
- When stimulated, a given neuron always fires at the same intensity and speed. This activity adheres to the **all-or-none principle**: Individual nerve cells fire at the same strength every time an action potential occurs. The strength of a sensation is determined by the rate at which nerve cells fire as well as by the number of nerve cells that are stimulated. A stimulus is experienced intensely because a greater number of cells are stimulated, and the firing of each cell occurs repeatedly.
- **The Chemical Messengers Neurotransmitters and Hormones:**
- The presynaptic neuron releases neurotransmitters into the synapse and then a fraction of these neurotransmitters will bind to receptors on the postsynaptic neuron. This binding can have one of two effects on the postsynaptic cell.
    1. If the actions of a neurotransmitter cause the neuron's membrane potential to become less negative, it is referred to as **excitatory** because it has increased the probability that an action potential will occur in a given period of time.
    2. If the actions of a neurotransmitter cause the membrane potential to become more negative, it is referred to as **inhibitory** because it has decreased the likelihood that an action potential will occur.
- An important factor in determining whether a postsynaptic neuron is excited or inhibited is the type of neurotransmitter binding with its receptors. Each neurotransmitter typically has its own unique molecular shape. When

neurotransmitters are released at the axon terminal, they cross the synapse and fit in a particular receptor of the dendrite.

- After neurotransmitter molecules have bound to postsynaptic receptors of a neighbouring cell, they are released back into the **synaptic cleft**, the minute space between the axon terminal and the dendrite. This process is almost as important as the action potential itself. Prolonged stimulation of the receptors makes it more difficult for the cell to return to its resting potential. Therefore, if a neurotransmitter remained latched onto a receptor for long periods of time, it would decrease the number of times that the neurons could fire.
- Once neurotransmitters have detached from the receptors and float back into the synapse, they are either broken down by enzymes or go through **reuptake**, a process whereby neurotransmitter molecules that have been released into the synapse are reabsorbed into the axon terminals of the presynaptic neuron. Reuptake serves as a sort of natural recycling system for neurotransmitters. It is also a process that is modified by many commonly used drugs.
- **Types of Neurotransmitters:**
- The most common neurotransmitters in the brain are glutamate and GABA.
- **Glutamate** is the most common excitatory neurotransmitter in the brains of vertebrates. It is involved in a number of processes, including our ability to form new memories. Abnormal functioning of glutamate-releasing neurons has also been implicated in a number of brain disorders including the triggering of seizures in epilepsy and damage caused by strokes.
- **GABA (gamma-amino butyric acid)** is the primary inhibitory neurotransmitter of the nervous system. It accomplishes this feat by reducing the negative charge of neighbouring neurons even further than their resting state of −70 mV. When GABA binds to receptors, it causes an influx of negatively charged chloride ions to enter the cell, which is the opposite net effect of what happens when a neuron is stimulated. As an inhibitor, GABA facilitates sleep and reduces arousal of the nervous system. Low levels of GABA have been linked to epilepsy.
- **Acetylcholine** is one of the most widespread neurotransmitters within the body. It is found at the junctions between nerve cells and skeletal muscles. It is very important for voluntary movement. Acetylcholine released from neurons connected to the spinal cord binds to receptors on muscles. The change in the electrical properties of the muscle fibres leads to a contraction of that muscle. This link between the nervous system and muscles is known as a **neuromuscular junction**. A number of animals release venom that influences the release of acetylcholine, including the black widow spider and a number of snakes. Neurotoxic snake venom disrupts the activity of acetylcholine transmission at the neuromuscular junctions. Some types of venom block acetylcholine release at the presynaptic terminals, preventing its release into the synapse, while another type of venom blocks the receptors on the postsynaptic cell, preventing acetylcholine from binding to them. In addition, acetylcholine activity in the brain is associated with attention and memory. Altered levels of this neurotransmitter have also been linked to cognitive deficits associated with aging and Alzheimer's disease.

- **Monoamines** include the well-known neurotransmitters dopamine, norepinephrine, and serotonin. Their functions change depending on where the neurotransmitter is released.
- **Dopamine** is a monoamine neurotransmitter involved in such varied functions as mood, control of voluntary movement, and processing of rewarding experiences.
- **Norepinephrine/noradrenaline** is a monoamine synthesized from dopamine molecules that is involved in regulating stress responses, including increasing arousal, attention, and heart rate. Norepinephrine is formed in specialized nuclei in the brainstem and projects throughout the cortex, influencing the activity of a number of different systems ranging from wakefulness to attention. It also projects down the spinal cord and serves as part of the "fight-or-flight" response to threatening stimuli. Norepinephrine often works alongside **epinephrine/adrenaline**, a hormone and neurotransmitter created in the adrenal gland on the kidneys. Both norepinephrine and epinephrine energize individuals to help them become more engaged with a given activity.
- **Serotonin** is a monoamine involved in regulating mood, sleep, aggression, and appetite. It is formed in the brainstem and projects throughout the brain and spinal cord. Serotonin is the neurotransmitter that you are most likely to have heard of due to its critical role in depression.
- **Drug Effects on Neurotransmission:**
- **Agonists** are drugs that enhance or mimic the effects of a neurotransmitter's action.
- Nicotine is an acetylcholine agonist while Xanax is a GABA agonist.
- A drug that behaves as a **direct agonist** physically binds to that neurotransmitter's receptors at the postsynaptic cells. A drug that acts as an **indirect agonist** facilitates the effects of a neurotransmitter, but does not physically bind to the same part of the receptor as the neurotransmitter. A drug that attaches to another binding site on a receptor but does not interfere with the neurotransmitter's binding would also be an indirect agonist.
- Drugs classified as **antagonists** inhibit neurotransmitter activity by blocking receptors or preventing synthesis of a neurotransmitter. An example of this is botox. Botox, which is derived from the nerve-paralyzing bacterium that causes botulism, blocks the action of acetylcholine by binding to its postsynaptic receptor sites. Because Botox directly binds with acetylcholine receptors, it is considered a **direct antagonist**. If a chemical reduces the influence of a neurotransmitter without physically blocking the receptor, it would be classified as an **indirect antagonist**.
- **Hormones and the Endocrine System:**
- **Hormones** are chemicals secreted by the glands of the endocrine system.
- Generally, neurotransmitters work almost immediately within the microscopic space of the synapse, whereas hormones are secreted into the bloodstream and travel throughout the body. Thus, the effects of hormones are much slower than those of neurotransmitters. With help from the nervous system, the endocrine system contributes to **homeostasis**, the balance of energy, metabolism, body temperature, and other basic functions that keep the body working properly.

- The brain area that is critical for this brain-endocrine relationship is the **hypothalamus**, a brain structure that regulates basic biological needs and motivational systems. The hypothalamus releases specialized chemicals called **releasing factors** that stimulate the **pituitary gland**, the master gland of the endocrine system that produces hormones and sends commands about hormone production to the other glands of the endocrine system.
- How we respond to stress illustrates nicely how the nervous and endocrine systems influence each other. In psychological terms, **stress** is loosely defined as an imbalance between perceived demands and the perceived resources available to meet those demands. The hypothalamus will set chemical events in motion that physically prepare the body for stress. It signals the pituitary gland to release a hormone into the bloodstream that in turn stimulates the **adrenal glands**, a pair of endocrine glands located adjacent to the kidneys that release stress hormones, such as **cortisol** and **epinephrine**. Cortisol and epinephrine help mobilize the body during stress, thus providing enough energy for you to deal with the sudden increase in activity necessary to respond to the stress-inducing situation.
- The **endorphin** is a hormone produced by the pituitary gland and the hypothalamus that functions to reduce pain and induce feelings of pleasure. Endorphins are released into the bloodstream during events such as strenuous exercise, sexual activity, or injury. They act on portions of the brain that are attuned to reward, reinforcement, and pleasure, inhibiting the perception of pain and increasing feelings of euphoria. Morphine molecules bind onto the same receptor sites as endorphins and therefore, produce the same painkilling and euphoric effects.
- Testosterone serves multiple functions, including driving physical and sexual development over the long term. Testosterone levels also surge during sexual activity. Testosterone is one of the main sex hormones produced by the body. In men, it is produced by specialized cells in the testes. In women, it is produced in the ovaries. It can also be secreted by the adrenal cortex on the kidneys. Because it is related to male sexual development and functioning, this hormone was traditionally targeted as an explanation for why men tend to be more physically aggressive than women. In other words, there was an assumption that testosterone causes aggression. Experiments and studies were done that shows that humans and rats with higher levels of testosterone were more socially aggressive. Testosterone appears to be involved with social aggression and dominance rather than with non-social forms of aggression.

- **Section 3.3:**
- **The Central Nervous System:**
- The **central nervous system (CNS)** consists of the brain and the spinal cord.
- The spinal cord runs from your neck down to the base of your spine. The spinal cord receives information from the brain and stimulates nerves that extend out into the body. This stimulation produces movements. It also receives information

from sensory nerves in the body and transmits it back to the brain, or in the case of reflexes, organizes rapid movements without the help of the brain.

- **The Peripheral Nervous System**
- The **peripheral nervous system (PNS)** is a division of the nervous system that transmits signals between the brain and the rest of the body and is divided into two subcomponents, the somatic system and the autonomic system.
- The **somatic nervous system** consists of nerves that control skeletal muscles, which are responsible for voluntary and reflexive movement. It also consists of nerves that receive sensory input from the body. Any voluntary behaviour makes use of the somatic nervous system.
- The **autonomic nervous system** is the portion of the peripheral nervous system responsible for regulating the activity of organs and glands. This system includes two subcomponents, the **sympathetic nervous system** and the **parasympathetic nervous system**.
- The **sympathetic nervous system** is responsible for the fight-or-flight response. In this process, blood is directed toward your skeletal muscles, heart rate and perspiration increase, and digestive processes are slowed. Each of these responses helps to direct energy where it is most needed in case you need to respond. However, if you remained in this heightened state of emotional arousal, you would quickly run out of energy resources.
- The **parasympathetic nervous system** helps maintain homeostatic balance in the presence of change. Following sympathetic arousal, it works to return the body to a baseline, non-emergency state.
- **The Brain and Its Structures**
- The brain is divided into two symmetrical halves known as **cerebral hemispheres**. Each hemisphere contains the same structures, although there are some small differences in the size of these brain areas.
- The human brain can be subdivided into three main regions: The hindbrain, midbrain and forebrain.
- **The Hindbrain Sustaining the Body:**
- At the top of the spinal cord is a region called the **brainstem**, which consists of two structures: the medulla and the pons.
- Nerve cells in the medulla connect with the body to perform basic functions such as regulating breathing, heart rate, sneezing, salivating, and even vomiting, all actions your body does with little conscious control on your part.
- The pons contributes to general levels of wakefulness, and also appears to have a role in dreaming. Due to its connections to other structures in the brain and spinal cord, the pons is also part of a number of networks including those that control balance, eye movements, and swallowing.
- A hindbrain structure, the **reticular formation**, extends from the medulla upwards to the midbrain. The reticular formation influences attention and alertness.
- The **cerebellum** is the lobe-like structure at the base of the brain that is involved in the monitoring of movement, maintaining balance, attention, and emotional responses. Patients with damage to the cerebellum have difficulty controlling

their attention as well as problems with emotional control, including personality changes and impulsivity, a set of symptoms now known as the **cognitive affective behavioural syndrome**.

- **The Midbrain Sensation and Action:**
- The **midbrain**, which resides just above the hindbrain, primarily functions as a relay station between sensory and motor areas.
- The ability to capture your visual attention is influenced by the **superior colliculus**.
- The ability to move your auditory attention is influenced by the **inferior colliculus**.
- **The Forebrain Emotion, Memory, and Thought:**
- The **forebrain** consists of all of the neural structures that are located above the midbrain, including all of the folds and grooves on the outer surface of the brain. The multiple interconnected structures in the forebrain are critical to complex processes such as emotion, memory, thinking, and reasoning.
- The forebrain also contains spaces called **ventricles**. Although the ventricles appear hollow, they are filled with **cerebrospinal fluid**, a solution that helps to eliminate wastes and provides nutrition and hormones to the brain and spinal cord. Cerebrospinal fluid also cushions the brain from impact against the skull.
- Next to the ventricles are the **basal ganglia**, a group of three structures that are involved in facilitating planned movements, skill learning, and integrating sensory and movement information with the brain's reward system.
- People who are very practised at a specific motor skill have actually modified their basal ganglia through practice to better coordinate engaging in the activity.
- Improper functioning of the basal ganglia can lead to movement disorders like Parkinson's disease, Huntington's disease and Tourette's syndrome.
- Some parts of the basal ganglia are also involved in emotion, particularly experiences of pleasure and reward. These structures form a network with the **nucleus accumbens**, whose activity accompanies many kinds of pleasurable experiences.
- Another major set of forebrain structures comprises of the **limbic system**, an integrated network involved in emotion and memory.
- One key structure in the limbic system is the **amygdala**, which facilitates memory formation for emotional events, mediates fear responses, and appears to play a role in recognizing and interpreting emotional stimuli, including facial expressions. In addition, the amygdala connects with structures in the nervous system that are responsible for adaptive fear responses.
- The **hippocampus** is critical for learning and memory, particularly the formation of new memories.
- The **hypothalamus** maintains body temperature and regulates drives such as aggression and sex by interacting with the endocrine system. Regions of the hypothalamus trigger orgasm for both females and males.
- The **thalamus** is a set of nuclei involved in relaying sensory information to different regions of the brain.
- **The Cerebral Cortex:**

- The **cerebral cortex** is the convoluted, wrinkled outer layer of the brain that is involved in multiple higher functions, such as thought, language, and personality.
- The cerebral cortex has increased dramatically in size as the primate brain has evolved. The wrinkled surface of the brain seems to have solved a biological problem endured by our species: how to pack more cells into the same amount of space. Because the skull can only be so large, the brain has countered this constraint by forming a wrinkled surface, thereby increasing the surface area of the cortex. More surface area means more neurons and greater cognitive complexity.
- **The Four Lobes:**
- In each cerebral hemisphere, the cortex forms the outer surface of four major areas known as lobes: the occipital, parietal, temporal, and frontal lobes.
- The **occipital lobes** are located at the rear of the brain and are where visual information is processed.
- The **parietal lobes** are involved in our experiences of touch as well our bodily awareness. At the front edge of the parietal lobe is the **somatosensory cortex**, a band of densely packed nerve cells that register touch sensations. The amount of neural tissue dedicated to a given body part in this region is roughly based on the number of sensory receptors present at each respective body region. Regions within the parietal lobes also function in performing mathematical, visuospatial, and attention tasks. Damage to different regions of the parietal lobe can lead to specific impairments. For instance, right parietal lobe damage can lead to **neglect**, a situation in which the patient does not attend to anything that appears in the left half of his or her visual field.
- The **temporal lobes** are located at the sides of the brain near the ears and are involved in hearing, language, and some higher-level aspects of vision such as object and face recognition. Different sections of the temporal cortex perform different roles. The top part of the temporal cortex is known as the **auditory cortex**, the part of the temporal lobe that processes auditory information in humans. Damage to this region leads to problems with hearing despite the fact that the patient's ears work perfectly, a condition called **cortical deafness**. Slightly behind this region is **Wernicke's area**, which is related to understanding language.
- The **frontal lobes** are important in numerous higher cognitive functions, such as planning, regulating impulses and emotions, language production, and voluntary movement. The frontal lobes also allow you to deliberately guide and reflect on your own thought processes. Toward the rear of the frontal lobes is a thick band of neurons that form the **primary motor cortex**, which is involved in the control of voluntary movement. Importantly, motor areas in the frontal lobes are also active when planning a movement. The front two-thirds of the frontal lobes are known as the **prefrontal cortex**. This region performs many of our higher-order cognitive functions such as decision making and controlling our attention. These control processes are known as **executive functions**.

- The **corpus callosum** is a collection of neural fibres connecting the two brain hemispheres. This thick band of fibres allows the right and left hemispheres to communicate with each other.
- **Left Brain, Right Brain Hemispheric Specialization:**
- Although they appear to be mirror images of each other, the two sides of the cortex often perform very different functions, a phenomenon called **hemispheric specialization**.
- Speaking in very general terms, the right hemisphere is specialized for cognitive tasks that involve visual and spatial skills, recognition of visual stimuli, and musical processing. In contrast, the left hemisphere is more specialized for language and math.
- **Section 3.4:**
- **Lesioning and Brain Stimulation:**
- Scientists will sometimes intentionally damage an area in the brain, a process called **lesioning**, to gain more experimental control.
- In addition, researchers can study brain functions using **transcranial magnetic stimulation (TMS)**, a procedure in which an electromagnetic pulse is delivered to a targeted region of the brain. This pulse interacts with the flow of ions around the neurons of the affected area. The result is a temporary disruption of brain activity, similar to the permanent disruption caused by a brain lesion. This procedure has the advantage that healthy human volunteers can be studied.
- **Structural Neuroimaging:**
- **Structural neuroimaging** is a type of brain scanning that produces images of the different structures of the brain. This type of neuroimaging is used to measure the size of different brain areas and to determine whether any brain injury has occurred.
- There are three commonly used types of structural neuroimaging:
    1. **Computerized tomography (CT scan)** is a structural neuroimaging technique in which x-rays are sent through the brain by a tube that rotates around the head. The x-rays will pass through dense tissue at a different speed than they will pass through less dense tissue. A computer then calculates these differences for each image that is taken as the tube moves around the head and combines that information into a three-dimensional image. CT scans are both cheap and safe.
    2. **Magnetic resonance imaging (MRI)** is a structural imaging technique in which clear images of the brain are created based on how different neural regions absorb and release energy while in a magnetic field. First, a brain or other body part is placed inside a strong magnetic field and this causes the protons of the brain's hydrogen atoms to spin in the same direction. Second, a pulse of radio waves is sent through the brain; the energy of this pulse is absorbed by the atoms in the brain and knocks them out of their previous position (aligned with the magnetic field). Finally, the pulse of radio waves is turned off. At this point, the atoms again become aligned with the magnetic field. But, as they do so, they release the energy they absorbed during the pulse. Different types of tissue, grey matter, white

matter, and fluid, release different amounts of energy and return to their magnetic alignment at different speeds. Computers are used to calculate these differences and provide a very detailed three-dimensional image of the brain. MRIs produce much clearer images than CT scans and are more accurate at detecting many forms of damage, but CT scans are still used because they are cheaper. Also, if the person has metal in their body, the metal would not react well to the magnet used in the MRI scan.

3. **Diffusion tensor imaging (DTI)** is a form of structural neuroimaging allowing researchers or medical personnel to measure white-matter pathways in the brain. Although it is natural to assume that grey matter, the cell bodies, is the most sensitive part of the brain, white-matter damage has been found in an increasing number of brain disorders.

- **Functional Neuroimaging:**
- **Functional neuroimaging** is a type of brain scanning that provides information about which areas of the brain are active when a person performs a particular behaviour.
- A common trade-off is between **temporal resolution** and **spatial resolution**.
- A neuroimaging method with fantastic temporal resolution is an **electroencephalogram (EEG)**, which measures patterns of brain activity with the use of multiple electrodes attached to the scalp. The neural firing of the billions of cells in the brain can be detected with these electrodes, amplified, and depicted in an electroencephalogram. EEGs measure this activity every millisecond. They can tell us a lot about general brain activity during sleep, during wakefulness, and while patients or research participants are engaged in a particular cognitive activity. The convenience and relatively inexpensive nature of EEGs, compared to other modern methods, make them very appealing to researchers.
- To link the EEG output with your stimuli, researchers have developed a technique known as **event-related potentials (ERPs)**. ERPs use the same sensors as EEGs, however, a computer takes note of exactly when a given stimulus was presented to the participant. The experimenter can then examine the EEG readout for a brief period of time following the appearance of that stimulus.
- Although ERPs are very useful for measuring when brain activity is occurring, they are much less effective at identifying exactly where that activity is taking place. Part of this problem is due to the fact that the skull disrupts the electrical signals from the neurons' firing. In order to get around this, some researchers measure the magnetic activity associated with cells firing by using **magnetoencephalography (MEG)**, a neuroimaging technique that measures the tiny magnetic fields created by the electrical activity of nerve cells in the brain. Like EEG, MEG records the electrical activity of nerve cells just a few milliseconds after it occurs, which allows researchers to record brain activity at nearly the instant a stimulus is presented. However, like ERPs, MEGs do not provide a detailed picture of the activity of specific brain areas. So, although its

ability to isolate the location of brain activity is slightly better than that of ERPs, it is still difficult to isolate exactly where in the brain the activity occurred.

- A **positron emission tomography (PET)** is a type of scan in which a low level of a radioactive isotope is injected into the blood, and its movement to regions of the brain engaged in a particular task is measured. This method works under the assumption that active nerve cells use up energy at a faster rate than do cells that are less active. As a result, more blood will need to flow into those active areas in order to bring more oxygen and glucose to the cells. If the blood contains a radioactive isotope, more radioactivity will be detected in areas of the brain that were active during that period of time. The greatest strength of PET scans is that they show metabolic activity of the brain. PET also allows researchers to measure the involvement of specific types of receptors in different brain regions while people perform an experimental task. A drawback is that PET scans take a long time to acquire, at least two minutes, which is a problem when you want to see moment-by-moment activity of the brain. The radioactivity of PET also generally limits the participants to men because it is possible that female participants could be in the early stages of pregnancy.
- **Functional magnetic resonance imaging** measures brain activity by detecting the influx of oxygen-rich blood into neural areas that were just active. The way fMRI works is the following. When a brain area is involved with a particular function, it will use up oxygen. The result is that blood in these areas will be deoxygenated. The body responds by sending in more oxygen-rich blood to replace the deoxygenated blood. Critically, these two types of blood have different magnetic properties. So, by measuring the changing magnetic properties of the blood in different brain areas, it is possible to see which areas were active when the person performed a particular task. fMRI provides very detailed images of where brain activity is occurring, but it can only measure activity at the level of seconds rather than milliseconds. Therefore, it lacks the temporal resolution of ERP and MEG.

Definitions:

- **Acetylcholine:** One of the most widespread neurotransmitters within the body, found at the junctions between nerve cells and skeletal muscles; it is very important for voluntary movement.
- **Action potential:** A wave of electrical activity that originates at the beginning of the axon near the cell body and rapidly travels down its length.
- **Adrenal glands:** A pair of endocrine glands located adjacent to the kidneys that release stress hormones, such as cortisol and epinephrine.
- **Agonists:** Drugs that enhance or mimic the effects of a neurotransmitter's action.
- **All-or-none principle:** Individual nerve cells fire at the same strength every time an action potential occurs.
- **Amygdala:** A group of nuclei in the medial portion (near the middle) of the temporal lobes in each hemisphere of the brain that facilitates memory formation for emotional events, mediates fear responses, and appears to play a role in recognizing and interpreting emotional stimuli, including facial expressions.

- **Antagonists:** Inhibit neurotransmitter activity by blocking receptors or preventing synthesis of a neurotransmitter.
- **Autonomic nervous system:** The portion of the peripheral nervous system responsible for regulating the activity of organs and glands.
- **Axon:** Transports information in the form of electrochemical reactions from the cell body to the end of the neuron.
- **Basal ganglia:** A group of three structures that are involved in facilitating planned movements, skill learning, and integrating sensory and movement information with the brain's reward system.
- **Behavioural genomics:** The study of DNA and the ways in which specific genes are related to behaviour
- **Behavioural genetics:** The study of how genes and the environment influence behaviour.
- **Brainstem:** The bottom of the brain and consists of two structures: the medulla and the pons.
- **Cell body:** The part of a neuron that contains the nucleus that houses the cell's genetic material.
- **Central nervous system (CNS):** Consists of the brain and the spinal cord.
- **Cerebellum:** The lobe-like structure at the base of the brain that is involved in the monitoring of movement, maintaining balance, attention, and emotional responses.
- **Cerebral cortex:** The convoluted, wrinkled outer layer of the brain that is involved in multiple higher functions, such as thought, language, and personality.
- **Chromosomes:** Structures in the cellular nucleus that are lined with all of the genes an individual inherits.
- **Computerized tomography (CT scans):** A structural neuroimaging technique in which x-rays are sent through the brain by a tube that rotates around the head.
- **Corpus callosum:** A collection of neural fibres connecting the two brain hemispheres.
- **Dendrites:** Small branches radiating from the cell body that receive messages from other cells and transmit those messages toward the rest of the cell.
- **Dizygotic twins:** Fraternal twins who come from two separate eggs fertilized by two different sperm cells that share the same womb; these twins have approximately 50% of their genetics in common.
- **DNA (deoxyribonucleic acid):** A molecule formed in a double-helix shape that contains four amino acids: adenine, cytosine, guanine, and thymine.
- **Dopamine:** A monoamine neurotransmitter involved in such varied functions as mood, control of voluntary movement, and processing of rewarding experiences.
- **Diffusion tensor imaging (DTI):** A form of structural neuroimaging allowing researchers or medical personnel to measure white-matter pathways in the brain.
- **Electroencephalogram (EEG):** A measure of brain activity that uses electrodes attached to the scalp to measure patterns of brain activity.
- **Endorphin:** A hormone produced by the pituitary gland and the hypothalamus that functions to reduce pain and induce feelings of pleasure.

- **Epigenetics:** Changes in gene expression that occur as a result of experience and that do not alter the genetic code.
- **Evolution:** The change in the frequency of genes occurring in an interbreeding population over generations.
- **Evolutionary psychology:** A field of psychology that attempts to explain human behaviours based on the beneficial function they may have served in our species' development.
- **Forebrain:** The most visibly obvious region of the brain, consists of all of the neural structures that are located above the midbrain, including all of the folds and grooves on the outer surface of the brain; the multiple interconnected structures in the forebrain are critical to such complex processes as emotion, memory, thinking, and reasoning.
- **Frontal lobes:** Important in numerous higher cognitive functions, such as planning, regulating impulses and emotion, language production, and voluntary movement.
- **Functional MRI (fMRI):** Brain imaging technology designed to measure changes in blood flow, which is correlated with neural activity, throughout the brain. It measures brain activity by detecting the influx of oxygen-rich blood into neural areas that were just active.
- **Functional neuroimaging:** A type of brain scanning that provides information about which areas of the brain are active when a person performs a particular behaviour.
- **GABA (gamma-amino butyric acid):** The primary inhibitory neurotransmitter of the nervous system, meaning that it prevents neurons from generating action potentials.
- **Genes:** The basic units of heredity; genes are responsible for guiding the process of creating the proteins that make up our physical structures and regulate development and physiological processes throughout the lifespan.
- **Genotype:** The genetic makeup of an organism. The unique set of genes that comprise that individual's genetic code.
- **Glial cells:** Specialized cells of the nervous system that are involved in mounting immune responses in the brain, removing waste, and synchronizing the activity of the billions of neurons that constitute the nervous system.
- **Glutamate:** Most common excitatory neurotransmitter in the brains of vertebrates.
- **Heritability:** A statistic, expressed as a number between zero and one, that represents the degree to which genetic differences between individuals contribute to individual differences in a behaviour or trait found in a population.
- **Hindbrain:** A brain region consisting of structures that are critical to controlling basic, life-sustaining processes.
- **Hippocampus:** Critical for learning and memory, particularly the formation of new memories.
- **Hormones**: Chemicals secreted by the glands of the endocrine system.

- **Hunter-gatherer theory:** Links performance on specific tasks to the different roles performed by males and females over the course of our evolutionary history.
- **Hypothalamus:** A brain structure that regulates basic biological needs and motivational systems.
- **Intersexual selection:** A situation in which members of one sex select a mating partner based on their desirable traits.
- **Intrasexual selection:** A situation in which members of the same sex compete in order to win the opportunity to mate with members of the opposite sex.
- **Lesioning:** A technique that inflicts controlled damage to brain tissue so as to study its function.
- **Limbic system:** An integrated network involved in emotion and memory.
- **Longitudinal studies:** Studies that follow the same set of individuals for many years, often decades.
- **Magnetic resonance imaging (MRI):** A structural imaging technique in which clear images of the brain are created based on how different neural regions absorb and release energy while in a magnetic field.
- **Magnetoencephalography (MEG):** A neuroimaging technique that measures the tiny magnetic fields created by the electrical activity of nerve cells in the brain.
- **Midbrain:** Resides just above the hindbrain, primarily functions as a relay station between sensory and motor areas.
- **Monozygotic twins:** Twins who come from a single ovum (egg), which makes them genetically identical (almost 100% genetic similarity).
- **Myelin:** A fatty sheath that insulates axons from one another, resulting in increased speed and efficiency of neural communication.
- **Natural selection:** The process by which favourable traits become increasingly common in a population of interbreeding individuals, while traits that are unfavourable become less common.
- **Neurogenesis:** The formation of new neurons.
- **Neurons:** One of the major types of cells found in the nervous system, which are responsible for sending and receiving messages throughout the body.
- **Neuroplasticity:** The capacity of the brain to change and rewire itself based on individual experience.
- **Neurotransmitters:** The chemicals that function as messengers allowing neurons to communicate with each other.
- **Norepinephrine/noradrenaline:** A monoamine synthesized from dopamine molecules that is involved in regulating stress responses, including increasing arousal, attention, and heart rate.
- **Occipital lobes:** Located at the rear of the brain and are where visual information is processed.
- **Parasympathetic nervous system:** Helps maintain homeostatic balance in the presence of change; following sympathetic arousal, it works to return the body to a baseline, non-emergency state.

- **Parietal lobes:** Involved in our experiences of touch as well our bodily awareness.
- **Phenotype:** The physical traits and behavioural characteristics that show genetic variation, such as eye colour, the shape and size of facial features, intelligence, and even personality.
- **Pituitary gland:** The master gland of the endocrine system that produces hormones and sends commands about hormone production to the other glands of the endocrine system.
- **Peripheral nervous system (PNS):** A division of the nervous system that transmits signals between the brain and the rest of the body and is divided into two subcomponents, the somatic system and the autonomic system.
- **Positron emission tomography (PET):** A type of brain scanning technology in which a low level of radioactive glucose is injected into the blood, and its movement to regions of the brain engaged in a particular task is measured.
- **Refractory period:** A brief period in which a neuron cannot fire and a time period during which erection and orgasm are not physically possible.
- **Resting potential:** Relatively stable state during which the cell is not transmitting messages.
- **Reuptake:** A process whereby neurotransmitter molecules that have been released into the synapse are reabsorbed into the axon terminals of the presynaptic neuron.
- **Serotonin:** A monoamine involved in regulating mood, sleep, aggression, and appetite.
- **Somatic nervous system:** Consists of nerves that control skeletal muscles, which are responsible for voluntary and reflexive movement; it also consists of nerves that receive sensory input from the body.
- **Stem cells:** A unique type of cell that does not have a predestined function.
- **Structural neuroimaging:** A type of brain scanning that produces images of the different structures of the brain.
- **Sympathetic nervous system:** Responsible for the fight-or-flight response of an increased heart rate, dilated pupils, and decreased salivary flow—responses that prepare the body for action.
- **Synapses:** The microscopically small spaces that separate individual nerve cells.
- **Synaptic cleft:** The minute space between the axon terminal and the dendrite.
- **Temporal lobes:** Located at the sides of the brain near the ears and are involved in hearing, language, and some higher-level aspects of vision such as object and face recognition.
- **Thalamus:** A set of nuclei involved in relaying sensory information to different regions of the brain.
- **Transcranial magnetic stimulation (TMS):** A procedure in which researchers send an electromagnetic pulse to a targeted region of the brain, which can either stimulate or temporarily disable it.

October 10:

- **Sensation** is the process that allows our brains to take in information via our five senses, which can then be experienced and interpreted by the brain.
- **Perception** is defined as our recognition and interpretation of sensory information.
- Human's best sense is vision.
- **Iris:** The colored part of your eye. It is actually a muscle that controls the size of the pupil.
- **Pupil:** The black part in the middle of the eye. It is the opening that allows light into the eyeball. The larger the pupil, the more light that comes in.
- **Sclera:** The white part of the eye. It is a tough membrane that serves as protection.
- **Cornea:** The fluid filled outer coating of the eye. It provides moisture and nutrients.
- **Lens:** Focuses the incoming light onto the retina. This lens is flexible and slight alterations in it can alter the focus of it, a process called **accommodation**.
  Aqueous Humor: This fluid nourishes the front of the eye.
- **Vitreous Humor:** This fluid nourishes and supports the inner part of the eye.
- **Retina:** The surface that the image lands on. The inner coating of the retina is the part that transmits the light signal into a neural signal.
- The retina **transduces** light from one form of energy to another form. Sensory neurons play the critical role of translating the physical properties of the outside world into neural signals, a process termed **transduction**. The sensory neurons are stimulated by light. When light hits them, it triggers a process that produces a neural signal, which is what our nerves use.
- **Photoreceptors:** Rods and Cones (Transduction proper – Red, Green, Blue) Light strikes the back of the eye stimulating photoreceptor cells which can be either rods or cones. Rods are not responsive to colour, but they are very responsive to dim light, which makes them great for low light situations. They are sensitive to the presence of light. Cones are sensitive to colour (red, green and blue) and provide a much more detailed image, which makes them great for high light, detailed imaging. The transduction is done via a bleaching process in which the photo-pigments are split, causing an action potential.
- **Bipolar Cells:** Image sharpening, edges and contours made crisper. The signal from the photoreceptors is then passed on to the bipolar cells which reprocess the signal in a way that tends to emphasize edges and contours. Essentially, when the photoreceptors associated with spatially close parts of the retina are sending very different signals, the bipolar cells accentuate these spots aiding us in our ability to perceive edges.
- **Ganglion Cells:** Colour sharpening, and introduction of yellow colour. The third and final step in the retina pre-processing of visual information is the ganglion cells. Ganglion cells come in two types, red/green and blue/yellow. Each cell represents an opponent process system. For example in red/green cells, the resting behaviour of the cell is to produce some mid-level rate of responding. This rate increases when red is present, and decreases when green is present.

The yellow/blue increases when both red and green are present but decreases when blue is present. Yellow stimulates both red and green photoreceptors.

October 7:

- **Confirmation bias** is the tendency to interpret new evidence as confirmation of one's existing beliefs or theories. Confirmation bias is especially strong these days because it's very easy to find other people who share your beliefs.
- The brain is excellent with dealing with confusion and uncertainty. It assumes information or ignores information in ways that allow it to make sense. It also relies heavily on past experiences to decide what makes sense.
- Once the sensation hits the brain, almost immediately, the brain starts to analyze it, and if necessary, change it.
- The raw sensory input that's coming in from the world through our eyes is called the **bottom-up influences**.
- As soon as the sensation enters the brain, the brain starts to analyze it, and if necessary, change it. This is called **top-down influences**.
- According to a group of German Psychologists called **Gestalt Psychologists**, the primary purpose of the visual system is the recognition of objects from basic visual elements. The objects are seen as more than a sum of the parts, and the critical problem facing the visual system is how to group the elements to form objects. Several principles, or laws, are used by the visual system to do this grouping. These laws are:
    1. **Proximity:** If things are close together in space, we tend to group them together.
    2. **Similar colour**
    3. **Similar size**
    4. **Common fate:** If a few elements within a complex display do something together, then they become grouped.
    5. **Good continuation:** Figures with edges that are smooth are more likely to be seen as continuous than edges that have abrupt or sharp angles.
    6. **Closure:** The brain tends to perceive forms and figures in their complete appearance despite the absence of one or more of their parts, either hidden or totally absent.
    7. **Common region**
    8. **Element Connectedness**
- Gestalt Psychologists looked at perception. Was one of European scientists' reactions to Freud.
- Gestalt in English means "The whole is more than the sum of the parts."
- The brain likes seeing things in one way.
- According to Piaget there are two processes at work in cognitive development: assimilation and accommodation. Cognitive growth is the result of the constant interweaving of assimilation and accommodation. **Assimilation** occurs when we modify or change new information to fit into our schemas. It keeps the new information or experience and adds to what already exists in our minds. **Accomodation** is when we restructure of modify what we already know so that

new information can fit in better. This results from problems posed by the environment and when our perceptions do not fit in with what we know or think.

October 9:

- To infer depth with one eye **(Monocular)**, we use the following:
    1. **Shading:** Depending on where light hits an object, you may perceive the depth as convex or concave.
       Convex: Coming out towards you.
       Concave: Going away from you.
       If the light hits the object from the top, then we perceive the depth as convex.
       If the light hits the object from the bottom, then we perceive the depth as concave.
- To infer depth with two eyes **(Binocular)**, we use the following:
    1. **Convergence:** Because the two eyes converge on an object when we are viewing it, the brain can use the angle of convergence as a cue to how far away that object is. The larger the angle, the nearer the object.
    2. **Retinal Disparity:** Whenever we are not focusing on an object, the image of that object falls on different points of the two retinas. The amount of disparity (difference) between the two retinal images can be used as a cue for distance.
- In order for people to recognize faces, the brain developed an area called the **fusiform gyrus/Brodmann area 37**, which is responsible for storing the unique features of everyone's face. If people have that area damaged, then it can be hard for them to recognize people by their faces. This is called **prosopagnosia/face blindness**. Prosopagnosia is a cognitive disorder of face perception in which the ability to recognize familiar faces, including one's own face, is impaired.
- **Capgras Syndrome/Imposter Syndrome** is a psychological condition in which people will have an irrational belief that someone they know or recognize has been replaced by an imposter.
  I.e. People with capgras syndrome can recognize faces but lose the sense of familiarity.

Textbook:

- **Section 4.1:**
- **Sensing the World Around Us:**
- The process of detecting and then translating the complexity of the world into meaningful experiences occurs in two stages.
- The first step is **sensation**, the process of detecting external events with sense organs and turning those stimuli into neural signals. All of this raw sensory information is then relayed to the brain, where perception occurs.
- **Perception** involves attending to, organizing, and interpreting stimuli that we sense.
- The raw sensations detected by the sensory organs are turned into information that the brain can process through **transduction**, when specialized receptors transform the physical energy of the outside world into neural impulses. These

neural impulses travel into the brain and influence the activity of different brain structures, which ultimately gives rise to our internal representation of the world.

- The sensory receptors involved in transduction are different for the different senses.
- All of our senses use the same mechanism for transmitting information in the brain, the action potential. As a result, the brain is continually bombarded by waves of neural impulses representing the world in all its complexity. Yet, it must be able to separate different sensory signals from one another so that we can experience distinct sensations. It accomplishes this feat by sending signals from different sensory organs to different parts of the brain. Therefore, it is not the original sensory input that is most important for generating our perceptions, but the brain area that processes this information. The idea that different senses are separated in the brain, was first proposed in 1826 by the German physiologist Johannes Müller and is known as the **doctrine of specific nerve energies**.
- Experience also influences how we adapt to sensory stimuli in our everyday lives. Generally speaking, our sensory receptors are most responsive upon initial exposure to a stimulus. The **orienting response** describes how we quickly shift our attention to stimuli that signal a change in our sensory world. In contrast, **sensory adaptation** is the reduction of activity in sensory receptors with repeated exposure to a stimulus.
- **Stimulus Thresholds:**
- An **absolute threshold** is the minimum amount of energy or quantity of a stimulus required for it to be reliably detected at least 50% of the time it is presented.
- A **difference threshold** is the smallest difference between stimuli that can be reliably detected at least 50% of the time.
- When you add salt to your food, you are attempting to cross a difference threshold that your taste receptors can register. Whether you actually detect a difference, known as a just noticeable difference, depends primarily on the intensity of the original stimulus. The more intense the original stimulus, the larger the amount of it that must be added for the difference threshold to be reached.
- This effect was formalized into an equation by Ernst Weber. **Weber's law** states that the just noticeable difference between two stimuli changes as a proportion of those stimuli.
- The study of stimulus thresholds has its limitations. Whether someone perceives a stimulus is determined by self-report. However, not all people are equally willing to say they sensed a weak stimulus.
- **Signal Detection:**
- If you are certain that a stimulus exists, then there is no reason to worry about whether you did or did not perceive something. However, there are many instances in which we must make decisions about sensory input that is uncertain. It is in these ambiguous situations that signal detection theory can be a powerful tool for the study of our sensory systems. **Signal detection theory** states that whether a stimulus is perceived depends on both the sensory experience and the

judgment made by the subject. Thus, the theory requires us to examine two processes: a sensory process and a decision process. In a typical signal detection experiment conducted in the laboratory, the experimenter presents either a faint stimulus or no stimulus at all; this is the sensory process. The subject is then asked to report whether or not a stimulus was actually presented; this is the decision process.

- In developing signal detection theory, psychologists realized that there are four possible outcomes:
    1. Hit
    2. Correct rejection
    3. False alarm
    4. Miss
- For example, you may be correct that you heard a sound (**hit**), or correct that you did not hear a sound (**correct rejection**). Of course, you will not always be correct in your judgments. Sometimes you will think you heard something that is not there (**false alarm**). On other occasions you may fail to detect that a stimulus was presented (**miss**). By analyzing how often a person's responses fall into each of these four categories, psychologists can accurately measure the sensitivity of that person's sensory systems.
- Studies using signal detection theory have shown that whether a person can accurately detect a weak stimulus appears to depend on a number of factors:
    1. The sensitivity of a person's sensory organs.
    2. A number of cognitive and emotional factors that influence how sensitive a person is to various sensory stimuli. These include expectations, level of psychological and autonomic-nervous-system arousal, and how motivated a person is to pay attention to nuances in the stimuli.
- Signal detection theory improves on simple thresholds by including the influence of psychological factors, such as a willingness to guess if uncertain.
- We can perceive **subliminal stimuli**, sensory stimulation that is below a person's threshold for perception, under strict laboratory conditions. Most laboratory-based studies use a technique known as **priming**, in which previous exposure to a stimulus can influence that individual's later responses, either to the same stimulus or to one that is related to it. In this type of study, experimenters often present a word or an image for a fraction of a second. This presentation is then immediately followed by another image, a **mask**, which is displayed for a longer period of time. The mask interferes with the conscious perception of the subliminal stimulus. The perceivers are often unaware that any stimulus appeared before the mask. Yet, a number of brain imaging studies have shown that these rapidly presented stimuli do in fact influence patterns of brain activity. Thus, it appears that subliminal perception can occur, and it can produce small effects in the nervous system.
- Subliminal messages have a mild effect on behaviour.
- **Gestalt Principles of Perception:**
- **Gestalt psychology** is an approach to perception that emphasizes that "the whole is greater than the sum of its parts." In other words, the individual parts of

an image may have little meaning on their own, but when combined, the whole takes on a significant perceived form. Gestalt psychologists identified several key principles to describe how we organize features that we perceive.

- One basic Gestalt principle is the **figure–ground principle**, which states that objects or figures in our environment tend to stand out against a background.
- **Proximity** and **similarity** are two additional Gestalt principles that influence perception. We tend to treat two or more objects that are in close proximity to each other as a group. As well, we tend to group individuals wearing the same uniform based on their visual similarity.
- **Continuity** refers to the perceptual rule that lines and other objects tend to be continuous, rather than abruptly changing direction.
- **Closure** refers to the tendency to fill in gaps to complete a whole object.
- **Working the Scientific Literacy Model:**
- **Top-down processing** occurs when our perceptions are influenced by our expectations or by our prior knowledge.
- **Bottom-up processing** occurs when we perceive individual bits of sensory information (e.g. sounds) and use them to construct a more complex perception (e.g. a message).
- **Attention and Perception:**
- **Divided attention** is when we are paying attention to more than one stimulus or task at the same time.
- **Selective attention** involves focusing on one particular event or task.
- **Inattentional blindness** is the failure to notice clearly visible events or objects because attention is directed elsewhere.
- **Section 4.2 The Visual System:**
- **How the Eye Gathers Light:**
- The primary function of the eye is to gather light and change it into an action potential.
- For the purposes of human perception, light is the radiation that occupies a relatively narrow band of the electromagnetic spectrum.
- Light travels in waves that vary in terms of two different properties: length and amplitude.
- The term **wavelength** refers to the distance between peaks of a wave.
- Long wavelengths correspond to our perception of reddish colours and short wavelengths correspond to our perception of bluish colours. Different shades of green would represent wavelengths of light in between the wavelengths of red and blue.
- **Amplitude** refers to the height of a wave.
- Low-amplitude waves are seen as dim colours, whereas high-amplitude waves are seen as bright colours.
- Light waves can also differ in terms of how many different wavelengths are being viewed at once. When you look at a clear blue sky, you are viewing many different wavelengths of light at the same time, but the blue wavelengths are more prevalent and therefore dominate your impression.

- If a large proportion of the light waves are clustered around one wavelength, you will see an intense, vivid colour. If there are a large variety of wavelengths being viewed at the same time, the colour will appear to be “washed out.”
- We experience wavelength, amplitude, and purity as **hue** (colour of the spectrum), **intensity** (brightness), and **saturation** (colourfulness or purity). It is in the eye that this transformation from sensation to perception takes place.
- **The Structure of the Eye:**
- The eye consists of specialized structures that regulate the amount of light that enters the eye and organizes it into a pattern that the brain can interpret.
- The **sclera** is the white, outer surface of the eye.
- The **cornea** is the clear layer that covers the front portion of the eye and also contributes to the eye’s ability to focus.
- Light enters the eye through the cornea and passes through the pupil. The **pupil** regulates the amount of light that enters by changing its size. It dilates to allow more light to enter and constricts to allow less light into the eye.
- The changes in the pupil’s size are performed by the **iris**, a round muscle that adjusts the size of the pupil; it also gives the eyes their characteristic colour.
- The lens can change its shape to ensure that the light entering the eye is refracted in such a way that it is focused when it reaches the back of the eye. This process is known as **accommodation**.
- When the light reaches the back of the eye, it will stimulate a layer of specialized receptors that convert light into a message that the brain can then interpret, a process known as transduction. These receptors are part of a complex structure known as the retina.
- The **retina** lines the inner surface of the back of the eye and consists of specialized receptors that absorb light and send signals related to the properties of light to the brain.
- The retina contains a number of different layers, each performing a slightly different function.
- At the back of the retina are specialized receptors called **photoreceptors**. These receptors are where light will be transformed into a neural signal that the brain can understand.
- Having the photoreceptors wedged into the back of the eye protects them and provides them with a constant blood supply, both of which are useful to your ability to see.
- Information from the photoreceptors at the back of the retina is transmitted to the ganglion cells closer to the front of the retina. The ganglion cells gather up information from the photoreceptors; this information will then alter the rate at which the ganglion cells fire. The activity of all of the ganglion cells is then sent out of the eye through the **optic nerve**, a dense bundle of fibres that connect to the brain. This nerve presents a challenge to the brain. Because it travels through the back of the eye, it creates an area on the retina with no photoreceptors, called the **optic disc**. The result is a **blind spot**, a space in the retina that lacks photoreceptors.

- **The Retina: From Light to Nerve Impulse:**
- There are two general types of photoreceptors, **rods** and **cones**, each of which responds to different characteristics of light.
- **Rods** are photoreceptors that occupy peripheral regions of the retina; they are highly sensitive under low light levels. This type of sensitivity makes rods particularly responsive to black and grey.
- **Cones** are photoreceptors that are sensitive to the different wavelengths of light that we perceive as colour. Cones tend to be clustered around the **fovea**, the central region of the retina.
- When the rods and cones are stimulated by light, their physical structure briefly changes. This change decreases the amount of the neurotransmitter glutamate being released, which alters the activity of neurons in the different layers of the retina. The final layer to receive this changed input consists of ganglion cells, which will eventually output to the optic nerve. The ratio of ganglion cells to cones in the fovea is approximately one to one. In contrast, there are roughly 10 rods for every ganglion cell.
- Cones are clustered in the fovea and have a one-to-one ratio with ganglion cells, while rods are limited to the periphery of the retina and have a ten-to-one ratio with ganglion cells.
- In daylight or under artificial light, the cones in the retina are more active than rods. They help us to detect differences in the colour of objects and to discriminate the objects' fine details. In contrast, if the lights suddenly go out or if you enter a dark room, at first you see next to nothing, but over time, you gradually begin to see your surroundings more clearly. **Dark adaptation** is the process by which the rods and cones become increasingly sensitive to light under low levels of illumination. What is actually happening during dark adaptation is that the photoreceptors are slowly becoming regenerated after having been exposed to light. Cones regenerate more quickly than do rods, often within about ten minutes. However, after this time, the rods become more sensitive than the cones.
- **The Retina and the Perception of Colours:**
- The cones of the retina are specialized for responding to different wavelengths of light that correspond to different colours. However, the subjective experience of colour occurs in the brain. Currently, two theories exist to explain how neurons in the eye can produce these colourful experiences.
- One theory suggests that three different types of cones exist, each of which is sensitive to a different range of wavelengths on the electromagnetic spectrum. These three types of cones were initially identified in the 18th century by physicist Thomas Young and then independently rediscovered in the 19th century by Hermann von Helmholtz. The resulting **trichromatic theory or Young-Helmholtz theory** maintains that colour vision is determined by three different cone types that are sensitive to short, medium, and long wavelengths of light. These cones respond to wavelengths associated with the colours blue, green, and red. The relative responses of the three types of cones allow us to perceive many different colours on the spectrum. Yellow is perceived by

combining the stimulation of red and green sensitive cones, whereas light that stimulates all cones equally is perceived as white.

- The second theory is the **opponent-process theory**. In the 19th century, Ewald Hering proposed the **opponent-process theory** of colour perception, which states that we perceive colour in terms of opposing pairs: red to green, yellow to blue, and white to black. This type of perception is consistent with the activity patterns of retinal ganglion cells. A cell that is stimulated by red is inhibited by green; when red is no longer perceived such as when you suddenly look at a white wall, a "rebound" effect occurs. Suddenly, the previously inhibited cells that fire during the perception of green are free to fire, whereas the previously active cells related to red no longer do so. The same relationship occurs for yellow and blue as well as for white and black.
- The trichromatic and opponent-process theories are said to be complementary because both are required to explain how we see colour. The trichromatic theory explains colour vision in terms of the activity of cones. The opponent-process theory of colour vision explains what happens when ganglion cells process signals from a number of different cones at the same time. Together, they allow us to see the intense world of colours that we experience every day.
- **Common Visual Disorders:**
- Most forms of **colour blindness** affect the ability to distinguish between red and green. In people who have normal colour vision, some cones contain proteins that are sensitive to red and some contain proteins that are sensitive to green. However, in most forms of colour blindness, one of these types of cones does not contain the correct protein. Most forms of colour blindness are genetic in origin.
- **Nearsightedness**, or **myopia**, occurs when the eyeball is slightly elongated, causing the image that the cornea and lens focus on to fall short of the retina. People who are nearsighted can see objects that are relatively close up but have difficulty focusing on distant objects.
- Alternatively, if the length of the eye is shorter than normal, the result is **farsightedness** or **hyperopia**. In this case, the image is focused behind the retina. Farsighted people can see distant objects clearly but not those that are close by.
- Both types of impairments can be corrected with contact lenses or glasses, thus allowing a focused visual image to stimulate the retina at the back of the eye, where light energy is converted into neural impulses.
- In the last 20 years, an increasing number of people have undergone laser eye surgery in order to correct near- or farsightedness. In this type of surgery, surgeons use a laser to reshape the cornea so that incoming light focuses on the retina, which produces close to perfect vision. In nearsighted patients, the doctors attempt to flatten the cornea, whereas in farsighted patients the doctors attempt to make the cornea steeper.
- **Visual Perception and the Brain:**
- Information from the optic nerve travels to numerous areas of the brain. The first major destination is the **optic chiasm**, the point at which the optic nerves cross

at the midline of the brain. For each optic nerve, about half of the nerve fibres travel to the same side of the brain (**ipsilateral**), and half of them travel to the opposite side of the brain (**contralateral**). The outside half of the retina, closest to your temples, sends its optic nerve projections ipsilaterally. In contrast, the inside half of the retina, closest to your nose, sends its optic nerve projections contralaterally. The result of this distribution is that the left half of your visual field is initially processed by the right hemisphere of your brain, whereas the right half of your visual field is initially processed by the left hemisphere of your brain. This serves important functions, particularly if a person's brain is damaged. In this case, having both eyes send some information to both hemispheres increases the likelihood that some visual abilities will be preserved.

- Fibres from the optic nerve first connect with the **thalamus**, the brain's "sensory relay station." The thalamus is made up of over 20 different nuclei with specialized functions. The **lateral geniculate nucleus (LGN)** is specialized for processing visual information. Fibres from this nucleus send messages to the visual cortex, located in the occipital lobe, where the complex processes of visual perception begin. The lateral geniculate nucleus in the thalamus is where the information from the left and right optic nerves converge.
- The visual cortex make sense of all this incoming information starting with a division of labour among specialized cells. One set of cells in the visual cortex, first discovered by Canadian David Hubel and his colleague Torsten Wiesel in 1959, are referred to as **feature detection cells**. These cells respond selectively to simple and specific aspects of a stimulus, such as angles and edges. Feature detection cells of the visual cortex are thought to be where visual input is organized for perception; however, additional processing is required for us to accurately perceive our visual world. From the primary visual cortex, information about different features is sent for further processing in the surrounding secondary visual cortex. This area consists of a number of specialized regions that perform specific functions, such as the perception of colour and movement. These regions begin the process of putting together primitive visual information into a bigger picture. These specialized areas are the beginning of two streams of vision, each of which performs different visual functions. The **ventral stream** extends from the visual cortex to the lower part of the temporal lobe. The **dorsal stream**, on the other hand, extends from the visual cortex to the parietal lobe.
- **The Ventral Stream:**
- The ventral stream of vision extends from the visual cortex in the occipital lobe to the front portions of the temporal lobe. This division of our visual system performs a critical function: object recognition. Groups of neurons in the temporal lobe gather shape and colour information from different regions of the secondary visual cortex and combine it into a neural representation of an object.
- We can identify objects even when they are viewed in different lighting conditions or at different angles. This observation is an example of what is called **perceptual constancy**, the ability to perceive objects as having constant shape, size, and colour despite changes in perspective. What makes perceptual

constancy possible is our ability to make relative judgments about shape, size, and lightness.

- Specific genetic problems or brain damage can lead to an inability to recognize faces, a condition known as **prosopagnosia** or face blindness. People with face blindness are able to recognize voices and other defining features of individuals, but not faces. Importantly, these patients tend to have damage or dysfunction in the same general area of the brain: the bottom of the right temporal lobe.
- Brain imaging studies have corroborated the location of the "face area" of the brain. Using fMRI, researchers have consistently detected activity in this region, now known as the **fusiform face area (FFA)**. The FFA responds more strongly to the entire face than to individual features. Unlike other types of stimuli, faces are processed holistically rather than as a nose, eyes, ears, chin, and so on. However, the FFA shows a much smaller response when we perceive inverted faces. In this case, people tend to perceive the individual components of the face rather than perceiving the faces as a holistic unit. Interestingly, the FFA is also active when we perceive images of faces in everyday objects. The fact that these illusory perceptions of faces, known as **face pareidolia**, also activate the FFA suggests that this structure is influenced by top-down processing that treats any face-like pattern as a face.
- Although no one doubts that faces are processed by the FFA, there are alternative explanations for these effects. One possibility is that the FFA is being activated by one of the cognitive or perceptual processes that help us perceive faces rather than by the perception of faces themselves.
- The fact that a specific brain region is linked with the perception of faces is very useful information for neurologists and emergency room physicians. If a patient has trouble recognizing people, it could be a sign that he has damage to the bottom of the right temporal lobe.
- **The Dorsal Stream:**
- The dorsal stream of vision extends from the visual cortex in our occipital lobe upwards to the parietal lobe. The ventral stream identifies the object, and the dorsal stream locates it in space and allows you to interact with it.
- **Depth Perception:**
- **Binocular depth cues** are distance cues that are based on the differing perspectives of both eyes.
- **Convergence** occurs when the eye muscles contract so that both eyes focus on a single object. Convergence typically occurs for objects that are relatively close to you.
- **Retinal disparity/binocular disparity** is the difference in relative position of an object as seen by both eyes, which provides information to the brain about depth.
- **Monocular cues** are depth cues that we can perceive with only one eye.
- During **accommodation**, a monocular depth cue, the lens of your eye curves to allow you to focus on nearby objects.
- **Motion parallax** is a monocular depth cue in which we view objects that are closer to us as moving faster than objects that are further away from us.

- **Section 4.3 The Auditory and Vestibular Systems:**
- **Sound:**
- The function of the human ear is to detect sound waves and to transform them into neural signals. Sound waves are simply changes in mechanical pressure transmitted through solids, liquids, or gases.
- Sound waves have two important characteristics: frequency and amplitude.
- **Frequency** refers to wavelength and is measured in **hertz (Hz)**, the number of cycles a sound wave travels per second. Frequency is the quality of sound waves that is associated with changes in pitch.
- **Pitch** is the perceptual experience of sound wave frequencies.
  I.e. Pitch is the degree of highness or lowness of a sound.
- High-frequency sounds have short wavelengths and a high pitch.
- Low-frequency sounds have long wavelengths and a low pitch.
- The **amplitude** of a sound wave determines its loudness. High-amplitude sound waves are louder than low-amplitude waves.
- Humans are able to detect sounds in the frequency range from 20 Hz to 20 000 Hz.
- **Loudness**, a function of sound wave amplitude, is typically expressed in units called **decibels (dB)**.
- **The Human Ear:**
- The human ear is divided into outer, middle, and inner regions.
- The most noticeable part of your ear is the **pinna**, the outer region that helps channel sound waves to the ear and allows you to determine the source or location of a sound.
- The **auditory canal** extends from the pinna to the eardrum. Sound waves reaching the eardrum cause it to vibrate. Even very soft sounds, such as a faint whisper, produce vibrations of the eardrum.
- The middle ear consists of three tiny movable bones called **ossicles**, known individually as the **malleus** (hammer), **incus** (anvil), and **stapes** (stirrup).
- The eardrum is attached to these bones, so any movement of the eardrum due to sound vibrations results in movement of the ossicles.
- The ossicles attach to an inner ear structure called the **cochlea**, a fluid-filled membrane that is coiled in a snail-like shape and contains the structures that convert sound into neural impulses.
- Converting sound vibrations to neural impulses is possible because of hair-like projections that line the basilar membrane of the cochlea. The pressing and pulling action of the ossicles causes parts of the basilar membrane to flex. This causes the fluid within the cochlea to move, displacing these tiny hair cells. When hair cells move, they stimulate the cells that comprise the auditory nerves. The auditory nerves are composed of bundles of neurons that fire as a result of hair cell movements. These auditory nerves send signals to the thalamus, the sensory relay station of the brain, and then to the auditory cortex, located within the temporal lobes.

- As you might expect, damage to any part of the auditory system will result in hearing impairments. However, recent technological advances, such as cochlear implants, are allowing individuals to compensate for this hearing loss.
- **Sound Localization Finding the Source:**
- **Sound localization**, the process of identifying where sound comes from, is handled by parts of the brainstem as well as by a midbrain structure called the **inferior colliculus**.
- There are two ways that we localize sound:
    1. We take advantage of the slight time difference between a sound hitting both ears to estimate the direction of the source.
    2. We localize sound by using differences in the intensity in which sound is heard by both ears. This is known as a **sound shadow**.
- **Theories of Pitch Perception:**
- How we perceive pitch is based on the location along the basilar membrane that sound stimulates, a tendency known as the **place theory of hearing**.
- High-frequency sounds stimulate hair cells closest to the ossicles, whereas lower-frequency sounds stimulate hair cells toward the end of the cochlea.
- Another determinant of how and what we hear is the rate at which the ossicles press into the cochlea, sending a wave of activity down the basilar membrane.
- According to **frequency theory**, the perception of pitch is related to the frequency at which the basilar membrane vibrates.
  E.g. A 70-Hz sound stimulates the hair cells 70 times per second. Thus, 70 nerve impulses per second travel from the auditory nerves to the brain, which interprets the sound frequency in terms of pitch.
- However, we quickly reach an upper limit on the capacity of the auditory nerves to send signals to the brain: Neurons cannot fire more than 1000 times per second.
- However, we hear sounds exceeding 1000 Hz because of the **volley principle**. According to the volley principle, groups of neurons fire in alternating fashion.
- **Auditory Perception and the Brain:**
- The **primary auditory cortex** is a major perceptual centre of the brain involved in perceiving what we hear.
- The auditory cortex is organized in a very similar fashion to the cochlea. Cells within different areas across the auditory cortex respond to specific frequencies.
- The primary auditory cortex is surrounded by brain regions that provide additional sensory processing. This secondary auditory cortex helps us to interpret complex sounds, including those found in speech and music.
- The auditory cortices in the two hemispheres of the brain are not equally sensitive. In most individuals the right hemisphere is able to detect smaller changes in pitch than the left hemisphere and thus, the right hemisphere is also superior at detecting sarcasm, as this type of humour is linked to the tone of voice used.
- We are not born with a fully developed auditory cortex. In order to perceive our complex auditory world, the auditory cortices must learn to analyze different patterns of sounds.

- Brain imaging studies have shown that infants as young as three months of age are able to detect simple changes in pitch.
- Infants can detect silent gaps in a tone between the ages of 4 to 6 months, and develop the ability to localize sound at approximately 8 months of age. By 12 months of age, the auditory system starts to become specialized for the culture in which the infant is living. However, infants who are 10–12 months of age do not recognize sound patterns that are not meaningful in their native language or culture. Thus, children in this age group show different patterns of brain activity when hearing culturally familiar and unfamiliar sounds. This brain plasticity explains why many of us have difficulty hearing fine distinctions in the sounds of languages we are exposed to later in life. Interestingly, this fine-tuning of the auditory cortex also influences how we perceive music.
- **The Perception of Music:**
- Our ability to compare different pitches uses both the primary and secondary auditory cortex.
- Music perception also uses the human brain's ability to organize information into a coherent structure or pattern.
- The body's ability to adjust its position leads us to a discussion of another role played by the structures found within our ears: balance.
- When we listen to music, most people are able to detect the fact that certain patterns tend to repeat; as a result, our brains begin to expect beats to occur at specific times. This is the basis of our ability to detect musical beats or rhythms. This ability to detect rhythms or beats appears to be innate as even babies can do it.
- A number of brain imaging studies have shown that perceiving musical beats leads to activity in brain areas that are involved with coordinating movements.
- Researchers have shown that individual differences in the ability to detect musical beats are linked to differences in activity in the basal ganglia, a group of brain structures in the centre of the brain that are related to the coordination of movement.
- However, the basal ganglia does not work alone. When we perceive beats, there is an increase in connectivity between the basal ganglia and areas of the frontal lobe related to the planning of movements.
- Recently, researchers found that individuals with Parkinson's disease, who have damage to structures that input to the basal ganglia, have difficulty picking out subtle musical beats.
- **Sensation and the Vestibular System:**
- Our sense of balance is controlled, at least in part, by our **vestibular system**, a sensory system in the ear that provides information about spatial orientation of the head as well as head motion.
- This system consists of two groups of structures:
    1. The **vestibular sacs** are structures that influence your ability to detect when your head is no longer in an upright position. This section of your vestibular system is made up of two parts, the **utricle** ("little pouch") and the **saccule** ("little sac"). The bottom of both of these sacs is lined with

cilia (small hair cells) embedded in a gelatinous substance. When you tilt your head, the gelatin moves and causes the cilia to bend. This bending of the cilia opens up ion channels, leading to an action potential.

2. The **semicircular canals** are three fluid-filled canals found in the inner ear that respond when your head moves in different directions (up-down, left-right, forward-backward). The semicircular canals are responsible for your ability to perceive when your head is in motion. Receptors in each of these canals respond to movement along one of these planes. At the base of each of these canals is an enlarged area called the **ampulla**. The neural activity within the ampulla is similar to that of the vestibular sacs. Cilia are embedded within a gelatinous mass. When you move your head in different directions, the gelatin moves and causes the cilia to bend. This bending makes an action potential more likely to occur.

- **The Vestibular System and the Brain:**
- The two parts of the vestibular system send information along the vestibular ganglion to nuclei in the brainstem. Vestibular nuclei can then influence activity in a number of brain areas.
- The vestibular nuclei also project to part of the **insula**, an area of cortex that is folded in the interior of the brain. The insula helps us link together visual, somatosensory, and vestibular information.
- One reason for motion sickness is because of an inconsistency in the input from your visual and vestibular systems. The visual input is not moving, yet your vestibular system is sending signals to your brain saying that your body is in a moving car.
- **Module 4.4 Touch and the Chemical Senses:**
- **The Sense of Touch:**
- Sensual experiences are dependent on the actions of several types of receptors located just beneath the surface of the skin and also in the muscles, joints, and tendons. These receptors send information to the **somatosensory cortex** in the parietal lobes of the brain, the neural region associated with your sense of touch.
- Sensitivity to touch varies across different regions of the body. One simple method of testing **acuity** is to use the two-point threshold test. Regions with high acuity, such as the fingertips, can detect the two separate, but closely spaced, pressure points of the device, whereas less sensitive regions such as the lower back will perceive the same stimuli as only one pressure point. Body parts such as the fingertips, palms, and lips are highly sensitive to touch compared to regions such as the calves and forearms.
- Research has shown that women have a slightly more refined sense of touch than men, precisely because their fingers and therefore their receptors are smaller.
- The sensitivity of different parts of the body also influences how much space in the somatosensory cortex is dedicated to analyzing each body part's sensations. Regions of the body that send a lot of sensory input to the brain such as the lips have taken over large portions of the somatosensory cortex while less sensitive regions like the thigh use much less neural space

- Like vision and hearing, touch is very sensitive to change. Merely laying your hand on the surface of an object does little to help identify it. What we need is an active exploration that stimulates receptors in the hand. **Haptics** is the active, exploratory aspect of touch sensation and perception.
- Active touch involves feedback. Haptics allows us not only to identify objects, but also to avoid damaging or dropping them. Fingers and hands coordinate their movements using **kinesthesis**, the sense of bodily motion and position.
- **Feeling Pain:**
- **Nociception** is the activity of nerve pathways that respond to uncomfortable stimulation.
- Our skin, teeth, corneas, and internal organs contain nerve endings called **nociceptors**, which are receptors that initiate pain messages that travel to the central nervous system.
- Two types of nerve fibres transmit pain messages:
    1. Fast fibres register sharp, immediate pain, such as the pain felt when your skin is scraped or cut.
    2. Slow fibres register chronic, dull pain, such as the lingering feelings of bumping your knee into the coffee table.
- The **gate-control theory** states that cells in the spinal cord regulate how much pain signalling reaches the brain. The spinal cord serves as a “neural gate” that pain messages must pass through. The spinal cord contains small nerve fibres that conduct pain messages and larger nerve fibres that conduct other sensory signals such as those associated with rubbing, pinching, and tickling sensations. Stimulation of the small pain fibres results in the experience of pain, whereas the larger fibres inhibit pain signals so that other sensory information can be sent to the brain. Thus, the large fibres close the gate that is opened by the smaller fibres.
- **Phantom Limb Pain:**
- **Phantom limb sensations** are frequently experienced by amputees, who report pain and other sensations coming from the absent limb.
- One explanation for phantom pain suggests that rewiring occurs in the brain following the loss of the limb. After limb amputation, the area of the somatosensory cortex formerly associated with that body part is no longer stimulated by the lost limb. Thus, if someone has her left arm amputated, the right somatosensory cortex that registers sensations from the left arm no longer has any input from this limb. Healthy nerve cells become hypersensitive when they lose connections. The phantom sensations, including pain, may occur because the nerve cells in the cortex continue to be active, despite the absence of any input from the body.
- One ingenious treatment for phantom pain involves the mirror box. This apparatus uses the reflection of the amputee’s existing limb, such as an arm and hand, to create the visual appearance of having both limbs. Amputees often find that watching themselves move and stretch the phantom hand, which is actually the mirror image of the real hand, results in a significant decrease in phantom pain and in both physical and emotional discomfort.

- **The Gustatory System Taste:**
- The **gustatory system** functions in the sensation and perception of taste.
- There are approximately 2500 identifiable chemical compounds in the food we eat. When combined, these compounds give us an enormous diversity of taste sensations. The **primary tastes** include salty, sweet, bitter, and sour. In addition, a fifth taste, **umami**, has been identified. **Umami**, sometimes referred to as "savouriness," is a Japanese word that refers to tastes associated with seaweed, the seasoning monosodium glutamate (MSG), and protein-rich foods such as milk and aged cheese.
- Taste is registered primarily on the tongue, where roughly 9000 taste buds reside. In addition, on average, approximately 1000 taste buds are also found throughout the sides and roof of the mouth.
- The middle of the tongue has very few taste receptors, giving it a similar character to the blind spot on the retina.
- Taste receptors replenish themselves every 10 days throughout the life span—the only type of sensory receptor to do so.
- Receptors for taste are located in the visible, small bumps (papillae) that are distributed over the surface of the tongue. The papillae are lined with taste buds. The bundles of nerves that register taste at the taste buds send the signal through the thalamus and on to higher-level regions of the brain, including the gustatory cortex. Another region, the **secondary gustatory cortex**, processes the pleasurable experiences associated with food.
- One reason that some people experience tastes vividly while other people do not is because the number of taste buds present on the tongue influences the psychological experience of taste. Although approximately 9000 taste buds is the average number found on the human tongue, there is wide variation among individuals. Some people may have many times this number. Supertasters, who account for approximately 25% of the population, are especially sensitive to bitter tastes such as those of broccoli and black coffee. They typically have lower rates of obesity and cardiovascular disease, possibly because they tend not to prefer fatty and sweet foods.
- **The Olfactory System Smell:**
- The **olfactory system** is involved in the detection of airborne particles with specialized receptors located in the nose.
- Our sensation of smell begins with nasal airflow bringing in molecules that bind with receptors at the top of the nasal cavity.
- Within the nasal cavity is the **olfactory epithelium**, a thin layer of cells that are lined by sensory receptors called **cilia**—tiny hair-like projections that contain specialized proteins that bind with the airborne molecules that enter the nasal cavity.
- Humans have roughly 1000 different types of odour receptors in their olfactory system, but can identify approximately 10,000 different smells. This is possible because it is the pattern of the stimulation which gives rise to the experience of a particular smell. Different combinations of cilia are stimulated in response to different odours.

- These groups of cilia then transmit messages directly to neurons that converge on the **olfactory bulb** on the bottom surface of the frontal lobes, which serves as the brain's central region for processing smells. Unlike our other senses, olfaction does not involve the thalamus.
- The olfactory bulb connects with several regions of the brain through the olfactory tract, including the limbic system as well as regions of the cortex where the subjective experience of pleasure or disgust occurs.
- **Multimodal Integration:**
- **Multimodal integration** is the ability to combine sensation from different modalities such as vision and hearing into a single integrated perception.
- **Synesthesia:**
- **Synesthesia** is a condition in which one sense (e.g. hearing) is simultaneously perceived as if by one or more additional senses such as sight.
- More recent studies suggest that the brains of people with synesthesia may contain networks that link different sensory areas in ways not found in other people.
- **Autonomous sensory meridian response (ASMR)** is a condition in which specific auditory or visual stimuli trigger tingling sensations in the scalp and neck, sometimes extending across the back and shoulders. Like synesthesia, ASMR appears to be caused by unusual patterns of connections between different brain areas.

Definitions:

- **Absolute threshold:** The minimum amount of energy or quantity of a stimulus required for it to be reliably detected at least 50% of the time it is presented.
- **Autonomous sensory meridian response (ASMR):** A condition in which specific auditory or visual stimuli trigger tingling sensations in the scalp and neck, sometimes extending across the back and shoulders.
- **Binocular depth cues:** Distance cues that are based on the differing perspectives of both eyes.
- **Bottom-up processing:** Occurs when we perceive individual bits of sensory information (e.g. sounds) and use them to construct a more complex perception (e.g. a message).
- **Cochlea:** A fluid-filled membrane that is coiled in a snail-like shape and contains the structures that convert sound into neural impulses.
- **Conduction hearing loss:** Hearing loss resulting from damage to any of the physical structures that conduct sound waves to the cochlea.
- **Cones:** Photoreceptors that are sensitive to the different wavelengths of light that we perceive as colour.
- **Convergence:** Occurs when the eye muscles contract so that both eyes focus on a single object.
- **Cornea:** The clear layer that covers the front portion of the eye and also contributes to the eye's ability to focus.
- **Dark adaptation:** The process by which the rods and cones become increasingly sensitive to light under low levels of illumination.

- **Difference threshold:** The smallest difference between stimuli that can be reliably detected at least 50% of the time.
- **Divided attention:** Paying attention to more than one stimulus or task at the same time.
- **Doctrine of specific nerve energies:** First proposed in 1826 by the German physiologist Johannes Muller, the doctrine states that the different senses are separated in the brain.
- **Fovea:** The central region of the retina.
- **Frequency theory:** The perception of pitch is related to the frequency at which the basilar membrane vibrates.
- **Gate-control theory:** Explains our experience of pain as an interaction between nerves that transmit pain messages and those that inhibit these messages.
- **Gustatory system:** Functions in the sensation and perception of taste.
- **Haptics:** The active, exploratory aspect of touch sensation and perception.
- **Inattentional blindness:** A failure to notice clearly visible events or objects because attention is directed elsewhere.
- **Iris:** A round muscle that adjusts the size of the pupil; it also gives the eyes their characteristic colour.
- **Kinesthesis:** The sense of bodily motion and position.
- **Lens:** A clear structure that focuses light onto the back of the eye.
- **Monocular cues:** Depth cues that we can perceive with only one eye.
- **Multimodal integration:** The ability to combine sensation from different modalities such as vision and hearing into a single integrated perception.
- **Nociception:** The activity of nerve pathways that respond to uncomfortable stimulation.
- **Olfactory bulb:** A structure on the bottom surface of the frontal lobes that serves as the brain's central region for processing smells.
- **Olfactory epithelium:** A thin layer of cells that are lined by sensory receptors called cilia.
- **Olfactory system:** Involved in smell—the detection of airborne particles with specialized receptors located in the nose.
- **Opponent-process theory:** A theory of colour perception stating that we perceive colour in terms of opposing pairs: red to green, yellow to blue, and white to black.
- **Optic nerve:** A dense bundle of fibres that connect to the brain.
- **Perception:** Involves attending to, organizing, and interpreting stimuli that we sense. Is the study of how physical events relate to psychological perceptions of those events.
- **Perceptual constancy:** The ability to perceive objects as having constant shape, size, and colour despite changes in perspective.
- **Phantom limb sensations:** Frequently experienced by amputees, who report pain and other sensations coming from the absent limb.
- **Pitch:** The perceptual experience of sound wave frequencies.
- **Place theory of hearing:** How we perceive pitch is based on the location along the basilar membrane that sound stimulates.

- **Primary auditory cortex:** A major perceptual centre of the brain involved in perceiving what we hear.
- **Psychophysics:** The study of the relationship between the physical world and the mental representation of that world.
- **Pupil:** Regulates the amount of light that enters the eye by changing its size. It dilates to allow more light to enter and constricts to allow less light into the eye.
- **Retina:** Lines the inner surface of the eye and consists of specialized receptors that absorb light and send signals related to the properties of light to the brain.
- **Retinal disparity/binocular disparity:** The difference in relative position of an object as seen by both eyes, which provides information to the brain about depth.
- **Rods:** Photoreceptors that occupy peripheral regions of the retina. They are highly sensitive under low light levels.
- **Sclera:** Is the white, outer surface of the eye.
- **Selective attention:** Involves focusing on one particular event or task.
- **Semicircular canals:** Three fluid-filled canals found in the inner ear that respond when the head moves in different directions (up-down, left-right, forward-backward).
- **Sensation:** The process of detecting external events with sense organs and turning those stimuli into neural signals.
- **Sensorineural hearing loss:** Hearing loss that results from damage to the cochlear hair cells and the neurons comprising the auditory nerve.
- **Sensory adaptation:** The reduction of activity in sensory receptors with repeated exposure to a stimulus.
- **Signal detection theory:** Whether a stimulus is perceived depends on both sensory experience and judgment made by the subject.
- **Sound localization:** The process of identifying where sound comes from.
- **Top-down processing:** When our perceptions are influenced by our expectations or by our prior knowledge.
- **Transduction:** Takes place when specialized receptors transform the physical energy of the outside world into neural impulses.
- **Trichromatic theory/Young-Helmholtz theory:** Maintains that colour vision is determined by three different cone types that are sensitive to short, medium, and long wavelengths of light.
- **Vestibular sacs:** Structures that influence your ability to detect when your head is no longer in an upright position.
- **Vestibular system:** A sensory system in the ear that provides information about spatial orientation of the head as well as head motion.
- **Weber's law:** States that the just noticeable difference between two stimuli changes as a proportion of those stimuli.

October 21:

- Psyche comes from the Latin word for soul.
- At one point, the mind and the soul meant the same thing, but psychology changed that. Psychologists are studying the mind, not the soul.
- The closest thing psychologists study that is related to the soul is consciousness.
- People used to study consciousness. The very early form of psychology was the psychology of our internal experiences, introspection. Then, we hit behaviourism. Behaviourism said don't talk about consciousness, it's too squishy. We only talk about things we can deal scientifically. However, consciousness has come back, through the cognitive revolution. People are now very interested in consciousness again.
- The first problem with studying consciousness is that there are a lot of definitions to it. So, two people can say they are studying consciousness, but are actually studying two very different things.
- **Consciousness** can refer to:
    1. The state of being awake and alert. Patients in a coma are not conscious. This is more medical oriented.
    2. In a more general sense, being "aware" of something. So one could be conscious of the threat of global warming or conscious of food in front of you.
    3. In a more specific sense, the state of being aware of oneself, or at least one's own thoughts.
       I.e. To be self-conscious or self-aware.
    4. When used as an adjective, "conscious" thoughts or processes are typical linked to goals and the notion of behavioural control. To most psychologists, the unconscious processes are your habits.
- **Capture error** occurs when two potential actions share the same or similar initial sequences but one action is relatively unfamiliar and the other is a well-known and well-practiced action. (The latter is often carried out almost automatically or subconsciously.) Goals and habits can be in conflict.
- **Intentionality:** Consciousness is directed toward something.
- **Unity:** Consciousness is very hard to divide. Most people are only conscious of one thing at a time. The brain chooses which thing to focus on. We're very sensitive to sudden movement and it usually gets our attention.
- **Selectivity:** Only certain aspects of stimuli are brought into consciousness.
- **Transience:** It is difficult to keep consciousness from moving.
  William James referred to this as "**The stream of consciousness**".
- William James also said that you are conscious every minute of every day.
- Some of the challenges that psychology faces around the concept of consciousness are:
    1. It is the "squishiest" concept we have.
    2. **Subjective phenomenology/qualia**: The psychological study of subjective experience. B.F. Skinner and others thought that our subjective phenomenology is just an illusion. He believed that our mental events are

caused by physical events in the brain, but have no effects upon any physical events. This is known as **epiphenomenalism**.

3. **The mind/body problem**: We believe that there's a distinction between our mind and our consciousness. We have questions such as "How do thoughts and our brain interact?", "Do they even interact?", and "Are they separate worlds?" There are a lot of evidence that suggests that our thoughts and brain do interact in powerful ways. Han Selye, a Canadian psychologist who studied stress, said that stressful people are very unhealthy. This is important because stress is mental.
4. **The problem of other minds and the notion of theory of mind**: This is not empathy. We can never know what's in someone's mind, but we can see how other people behave and guess what's in their mind. The theory of mind is how well you can tell what other people are thinking, while empathy is a sharing of their emotional state. Psychopaths are very good at the theory of mind.

- The radial arm maze experiment is when researchers place a rat in the centre of a maze, where there are a lot of arms. In each arm, there's food. It has been found that after the rat goes into one arm, eats the food, and goes back to the centre, it won't go down the same arm again. It remembers which arm it went down. However, if you removed the rat's hippocampus, they sometimes will still go down the same arm.
- Rene Descarte said that the human body is like a complex biological machine, but we still have a soul that can control our actions.
- Often habits result from indoctrination, and not from rational (conscious) thought. I.e. Habits are formed by repetition.
- The Freudian notion of unconsciousness has a sensor that blocks things it thinks that your consciousness can't handle.
- The Freudian notion of unconsciousness has its own goals. However, to most psychologists, only the conscious has goals. So, the Freudian notion of unconsciousness seems too complex for most psychologists and scientists.
- The dichotic listening task is when you a participant puts on a headphone, but there are different sounds coming out of each side. The participant is asked to focus on one sound and to repeat what they heard. People can not listen to both sounds simultaneously. However, people could tell you what they listened to in one sound.

October 28:

- For dichotic listening tasks, people will only notice stuff in the ear that is not focusing on the sound if there was a dramatic perceptual change.
- Donald Broadbent discovered that the things we don't pay attention to, we hardly process at all. However, subsequent experiments showed that Broadbent's theory was too strong.
- Participants often notice their name when it's in the unattended channel.
- Participants will follow the "message" (semantic meaning) from the attended to the unattended ear.

- Our previous discussion of consciousness was focused on the normal conscious experience of an awake, sober, self-controlled individual, but normal consciousness can be altered by sleep, hypnosis, drugs and sensory perception.
- Why we sleep:
    - Psychologists don't really know why we sleep. While there is some truth to evolution, sometimes evolution-based arguments are too flexible.
    - One theory states that sleep must be very critical. We sleep for about 8 hours a day and during those 8 hours, we're defenseless. Therefore, sleep must play some very important role.
    - Another theory states that since vision is human's best sense and our vision is limited during the night, we can sleep during the night to conserve energy for the day.
- Stages of sleep:
    - There are 5 main stages of sleep.
    - The first stage is stage 1. This is about 4-5% of the time you will spend in phase 1. Light sleep. Muscle activity slows. Occasional muscle twitching. Brain waves have low amplitude and high frequency. (Alpha wave)
    - The next stage is stage 2. This is about 44-55% of the time you will spend in phase 1. Breathing pattern and heart rate slows. Slight decrease in body temperature. Starting to go to sleep.
    - The next stage is stage 3. This is about 4-6% of the time you will spend in phase 1. This is the beginning of deep sleep. Brain begins generating delta waves. Brain waves have high amplitude and low frequency.
    - The next stage is stage 4. This is about 12-15% of the time you will spend in phase 1. This is very deep sleep. Rhythmic breathing. Limited muscle activity. Brain produces delta waves. People sleepwalk in this phase.
    - The final stage is stage 5. This is known is REM sleep. This is about 20-25% of the time you will spend in phase 1. Rapid eye movement. Brainwaves speed up and dreaming occurs. Muscles relax and heart rate increases. Breathing is rapid and shallow. The electrical activity is similar to that of an awake person. However for most people, their body is paralyzed. For the people whose body is not paralyzed, they act out their dreams and can get hurt. For others, they may be conscious, but their body is paralyzed. As such, they lay awake, unable to move. This is called **sleep paralysis**.
- Most people wake up just as the paralyzing drug is exiting their body. This makes their body feel hard.
- Sometimes, our nightmares are connected to sleep paralysis. When the brain realizes that the body is paralyzed, it makes up stories to make sense of why the body is paralyzed.
- In stage 4, people might get **night terrors**. A person experiencing a night terror feel like they're about to die. People feel more scared in night terrors than nightmares.
- In stage 5, people might get nightmares.

- The sleep cycle is repeated many times during our sleep. The most likely order of sleep stages during the first 90 minutes of a night is Stages 1-2-3-4-3-2-REM.
- As you sleep longer, you sleep less time in deep sleep and more time in light sleep or REM.
- If you wake up naturally, you're more likely to remember your dreams. However, if you wake up by an alarm clock or your parents, depending on where you're at in the sleep cycle, you might remember or forget your dream. If you're in REM when you're woken up, you'll remember your dreams. Otherwise, you won't.
- Although proper sleep seems to be tied to good health, the link may be more psychological than physical, at least in the most simplistic terms.
- Habitual tasks seem to be immune to sleep disruption, only those that require deep thought seem to be affected by lack of sleep.
- Deep sleep is associated with learning of information.
- REM sleep is associated with learning of skills.
- **Insomnia** which is associated with a wide range of both cognitive impairments and health risks is often associated with worry, guilt or stress and can lead to addiction to sleep medications.
- **Parasomnias**, which includes somnambulism (sleep walking), is when a person does waking behaviours (walking, eating, etc) while sleeping. This usually occurs when the person is in Stage 4 sleep. This is linked to improper paralysis and usually motor activity synchrony.
- Hypnotic induction almost always begins with progressive relaxation. The resulting state of deep relaxation often makes the client open to suggestion and capable of experiencing rich imagery. A therapist can use this context to produce strong associations, or to walk through positive mental experiences, that can have an effect after the session.

Textbook:

- **Section 5.1 Biological Rhythms of Consciousness Wakefulness and Sleep:**
- **Consciousness** is a person's subjective awareness, including thoughts, perceptions, experiences of the world, and self-awareness.
- **Biological Rhythms:**
- Organisms have evolved **biological rhythms** that are neatly adapted to the cycles in their environment.
- **Circannual rhythms** are biological rhythms with a period length approximating to 1 year. Circannual rhythms are examples of **infradian rhythm**, which is any rhythm that occurs over a period of time longer than a day. In humans, the best-known infradian rhythm is the menstrual cycle.
- Most biological rhythms occur with a much greater frequency than once a month. For instance, heart rate, urination, and some hormonal activity occur in 90–120-minute cycles. These more frequent biological rhythms are referred to as **ultradian rhythms**.
- The biological rhythm that appears to have the most obvious impact upon our lives is a cycle that occurs over the course of a day. **Circadian rhythms** are internally driven daily cycles of approximately 24 hours affecting physiological and behavioural processes. They involve the tendency to be asleep or awake at

specific times, to feel hungrier during some parts of the day, and even the ability to concentrate better at certain times than at others.

- Night shift workers and night owls aside, we tend to get most of our sleep when it is dark outside because our circadian rhythms are regulated by daylight interacting with our nervous and endocrine (hormonal) systems. One key brain structure in this process is the **suprachiasmatic nucleus (SCN)** of the hypothalamus. Cells in the retina of the eye relay messages about light levels in the environment to the SCN. The pineal gland releases a hormone called **melatonin**, which peaks in concentration at nighttime and is reduced during wakefulness. Information about melatonin levels feeds back to the hypothalamus; this feedback helps the hypothalamus monitor melatonin levels so that the appropriate amount of this hormone is released at different times of the day. Cells in the retina send messages about light levels to the suprachiasmatic nucleus, which in turn relays the information to the pineal gland, which secretes melatonin.
- There are two explanations for our 24-hour rhythms:
    1. One is **entrainment**, when biological rhythms become synchronized to external cues such as light, temperature, or even a clock. Because of its effects on the SCN-melatonin system, light is the primary entrainment mechanism for most mammals. We tend to be awake during daylight and asleep during darkness. We're also influenced by the time on our clocks.
    2. The other is **endogenous rhythms**, biological rhythms that are generated by our body independent of external cues such as light. While most people possess an endogenous circadian rhythm that is 24–25 hours in length, some people have longer cycles, sometimes as long as 48-hour days.
- Although our sleep–wake cycle remains relatively close to 24 hours in length throughout our lives, some patterns within our circadian rhythms do change with age. Researchers have found that we need much less sleep, especially a type called REM sleep, as we move from infancy and early childhood into adulthood. Moreover, people generally experience a change in when they prefer to sleep. In your teens and 20s, many of you have or will become night owls who prefer to stay up late and sleep in. When given the choice, most people in this age range prefer to work, study, and play late in the day, and then awake later in the morning. Later in adulthood, many of you will find yourselves going to bed earlier and getting up earlier, and you may begin to prefer working or exercising before teenagers even begin to stir.
  People tend to spend progressively less time sleeping as they age. The amount of a certain type of sleep, REM sleep, declines the most.
- **The Stages of Sleep:**
- Sleep itself has rhythms. In order to measure these rhythms, scientists use **polysomnography**, a set of objective measurements used to examine physiological variables during sleep. Sleep cycles themselves are most often defined by the **electroencephalogram (EEG)**, a device that measures brain activity using sensors attached to the scalp. EEGs detect changes involving the ion channels on neurons. Ion channels are involved with receiving excitatory and

inhibitory potentials from other cells and are also involved with the transmission of an action potential down the axon. Each EEG sensor would receive input from hundreds (possibly thousands) of cells. The output of an EEG is a waveform, representing the overall activity of these groups of neurons. These waves can be described by their **frequency**, the number of up-down cycles every second, and their **amplitude**, the height and depth of the up-down cycle. **Beta waves**, high-frequency, low-amplitude waves (15–30 Hz), are characteristic of wakefulness. Their irregular nature reflects the bursts of activity in different regions of the cortex, and they are often interpreted as a sign that a person is alert. As the individual begins to shift into sleep, the waves start to become slower, larger, and more predictable; these **alpha waves** (8–14 Hz) signal that a person may be daydreaming, meditating, or starting to fall asleep. These changes in the characteristics of the waves continue as we enter deeper and deeper stages of sleep.

- The EEG signals during sleep move through four different stages. In stage 1, brain waves slow down and become higher in amplitude. These are known as **theta waves** (4–8 Hz). Breathing, blood pressure, and heart rate all decrease slightly as an individual begins to sleep. However, at this stage of sleep, you are still sensitive to noises such as the television in the next room. After approximately 10 to 15 minutes, the sleeper enters stage 2, during which brain waves continue to slow. Stage 2 includes **sleep spindles** (clusters of high-frequency but low-amplitude waves) and **K complexes** (small groups of larger amplitude waves), which are detected as periodic bursts of EEG activity. What these bursts in brain activity mean is not completely understood, but evidence suggests they may play a role in helping maintain a state of sleep and in the process of memory storage. As stage 2 sleep progresses, we respond to fewer and fewer external stimuli, such as lights and sounds. Approximately 20 minutes later, we enter stage 3 sleep, in which brain waves continue to slow down and assume a new form called **delta waves** (large, looping waves that are high-amplitude and low-frequency—typically less than 3 Hz). The process continues with the deepest stage of sleep, stage 4, during which time the sleeper will be difficult to awaken. About an hour after falling asleep, we reach the end of our first stage 4 sleep phase. At this point, the sleep cycle goes in reverse and we move back toward stage 2. From there, we move into a unique stage of **REM sleep**, a stage of sleep characterized by quickening brain waves, inhibited body movement, and rapid eye movements (REM). This stage is sometimes known as paradoxical sleep because the EEG waves appear to represent a state of wakefulness despite the fact that we remain asleep. The REM pattern is so distinct that the first four stages are known collectively as non-REM (NREM) sleep. At the end of the first REM phase, we cycle back toward deep sleep stages and back into REM sleep again every 90 to 100 minutes.
- The most likely order of sleep stages during the first 90 minutes of a night of rest is Stages 1-2-3-4-3-2-REM.
- The deeper stages of sleep (3 and 4) predominate during the earlier portions of the sleep cycle, but gradually give way to longer REM periods.

- Brain waves, as measured by the frequency and amplitude of electrical activity, change over the course of the normal circadian rhythm. Beta waves are predominant during wakefulness but give way to alpha waves during periods of calm and as we drift into sleep. Theta waves are characteristic of stage 1 sleep. As we reach stage 2 sleep, the amplitude (height) of brain waves increases. During deep sleep (stages 3 and 4), the brain waves are at their highest amplitude. During REM sleep, they appear similar to the brain waves occurring when we are awake.
- Our sleep stages progress through a characteristic pattern. The first half of a normal night of sleep is dominated by deep, slow-wave sleep. REM sleep increases in duration relative to deep sleep during the second half of the night.
- **Why Do We Need Sleep:**
- The most intuitive explanation for why we sleep is probably the **restore and repair hypothesis**, the idea that the body needs to restore energy levels and repair any wear and tear experienced during the day's activities. Research on sleep deprivation clearly shows that sleep is a physical and psychological necessity. A lack of sleep eventually leads to cognitive decline, emotional disturbances, and impaired functioning of the immune system. It appears that sleeping helps animals, including humans, clear waste products and excess proteins from the brains.
- A second explanation for sleep, the **preserve and protect hypothesis**, suggests that two more adaptive functions of sleep are preserving energy and protecting the organism from harm. To support this hypothesis, researchers note that the animals most vulnerable to predators sleep in safe hideaways during the time of day when their predators are most likely to hunt. Because humans are quite dependent upon vision, it made sense for us to sleep at night, when we would be at a disadvantage compared to nocturnal predators.
- **Sleep Deprivation and Sleep Displacement:**
- **Sleep deprivation** occurs when an individual cannot or does not sleep. It can be due to some external factor that is out of your control or to some self-inflicted factor.
- The problems associated with sleep deprivation aren't limited to your ability to think. Research with adolescents shows that for every hour of sleep deprivation, predictable increases in physical illness, family problems, substance abuse, and academic problems occur. Issues also arise with your coordination, a problem best seen in studies of driving ability. Using a driving simulator, researchers found that participants who had gone a night without sleeping performed at the same level as people who had a blood-alcohol level of 0.07. Given that sleep deprivation is as dangerous as driving while mildly intoxicated, it is not surprising that it is one of the most prevalent causes of fatal traffic accidents.
- Cognitive and coordination errors are not limited to situations involving full or partial sleep deprivation. They can also occur when the timing of our sleep is altered. This phenomenon, **sleep displacement**, occurs when an individual is prevented from sleeping at the normal time although she may be able to sleep earlier or later in the day than usual.

- **Jet lag** is the discomfort a person feels when their sleep cycles are out of synchronization with light and darkness.
- It is typically easier to adjust when travelling west. When travelling east, a person must try to fall asleep earlier than usual, which is difficult to do. Most people find it easier to stay up longer than usual, which is what westward travel requires.
- **The Psychoanalytic Approach:**
- One of the earliest and most influential theories of dreams was developed by Sigmund Freud in 1899 in his novel, The Interpretation of Dreams. Freud viewed dreams as an unconscious expression of wish fulfillment. He believed that humans are motivated by primal urges, with sex and aggression being the most dominant. Because giving in to these urges is impractical/immoral/illegal most of the time, we learn ways of keeping these urges suppressed and outside of our conscious awareness. When we sleep, however, we lose the power to suppress our urges. Without this active suppression, these drives are free to create the vivid imagery found in our dreams. This imagery can take two forms:
    1. **Manifest content** involves the images and storylines that we dream about. In many of our dreams, the manifest content involves sexuality and aggression, consistent with the view that dreams are a form of wish fulfillment. In other cases, the manifest content of dreams might seem like random, bizarre images and events. However, Freud would argue that these images are anything but random; instead, he believed they have a hidden meaning.
    2. **Latent content** is the actual symbolic meaning of a dream built on suppressed sexual or aggressive urges. Because the true meaning of the dream is latent, Freud advocated **dream work**, the recording and interpreting of dreams. Through such work, Freudian analysis would allow you to bring the previously hidden sexual and aggressive elements of your dreams into the forefront.
- **The Activation–Synthesis Hypothesis:**
- Freud saw deep psychological meaning in the latent content of dreams. In contrast, the **activation–synthesis hypothesis** suggests that dreams arise from brain activity originating from bursts of excitatory messages from the pons, a part of the brainstem. This electrical activity produces the telltale signs of eye movements and patterns of EEG activity during REM sleep that resemble wakefulness; moreover, the burst of activity stimulates the occipital and temporal lobes of the brain, producing imaginary sights and sounds, as well as numerous other regions of the cortex. Thus, the brainstem initiates the activation component of the model. The synthesis component arises as different areas of the cortex of the brain try to make sense of all the images, sounds, emotions, and memories.
- The pons, located in the brainstem, sends excitatory messages through the thalamus to the sensory and emotional areas of the cortex. The images and emotions that arise from this activity are then woven into a story. Inhibitory signals are also relayed from the pons down the spinal cord, which prevents movement during dreaming.

- If the cortex is able to provide a temporary structure to input from the brainstem and other regions of the brain, then that means the brain is able to work with and restructure information while we dream.
- Interestingly, REM sleep is not the only stage of sleep that affects our ability to learn. There is some evidence that the sleep spindles found in stage 2 sleep are involved with learning new movements.
- **Working the Scientific Literacy Model Dreams, REM Sleep, and Learning:**
- The activation–synthesis model of dreaming suggests that our dreams result from random brainstem activity that is organized, to some degree, by the cortex. Although this theory is widely accepted, it doesn't provide many specifics about the purpose of dreams. Dream researcher Rosalind Cartwright proposed the **problem-solving theory**, the theory that thoughts and concerns are continuous from waking to sleeping, and that dreams may function to facilitate finding solutions to problems encountered while awake. This theory suggests that many of the images and thoughts we have during our dreams are relevant to the problems that we face when we are awake. Although no one doubts that our daily concerns find their way into our dreams, the problem-solving theory does not explain if or how any specific cognitive mechanisms are influenced by dreaming. In contrast, increasing evidence suggests that REM sleep, the sleep stage involved with dreaming, is essential for a number of cognitive functions.
- Approximately 20–25% of our total sleep time is taken up by REM, or rapid eye movement, sleep. When we are deprived of REM sleep, we typically experience **REM rebound**, our brains spend increased time in REM-phase sleep when given the chance. The fact that our bodies actively try to catch up on missed REM sleep suggests that it may serve an important function.
- REM sleep produces brainwaves similar to being awake, yet we are asleep. This similarity suggests that the types of functions being performed by the brain are likely similar during the two states. Studies with animals have shown that REM sleep is associated with a number of different neurotransmitter systems, all of which influence activity in the brainstem. Projections from the brainstem can then affect a number of different functions, including movement, emotional regulation, and learning.
- Several studies have shown that the amount of REM sleep people experience increases the night after learning a new task.
- Research has also demonstrated that REM sleep and dreaming also influence our ability to problem solve.
- **Insomnia:**
- The most widely recognized sleeping problem is **insomnia**, a disorder characterized by an extreme lack of sleep.
- Although the average adult may need 7 to 8 hours of sleep to feel rested, substantial individual differences exist. For this reason, insomnia is defined not in terms of the number of hours of sleep, but rather in terms of the degree to which a person feels rested during the day. If a person feels that her sleep disturbance is affecting her schoolwork, her job, or her family and social life, then it is indeed a problem. However, for this condition to be thought of as a sleep disorder, it

would have to be present for three months or more—one or two “bad nights” is unpleasant, but is not technically insomnia.

- Although insomnia is often thought of as a single disorder, it may be more appropriate to refer to insomnias in the plural. **Onset insomnia** occurs when a person has difficulty falling asleep (30 minutes or more), **maintenance insomnia** occurs when an individual cannot easily return to sleep after waking in the night, and **terminal insomnia/early morning insomnia** is a situation in which a person wakes up too early—sometimes hours too early—and cannot return to sleep.
- It is important to remember that for a sleep disorder to be labelled insomnia, the problems with sleeping must be due to some internal cause. Sometimes insomnia occurs as part of another problem, such as depression, pain, developmental disorders such as attention deficit hyperactivity disorder (ADHD), or various drugs. in these cases, the sleep disorder is referred to as a **secondary insomnia**.
- When insomnia is the only symptom that a person is showing, and other causes can be ruled out, physicians would label the sleep disorder as **insomnia disorder.**
- **Nightmares and Night Terrors:**
- **Nightmares** are particularly vivid and disturbing dreams that occur during REM sleep. They can be so emotionally charged that they awaken the individual.
- Data from numerous studies indicate that nightmares are correlated with psychological distress including anxiety, negative emotionality, and emotional reactivity.
- Nightmares are more common in females, likely because women tend to have higher levels of depression and emotional disturbances. In individuals with emotional disorders, the “synthesis” part of dreaming appears to reorganize information in a way consistent with their mental state, with a focus on negative emotion.
- **Night terrors** are intense bouts of panic and arousal that awaken the individual, typically in a heightened emotional state.
- These episodes occur during NREM sleep, and the majority of people who experience them typically do not recall any specific dream content. Night terrors increase in frequency during stressful periods. There is also some evidence linking them to feelings of anxiety.
- **Movement Disturbances:**
- To sleep well, an individual needs to remain still. During REM sleep, the brain prevents movement by sending inhibitory signals down the spinal cord. A number of sleep disturbances, however, involve movement and related sensations. For example, **restless legs syndrome** is a persistent feeling of discomfort in the legs and the urge to continuously shift them into different positions.
- A more common movement disturbance is **somnambulism/sleepwalking**, a disorder that involves wandering and performing other activities while asleep. It occurs during NREM sleep, stages 3 and 4, and is more prevalent during childhood. Sleepwalking is not necessarily indicative of any type of sleep or emotional disturbance, although it may put people in harm’s way. People who

sleepwalk are not acting out dreams, and they typically do not remember the episode. It is not dangerous to wake up a sleepwalker, as is commonly thought. At worst, he or she will be disoriented. There is no reliable medicine that curbs sleepwalking; instead, it is important to add safety measures to the person's environment so that the sleepwalker doesn't get hurt.

- A similar, but more adult, disorder is **sexomnia/sleep sex**. Individuals with this condition engage in sexual activity such as the touching of the self or others, vocalizations, and sex-themed talk while in stages 3 and 4 sleep.
- Another potentially dangerous condition is **REM behaviour disorder**. People with this condition do not show the typical restriction of movement during REM sleep; in fact, they appear to be acting out the content of their dreams. Unlike sleepwalking and restless legs syndrome, REM behaviour disorder can be treated with medication; benzodiazepines, which inhibit the central nervous system, have proven effective in reducing some of the symptoms associated with this condition.
- **Sleep Apnea:**
- **Sleep apnea** is a disorder characterized by the temporary inability to breathe during sleep.
- Although a variety of factors contribute to sleep apnea, this condition appears to be most common among overweight and obese individuals, and it is roughly twice as prevalent among men as among women.
- In most cases of apnea, the airway becomes physically obstructed at a point anywhere from the back of the nose and mouth to the neck. Therefore, treatment for mild apnea generally involves dental devices that hold the mouth in a specific position during sleep. Weight-loss efforts should accompany this treatment in cases in which it is a contributing factor. In moderate to severe cases, a continuous positive airway pressure (CPAP) device can be used to force air through the nose, keeping the airway open through increased air pressure.
- In rare but more serious cases, sleep apnea can also be caused by the brain's failure to regulate breathing. This failure can happen for many reasons, including damage to or deterioration of the medulla of the brainstem, which is responsible for controlling the chest muscles during breathing.
- **Narcolepsy:**
- **Narcolepsy** is a disorder in which a person experiences extreme daytime sleepiness and even sleep attacks.
- These bouts of sleep may last only a few seconds, especially if the person is standing or driving when she falls asleep and is jarred awake by falling, a nodding head, or swerving of the car. Even without such disturbances, the sleep may last only a few minutes or more, so it is not the same as falling asleep for a night's rest.
- Narcolepsy differs from more typical sleep in a number of other ways. People with a normal sleep pattern generally reach the REM stage after more than an hour of sleep, but a person experiencing narcolepsy is likely to go almost immediately from waking to REM sleep. Also, because REM sleep is associated

with dreaming, people with narcolepsy often report vivid dream-like images even if they did not fully fall asleep.

- Individuals with narcolepsy have fewer brain cells that produce orexin, a hormone that functions to maintain wakefulness, resulting in greater difficulty maintaining wakefulness.
- **Overcoming Sleep Problems:**
- Fortunately, most people respond very well to psychological interventions. By practising good **sleep hygiene**, healthy sleep-related habits, they can typically overcome sleep disturbances in a matter of a few weeks.
- While alcohol can make you sleepy, it disrupts the quality of sleep, especially the REM cycle, and may leave you feeling unrested the next day.
- Many people turn to drugs to help them sleep. A number of sleep aids are available on an over-the-counter basis, and several varieties of prescription drugs have been developed as well. Although these drugs managed to put people to sleep, several problems with their use were quickly observed. Notably, people quickly developed tolerance to these agents, meaning they required increasingly higher doses to get the same effect, and many soon came to depend on the drugs so much that they could not sleep without them.
- **Here are some Non-pharmacological Techniques for Improving Sleep:**
    1. Use your bed for sleeping only, not for working or studying.
    2. Do not turn sleep into work. Putting effort into falling asleep generally leads to arousal instead of sleep.
    3. Keep your clock out of sight. Watching the clock increases pressure to sleep and worries about getting enough sleep.
    4. Get exercise early during the day. Exercise may not increase the amount of sleep, but it may help you sleep better. Exercising late in the day, however, may leave you restless and aroused at bedtime.
    5. Avoid substances that disrupt sleep. Such substances include caffeine (in coffee, tea, many soft drinks, and other sources), nicotine, and alcohol. Illicit drugs such as cocaine, marijuana, and ecstasy also disrupt healthy sleep.
    6. If you lie in bed worrying at night, schedule evening time to deal with stress. Write down your worries and stressors for approximately 30 minutes prior to bedtime.
    7. If you continue to lie in bed without sleeping for 30 minutes, get up and do something else until you are about to fall asleep, and then return to bed.
    8. Get up at the same time every morning. Although this practice may lead to sleepiness the first day or two, eventually it helps set a daily rhythm.
    9. If you still have problems sleeping after four weeks, consider seeing a sleep specialist to get tested for sleep apnea, restless legs syndrome, or other sleep problems that may require more specific interventions.

- **Section 5.2: Altered States of Consciousness Hypnosis, Mind-Wandering, and Disorders of Consciousness:**
- **Hypnosis:**
- **Hypnosis** is a procedure of inducing a heightened state of suggestibility.
- Hypnosis is not a trance
- Hypnotic suggestions generally are most effective when they fall into one of three categories:
    1. **Ideomotor suggestions** are related to specific actions that could be performed, such as adopting a specific position.
    2. **Challenge suggestions** indicate actions that are not to be performed, so that the subject appears to lose the ability to perform an action.
    3. **Cognitive-perceptual suggestions** involve a subject remembering or forgetting specific information, or experiencing altered perceptions such as reduced pain sensations.
- It is important to note that hypnotists cannot make someone do something against their will.
  E.g. The hypnotist could not suggest that an honest person rob a bank and expect the subject to comply. Instead, the hypnotist can increase the likelihood that subjects will perform simple behaviours that they have performed or have thought of before, and would be willing to do, in some contexts, when in a normal conscious state.
- **Theories of Hypnosis:**
- The word hypnosis comes from the Greek word hypno, meaning “sleep.” However, in reality, scientific research tells us that hypnosis is nothing like sleep. Instead, hypnosis is based on an interaction between:
    1. Automatic (unconscious) thoughts and behaviours.
    2. A supervisory system sometimes referred to as **executive processing**, which is involved in processes such as the control of attention and problem solving
- **Dissociation theory** explains hypnosis as a unique state in which consciousness is divided into two parts: a lower-level system involved with perception and movement and an “executive” system that evaluates and monitors these behaviours.
- This kind of divided state is actually quite common. Take any skill that you have mastered, such as driving a car or playing an instrument. When you began, it took every bit of your conscious awareness to focus on the correct movements—you were a highly focused observer of your actions. In this case, your behaviour required a lot of executive processing. After a few years of practice, you can do it automatically while you observe and pay attention to something else. In this case, you require much less executive processing. Although we call the familiar behaviour automatic, part of you is still paying attention to what you are doing in case you suddenly need to change your behaviour.

- During hypnosis, there appears to be a separation between these two systems. As a result, actions or thoughts suggested by the hypnotist may bypass the evaluation and monitoring system and go directly to the simpler perception and movement systems. In other words, suggestible individuals will experience less input from the executive system. In support of this view, neuroimaging studies have found reduced activity in the anterior cingulate cortex, a region of the frontal lobe related to executive functions, in hypnotized subjects.
- A second approach, **social-cognitive theory**, explains hypnosis by emphasizing the degree to which beliefs and expectations contribute to increased suggestibility. This perspective is supported by experiments in which individuals who are not yet hypnotized are told either that they will be able to resist ideomotor suggestions or that they will not be able to resist them. In these studies, people tend to conform to what they have been told to expect—a result that cannot be easily explained by dissociation theory. Similarly, research on hypnosis as a treatment for pain shows that response expectancy, whether the individual believes the treatment will work, plays a large role in the actual pain relief experienced.
- **Applications of Hypnosis:**
- Hypnosis has been used to treat a number of different physical and psychological conditions. Hypnosis is often used in conjunction with other psychotherapies such as cognitive-behavioural therapy rather than as a stand-alone treatment. The resulting **cognitive hypnotherapy** has been used as an effective treatment for depression, anxiety, eating disorders, hot flashes of cancer survivors, and irritable bowel syndrome.
- Hypnosis is far from a cure-all.
- The best conclusion regarding hypnosis in therapy is that it shows promise, especially when used in conjunction with other evidence-based psychological or medical treatments.
- Perhaps the most practical use for hypnosis is in the treatment of pain. If researchers can demonstrate its effectiveness in this application, it may be a preferred method of pain control given painkillers' potential side effects and risk of addiction. Research has shown that hypnosis generally works as well as drug treatments for **acute pain**, which is the intense, temporary pain associated with a medical or dental procedure. The effect of hypnosis on chronic pain is more complicated, as some conditions are due to purely physical causes whereas others are more psychological in nature. For these latter conditions, it is likely that the patient will expect to continue to feel pain regardless of the treatment, thus reducing the effectiveness of hypnosis.
- Hypnosis does not improve memory. Today, responsible psychologists do not use hypnotherapy to uncover or reconstruct lost memories. Police officers have also largely given up this practice. In 2007, the Supreme Court of Canada ruled that testimony based on hypnosis sessions alone cannot be submitted as evidence.

- **Mind-Wandering:**
- **Mind-wandering** is the unintentional redirection of attention from one's current task to an unrelated train of thought.
- Several studies have shown that mind-wandering decreases reading comprehension.
- **Mind-Wandering and the Brain:**
- In the late 1990s, Marcus Raichle and his research team made a discovery that would change psychology. While looking at their brain-imaging data, Raichle noticed that a number of brain areas were active. But Raichle noticed something else in his data. He noticed that across a number of studies, the same pattern of deactivations also occurred.
  I.e. A network of brain regions became less active when participants performed a task.
  This network, now known as the **default mode network**, is a network of brain regions including the medial prefrontal cortex, posterior cingulate gyrus, and medial and lateral regions of the parietal lobe that is most active when an individual is awake but not responding to external stimuli.
  I.e. The default mode network is more active when a person is paying attention to his internal thoughts rather than to an outside stimulus or task.
- The default mode network also appears to be related to mind-wandering.
- However, the default mode network wasn't the only group of brain areas found to be active during mind-wandering. A network involving parts of the frontal and parietal lobes also showed increased activity when mind-wandering was occurring. This **frontoparietal network** is associated with goal-directed thinking such as planning for the future, as well as the control of attention.
- The default mode network is involved with self-related thinking. The frontoparietal network is linked with goal-directed thought and planning. Both are involved with mind-wandering.
- **The Benefits of Mind-Wandering:**
- Mind-wandering typically occurs during tasks that are repetitive, don't require much thought, and/or that we've experienced before. If we're not dedicating many mental resources to a given task, we will have more resources to dedicate to mind-wandering.
- One function of the frontal lobes is planning future goals and actions. As it turns out, mind-wandering is related to future thinking.
- **Disorders of Consciousness:**
- The lowest level of consciousness in a person who is still technically alive is known as **brain death**, a condition in which the brain, specifically including the brainstem, no longer functions. Individuals who are brain dead have no hope of recovery because the brainstem regions responsible for basic life functions like breathing and maintaining the heartbeat do not function

- In contrast to brain death, a **coma** is a state marked by a complete loss of consciousness. It is generally due to damage to the brainstem or to widespread damage to both hemispheres of the brain. Patients who are in a coma have an absence of both wakefulness and awareness of themselves or their surroundings. Some of the patient's brainstem reflexes will be suppressed, including pupil dilation and constriction in response to changes in brightness. Typically, patients who survive this stage begin to recover to higher levels of consciousness within 2–4 weeks, although there is no guarantee that the patient will make a full recovery.
- If a patient in a coma improves slightly, the individual may enter a **persistent vegetative state**, a state of minimal to no consciousness in which the patient's eyes may be open, and the individual will develop sleep–wake cycles without clear signs of consciousness. For example, vegetative state patients do not appear to focus on objects in their visual field, nor do they track movement. These patients generally do not have damage to the brainstem. Instead, they have extensive brain damage to the grey matter and white matter of both hemispheres, leading to impairments of most functions. The likelihood of recovery from a vegetative state is time dependent. If a patient emerges from this state within the first few months, he or she could regain some form of consciousness. In contrast, if symptoms do not improve after three months, the patient is classified as being in a **permanent vegetative state**; the chances of recovery from that diagnosis decrease sharply.
- There are two other disorders of consciousness that are often diagnosed by neurologists.
    1. **Minimally conscious state (MCS)**, a disordered state of consciousness marked by the ability to show some behaviours that suggest at least partial consciousness, even if on an inconsistent basis. A minimally conscious patient must show some awareness of himself or his environment, and be able to reproduce this behaviour. Examples of some behaviours that are tested are following simple commands, making gestures or yes/no responses to questions, and producing movements or emotional reactions in response to some person or object in their environment. When neuroimaging is used, minimally conscious patients show more activity than vegetative patients, including activity in some higher-order sensory and cognitive region.
    2. The disorder of consciousness that most resembles the healthy, awake state, at least in terms of awareness, is **locked-in syndrome**, a disorder in which the patient is aware and awake but, because of an inability to move his or her body, appears unconscious.
- **Working the Scientific Literacy Model Assessing Consciousness in the Vegetative State:**
- The initial assessment of consciousness in severely brain-damaged patients is generally performed at the patient's bedside. Doctors will perform tests of a patient's reflexes and examine other simple responses. The most common assessment tool is the **Glasgow Coma Scale (GCS)**, a 15-item checklist for the

physician. The GCS measures eye movements—whether they can open at all, open in response to pain, open in response to speech, or open spontaneously without any reason. The next five items on this checklist assess language abilities. The final six items measure movement abilities such as whether the patient responds to pain and whether she can obey commands. Scores of 9 or below reflect a severe disturbance of consciousness. For comparison, individuals suffering from a concussion tend to score between 13 and 15, which is labelled as a mild disturbance.

- Checklists such as the GCS provide a useful initial indicator of a brain-damaged patient's abilities. However, many of the behaviours measured by this and similar assessment tools focus more on overt behaviours than on direct indications of awareness. A patient's inability to move may imply a greater disturbance of consciousness than actually exists, thus leading to potential misdiagnoses. Improvements in brain-imaging techniques may prove to be a more sensitive tool for investigating consciousness.
- Researchers have argued for some time that some patients in a persistent vegetative state can show some signs of consciousness.
- The initial neuroimaging studies of consciousness in vegetative state patients are indeed promising. However, there are some important issues that need to be dealt with. First, we mentioned above that up to 43% of patients with disorders of consciousness are misdiagnosed. Given that a small subset of the vegetative state patients were able to modify their brain activity, it is possible that they were not actually in a vegetative state, but instead had a less severe condition. Second, the researchers are equating language abilities with consciousness; yet, consciousness could take the form of responses to other, non-linguistic stimuli. This criticism would be particularly important if a vegetative state patient had damage to brain areas related to language comprehension.
- We also have to be cautious about the use of PET and fMRI scans in patients with widespread brain damage. Both types of neuroimaging measure characteristics of blood flow in the brain. But, damage to the brain will alter how the blood flows; therefore, we need to be careful when comparing patients with healthy controls. One way around this latter concern is to use multiple methods of neuroimaging. Increasing numbers of research groups are using EEG, which measures neural activity using electrodes attached to the scalp, to search for brain function in vegetative patients. Given that distinct brain waves have been identified for sensory detection of a stimulus, the detection of unexpected auditory stimuli, higher-level analysis of stimuli, and semantic analysis of language, this technology could provide important insights into the inner worlds of vegetative state patients.
- **<u>Section 5.3 Drugs and Conscious Experience:</u>**
- **Physical and Psychological Effects of Drugs:**
- Your brain contains a number of different chemical messengers called neurotransmitters. These brain chemicals are released by the presynaptic neuron into the synapse, the space between the cells. They then bind to receptors on the surface of the postsynaptic neurons, thus making these neurons more or less

likely to fire. Drugs influence the amount of activity occurring in the synapse. Thus, they can serve as an **agonist**, which enhances or mimics the activity of a neurotransmitter, or as an **antagonist**, which blocks or inhibits the activity of a neurotransmitter.

- The short-term effects of drugs can be caused by a number of different brain mechanisms including:
    1. Altering the amount of the neurotransmitter being released into the synapse.
    2. Preventing the reuptake (reabsorption back into the cell that released it) of the neurotransmitter once it has been released, thereby allowing it to have a longer influence on other neurons.
    3. Blocking the receptor that the neurotransmitter would normally bind to.
    4. Binding to the receptor in place of the neurotransmitter.

  In all of these scenarios, the likelihood of the postsynaptic neurons firing is changed, resulting in changes to how we think, act, and feel.
- Different drugs will influence different neurotransmitter systems.
  E.g. Ecstasy primarily affects serotonin levels, whereas painkillers like OxyContin™ affect opioid receptors.
- However, the brain chemical that is most often influenced by drugs is dopamine, a neurotransmitter that is involved in responses to rewarding, pleasurable feelings. Dopamine release in two brain areas, the nucleus accumbens and the ventral tegmental area, is likely related to the “high” associated with many drugs. These positive feelings serve an important, and potentially dangerous, function: They reinforce the drug-taking behaviour. In fact, the dopamine release in response to many drugs makes them more rewarding than sex or delicious food. This reinforcing effect is so powerful that, for someone who has experience with a particular drug, even the anticipation of taking the drug is pleasurable and involves the release of dopamine.
- The nucleus accumbens and ventral tegmental area are associated with reward responses to many different drugs.
- However, the drug–neurotransmitter relationship is not as simple as it would seem because the effects of drugs involve biological, psychological, and social mechanisms. The setting in which drugs are consumed can also have a more sinister effect: Overdoses of some drugs are more common when they are taken in new environments than when they are taken in a setting that the person often uses for drug consumption. When people enter an environment that is associated with drug use, their bodies prepare to metabolize drugs even before they are consumed (their bodies become braced for the drug’s effects). Similar preparations do not occur in new environments, which leads to larger, and potentially fatal, drug effects. Another psychological factor that influences drug effects is the person’s experience with a drug. It takes time for people to learn to associate taking the drug with the drug’s effects on the body and brain. Therefore, a drug might have a much more potent effect on a person the third or fourth time he took it than it did the first time, which is very common with some

drugs, such as marijuana. Finally, a person's expectations about the drug can dramatically influence its effects.

- **Long-Term Effects:**
- The effects that different drugs will have on us change as we become frequent users.
- **Tolerance** occurs when repeated use of a drug results in a need for a higher dose to get the intended effect.
- Tolerance is the brain's attempt to keep the level of neurotransmitters at stable levels. When receptors are overstimulated by neurotransmitters, as often happens during drug use, the neurons fire at a higher rate than normal. In order to counteract this effect and return the firing rate to normal, some of the receptors move further away from the synapse so that they are more difficult to stimulate, a process known as **down-regulation**.
- Tolerance is not the only effect that can result from long-term use of legal or illegal drugs. Another is **physical dependence**, the need to take a drug to ward off unpleasant physical withdrawal symptoms. The characteristics of dependence and withdrawal symptoms differ from drug to drug. Caffeine withdrawal can involve head and muscle aches and impaired concentration. Withdrawal from long-term alcohol abuse is much more serious. A person who is dependent on alcohol can experience extremely severe, even life-threatening, withdrawal symptoms including nausea, increased heart rate and blood pressure, and hallucinations and delirium. Furthermore, drug dependence is not limited to physical symptoms. **Psychological dependence** occurs when emotional need for a drug develops without any underlying physical dependence. Many people use drugs in order to ward off negative emotions. When they no longer have this defence mechanism, they experience the negative emotions they have been avoiding, such as stress, depression, shame, or anxiety. Therefore, treatment programs for addiction often include some form of therapy that will allow users to learn to cope with these emotional symptoms while they are attempting to deal with the physical symptoms of withdrawal.
- At the biological level, researchers are attempting to identify the specific genes, or groups of genes, that make someone prone to becoming addicted to different drugs. For example, the A1 allele of the DRD2 gene, which influences the activity of dopamine receptors, is related to reward processing and to being open to new experiences and is also more common in people who are addicted to opioid drugs such as heroin. In contrast, researchers at the University of Toronto found that a protective version of the CYP2A6 gene is more common in people who do not smoke; this version of the gene is related to feelings of nausea and dizziness occurring when the person is exposed to smoking.
- Researchers are also examining cognitive factors affecting drug-taking behaviour. Dependence is influenced by the fact that drugs are often taken in the same situations.
- Addiction rates are also affected by social factors, such as the culture in which a person lives. Family attitudes toward drugs is a factor as well, as early experiences with different drugs can shape our attitudes toward them and

influence how we consume those drugs later in life. If a young person first tries wine in a family setting, it will feel much less like a cool part of teenage rebellion than if that person first tried the same drink at a high school house party. That initial introduction can alter how that person views alcohol for years to come.

- Drug dependence is also influenced by the social support available. A key factor in drug dependence is a feeling of isolation.
- Finally, all of these variables interact with a person's personality. Individuals with impulsive personality traits are more likely to become addicted to drugs regardless of their early experiences or cultural setting.
- **Commonly Abused "Recreational" Drugs:**

	Psychological Effects	**Chemical Effects**	**Tolerance**	**Likelihood of Dependence**
Stimulants: cocaine, amphetamine, ecstasy	Euphoria, increased energy, lowered inhibitions	Increase dopamine, serotonin, norepinephrine activity	Develops quickly	High
Marijuana	Euphoria, relaxation, distorted sensory experiences, paranoia	Stimulates cannabinoid receptors	Develops slowly	Low
Hallucinogens: LSD, psilocybin, DMT, ketamine	Major distortion of sensory and perceptual experiences. Fear, panic, paranoia	Increase serotonin activity Blocks glutamate receptors	Develops slowly	Very low
Opiates: heroin	Intense euphoria, pain relief	Stimulate endorphin receptors	Develops quickly	Very high
Sedatives: barbiturate, benzodiazepine	Drowsiness, relaxation, sleep	Increase GABA activity	Develops quickly	High
Alcohol	Euphoria, relaxation, lowered inhibitions	Primarily facilitates GABA activity; also stimulates endorphin and dopamine receptors	Develops gradually	Moderate to high

- **Psychoactive drugs** are substances that affect thinking, behaviour, perception, and emotion.

- Many common prescription medications are chemically similar, albeit safer, versions of illicit drugs. Additionally, many legal prescription drugs are purchased illegally and used in ways not intended by the manufacturer.
- **Stimulants:**
- **Stimulants** are a category of drugs that speed up the activity of the nervous system, typically enhancing wakefulness and alertness.
- There are a number of different types of stimulant drugs, ranging from naturally occurring substances such as leaves (cocaine) and beans (coffee) to drugs produced in a laboratory (crystal meth).
- The most widely used and abused stimulant is caffeine. However, caffeine is not a recreational drug.
- Caffeine tends to temporarily increase energy levels and alertness by influencing the activity of a brain chemical called **adenosine**. When adenosine binds to its receptors in the brain, it slows down neural activity. In fact, it helps you become sleepy. Caffeine binds to adenosine receptors, but without causing a reduction in neural activity. I.e. It prevents adenosine from doing its job. At the same time, caffeine stimulates the adrenal glands to release adrenaline. This hormone accounts for the burst of energy associated with caffeine. Given that adrenaline is also associated with “fight or flight” responses, it may also explain why many people feel jittery after consuming too much caffeine. Although no drug is harmless, the withdrawal effects associated with it are far less severe than those found for other stimulants. Depriving yourself of caffeine will typically result in headaches, fatigue, and occasionally nausea; however, these symptoms will usually disappear after two to three days.
- Cocaine is another commonly abused stimulant. It is synthesized from coca leaves, most often grown in South American countries such as Colombia, Peru, and Bolivia. The people who harvest these plants often take the drug in its simplest form—they chew on the leaves and experience a mild increase in energy. However, by the time it reaches Canadian markets, it has been processed into powder form. It is typically snorted and absorbed into the bloodstream through the nasal passages or, if prepared as crack cocaine, smoked in a pipe. Cocaine influences the nervous system by blocking the reuptake of dopamine in reward centres of the brain, although it can also influence serotonin and norepinephrine levels as well. By preventing dopamine from being reabsorbed by the neuron that released it, cocaine increases the amount of dopamine in the synapse between the cells, thus making the postsynaptic cell more likely to fire. The result is an increase in energy levels and a feeling of euphoria.
- Like many addictive drugs, cocaine and amphetamines stimulate the reward centres of the brain, including the nucleus accumbens and ventral tegmental area. Cocaine works by blocking reuptake of dopamine, and methamphetamine works by increasing the release of dopamine at presynaptic neurons.
- Amphetamines, another group of stimulants, come in a variety of forms. Some are prescription drugs, such as methylphenidate (Ritalin) and modafinil (Provigil), which are typically prescribed for attention deficit hyperactivity disorder (ADHD)

and narcolepsy, respectively. When used as prescribed, these drugs can have beneficial effects; oftentimes, however, these drugs are used recreationally.

- Methamphetamine, which stimulates the release of dopamine in presynaptic cells, may be even more potent than cocaine when it comes to addictive potential. Methamphetamines are also notorious for causing significant neurological and external physical problems. For example, chronic methamphetamine abusers often experience deterioration of their facial features, teeth, and gums, owing to a combination of factors. First, methamphetamine addiction can lead to neglect of basic dietary and hygienic care. Second, the drug is often manufactured from a potent cocktail of substances including hydrochloric acid and farm fertilizer—it is probably not surprising that these components can have serious side effects on appearance and health.
- Long-term use of potent stimulants like methamphetamines can actually alter the structure of the user's brain. Compared to non-users, people who have a history of abusing methamphetamine have been shown to have structural abnormalities of cells in the frontal lobes, which reduces the brain's ability to inhibit irrelevant thoughts. This ability can be measured through the Stroop test, which challenges a person's ability to inhibit reading a word in favour of identifying its colour. Methamphetamine abusers had greater difficulty with this task than non-users, and they also had reduced activity in the frontal lobes, likely because of the damage described previously.
- Changes in brain structure have also been noted in chronic users of **ecstasy/3,4-methylenedioxy-N-methylamphetamine/MDMA**, a drug that is typically classified as a stimulant, but also has hallucinogenic effects. Ecstasy exerts its influence on the brain by stimulating the release of massive amounts of the neurotransmitter serotonin; it also blocks its reuptake, thereby ensuring that neurons containing serotonin receptors will fire at levels much greater than normal. Ecstasy heightens physical sensations and is known to increase social bonding and compassion among those who are under its influence. Unfortunately, this drug has also been linked to a number of preventable deaths. Heat stroke and dehydration are major risks associated with ecstasy use, especially when the drug is taken at a rave where there is a high level of physical exertion from dancing in an overheated environment. It can also lead to lowered mood two to five days after consumption, as it takes time for serotonin levels to return to normal. Several studies have shown that MDMA impairs the sensitivity of many visual regions in the occipital lobe. Additionally, recent neuroimaging data show that using ecstasy can produce unique damage (independent of the effects of other drugs) in several areas of the cortex in the left hemisphere. Given that the left hemisphere is also critical for language abilities, it should come as no surprise that ecstasy users show slight impairments on language-based tests of memory.
- **Hallucinogens:**
- **Hallucinogenic drugs** are substances that produce perceptual distortions.
- Depending on the type of hallucinogen consumed, these distortions may be visual, auditory, and sometimes tactile in nature, such as the experience of

crawling sensations against the skin. Hallucinogens also alter how people perceive their own thinking.

- One commonly used hallucinogen is LSD, which is a synthetic drug. A recent study examined brain activity of individuals after they had just taken LSD. These researchers found that the LSD experience involves greater activity in visual areas; this activity strongly correlated with participants' reports of hallucinations. The researchers also noted reduced connectivity between areas in the temporal and parietal lobe; these changes were related to feelings of "losing oneself" and finding "altered meanings." These results show the strong link between brain activity and moment-to-moment experiences.
- Hallucinogenic substances also occur in nature, such as psilocybin (a mushroom) and mescaline (derived from the peyote cactus). Hallucinogens can have very long-lasting effects. LSD can last for more than 12 hours. These drugs may also elicit powerful emotional experiences that range from extreme euphoria to fear, panic, and paranoia. The two most common hallucinogens, LSD and psilocybin, both act on the transmission of serotonin.
- Short-acting hallucinogens have become increasingly popular for recreational use. The effects of two of these hallucinogens, ketamine and DMT (dimethyltryptamine), last for about an hour. Ketamine was originally developed as a surgical anesthetic to be used in cases where a gaseous anesthetic could not be applied, such as on the battlefield. Ketamine induces dream-like states, memory loss, dizziness, confusion, and a distorted sense of body ownership. This synthetic drug blocks receptors for glutamate, which is an excitatory neurotransmitter that is important for, among other things, memory.
- The short-acting hallucinogen known as DMT occurs naturally in such different places as the bark from trees native to Central and South America and on the skin surface of certain toads. DMT is even found in very small, naturally produced amounts in the human nervous system. The function of DMT in the brain remains unclear, although some researchers have speculated that it plays a role in sleep and dreaming, and even out-of-body experiences. DMT is used in Canada primarily for recreational purposes. Users frequently report having intense "spiritual" experiences, such as feeling connected to or communicating with divine beings (as well as aliens, plant spirits, and other beings that aren't part of most modern people's version of reality). In fact, its ability to apparently enhance spiritual experiences has been well known in South American indigenous cultures. DMT is the primary psychoactive ingredient in **ayahuasca**, which plays a central role in shamanistic rituals involving contact with the spirit world. An increasing number of Canadians have used another drug, **salvia divinorum**, for similar purposes.
- Salvia divinorum is an herb that grows in Central and South America. When smoked or chewed, salvia induces highly intense but short-lived hallucinations. Use of this drug also leads to **dissociative experiences**, a detachment between self and body.
- Many psychedelics can have serious negative consequences on users, ranging from memory problems to unwanted "flashbacks" in which the user

re-experiences the visual distortions and emotional changes associated with the psychedelic state. However, some psychedelics are now being used to treat a number of clinical conditions. LSD has been used to help people deal with the anxiety associated with terminal illnesses. Psilocybin (magic mushrooms), ayahuasca, and DMT have all been used to help reduce addiction to tobacco and alcohol. MDMA (ecstasy) has been used to help people suffering from post-traumatic stress disorder or PTSD.

- **Marijuana:**
- **Marijuana** is a drug comprising of the leaves and buds of the Cannabis plant that produces a combination of hallucinogenic, stimulant, and relaxing (narcotic) effects. These buds contain a high concentration of a compound called tetrahydrocannabinol (THC). THC mimics **anandamide**, a chemical that occurs naturally in the brain and the peripheral nerves. Both anandamide and THC bind to cannabinoid receptors and induce feelings of euphoria, relaxation, reduced pain, and heightened and sometimes distorted sensory experiences. They also stimulate one's appetite.
- Marijuana use often starts during the teenage years. From a neurological perspective, early drug use is a particular cause for concern. The brain develops in a step-by-step fashion, with higher-order cognitive areas, particularly the frontal lobes, developing after other areas have fully matured. As part of this step-by-step development, the white-matter fibres connecting brain regions grow and form new connections while unnecessary synapses are pruned away. Marijuana use during the teenage years has been shown to impair both of these developmental processes. It has also been linked with thinning (i.e. fewer cells) in a number of cortical areas and smaller hippocampal volumes.
- These changes in the brain's development can affect cognitive abilities. Increasing evidence indicates that the effects of marijuana on memory and executive functions are much larger in people who started taking the drug before the age of 17. In other words, using marijuana during an earlier stage of development can have a much larger effect on a person's future than if the same dose were to be consumed or smoked later in life.
- It is important to note that if you did smoke marijuana before the age of 17, your life isn't ruined. It just means that if you continue to frequently use marijuana, you are statistically more likely to have memory and executive functioning problems later in life. It is quite possible that your brain will recover. You can help it bounce back by reducing your consumption of drugs and by engaging in behaviours that help increase the thickness of white-matter pathways in the frontal lobes.
- Currently, marijuana is the most commonly used recreational drug in Canada. This high usage rate reflects, in part, the fact that this drug is so readily available.
- Studies of people under the influence of marijuana have demonstrated a number of different impairments to memory processes. Several researchers have confirmed that marijuana disrupts short-term memory. Studies of long-term memory have indicated that marijuana use was associated with a reduced ability to recall information and a greater tendency to commit intrusion errors.

- Many executive functions are impaired by THC. For instance, marijuana impairs people's ability to problem solve and to change their strategies while performing a task. It may impair creative thinking and attention as well.
- Neuroimaging results indicate that the memory and cognitive difficulties experienced by people who smoke marijuana are likely related to changes in their brains.
- A number of studies have noted that reduced performance on memory tests is related to decreases in brain activity in the right frontal lobe, an area involved with memory retrieval.
- **Opiates:**
- **Opiates/narcotics** are drugs such as heroin and morphine that reduce pain and induce extremely intense feelings of euphoria.
- These drugs bind to endorphin receptors in the nervous system. Endorphins (endogenous morphine) are neurotransmitters that reduce pain and produce pleasurable sensations, whose effects are magnified by opiates.
- Naturally occurring opiates are derived from certain species of poppy plants that are primarily grown in Asia and the Middle East (particularly Afghanistan).
- Opiate drugs are very common in medical and emergency room settings. For example, the drug fentanyl is used in emergency rooms to treat people in extreme pain. A street version of fentanyl, known as "China White," can be more than 20 times the strength of more commonly sold doses of heroin. This drug is so dangerous that in April 2016, British Columbia declared a public health emergency after more than 200 people died from overdoses of the drug.
- Treating opiate addiction can be incredibly challenging. Opiates produce very rapid and powerful "highs". Because the time between injecting or smoking opiates and their physical impact is so short, it is easy for people to mentally link the drug to the pleasurable feeling. This increases the addictiveness of these drugs. People who are addicted to opiates and other highly addictive drugs enter a negative cycle of having to use these drugs simply to ward off withdrawal effects, rather than to actually achieve the sense of euphoria they may have experienced when they started using them. Methadone is an **opioid** (a synthetic opiate) that binds to opiate receptors but does not give the same kind of high that heroin does. A regimen of daily methadone treatment can help people who are addicted to opiates avoid painful withdrawal symptoms as they learn to cope without the drug.
- Another opioid, oxycodone (OxyContin), has helped many people reduce severe pain while having relatively few side effects. Unfortunately, this drug, along with a similar product, Percocet, has very high abuse potential. It is often misused, especially by those who have obtained it through illegal means.
- **Legal Drugs and Their Effects on Consciousness:**
- **Sedative drugs**, sometimes referred to as "downers," depress activity of the central nervous system.
- Barbiturates were an early form of medication used to treat anxiety and promote sleep. High doses of these drugs can shut down the brainstem regions that regulate breathing, so their medical use has largely been discontinued in favour

of safer drugs. Barbiturates have a high potential for abuse, typically by people who want to lower inhibitions, relax, and try to improve their sleep. Incidentally, while these agents may knock you out, they do not really improve the quality of sleep. Barbiturates actually reduce the amount of REM sleep.

- Newer forms of sedative drugs, called **benzodiazepines**, include prescription drugs such as Xanax, Ativan, and Valium. These drugs increase the effects of gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter that helps reduce feelings of anxiety or panic. The major advantage of benzodiazepine drugs over barbiturates is that they do not specifically target the brain regions responsible for breathing and, even at high doses, are unlikely to be fatal. However, people under the influence of any kind of sedative are at greater risk for injury or death due to accidents caused by their diminished attention, reaction time, and coordination.
- **Prescription Drug Abuse:**
- Prescription drugs are commonly abused by illicit users.
- Over 15% of Canadian high school students have reported abusing prescription drugs at some point in their lives. The prevalence of prescription drug abuse becomes even more extreme when these students enter university. Surveys have shown that as many as 31% of university students sampled have abused Ritalin, the stimulant commonly prescribed as a treatment for ADHD.
- A massive number of prescription drugs are available on the market, including stimulants, opiates, and sedatives. In 2011, 3.2% of Canadians (approximately 1.1 million people) used prescription drugs for nonmedical reasons within the year prior to the survey. Users typically opt for prescription drugs as their drugs of choice because they are legal, pure, and relatively easy to get.
- Prescription drugs are typically taken at large doses, and administered in such a way as to get a quicker, more intense effect.
- Some of the most commonly abused prescription drugs in Canada are painkillers such as OxyContin. When used normally, OxyContin is a pain-reliever that slowly releases an opioid over the course of approximately 12 hours, thus making it a relatively safe product. However, crushing the OxyContin tablet frees its opioid component oxycodone from the slow-release mechanism; it can then be inhaled or dissolved in liquid and injected to provide a rapid high. Almost 80% of people entering treatment programs for OxyContin abuse admitted that the drug was not prescribed to them, suggesting that there is a flourishing trade in this drug.
- Approaches to reducing prescription drug abuse include efforts to develop pain medications that do not act on pleasure and reward centres of the brain. Furthermore, many communities offer prescription drug disposal opportunities, which helps remove unused drugs from actual or potential circulation. In addition, doctors and other health care professionals are becoming increasingly aware that some individuals seeking prescription drugs are doing so because they are addicted to them.
- **Alcohol:**
- Alcohol has a number of effects on the brain. It initially targets GABA receptors, and subsequently affects opiate and dopamine receptors. The stimulation of

opiate and dopamine receptors accounts for the euphoria associated with lower doses as well as its rewarding effects. The release of GABA, an inhibitory neurotransmitter, reduces the activity of the central nervous system, which helps explain the impairments in balance and coordination associated with consumption of alcohol. The reason that people become less inhibited when they drink is that alcohol inhibits the frontal lobes of the brain. One function of the frontal lobes is to inhibit behaviour and impulses, and alcohol appears to impair the frontal lobe's ability to do so.

- Many socially unacceptable consequences are also associated with alcohol use. Alcohol abuse has been linked to health problems, sexual and physical assault, automobile accidents, missing work or school, unplanned pregnancies, and contracting sexually transmitted diseases. These effects are primarily associated with heavy consumption, which can often lead to **alcohol myopia**. When intoxicated, people often pay more attention to cues related to their desires and impulses and less attention to cues related to inhibiting those desires. This tendency to focus on short-term rewards rather than long-term consequences is particularly noticeable in underage drinkers whose frontal lobes are not fully developed. Alcohol myopia is also more likely to occur in people with low self-esteem; these individuals may focus on their fear of social rejection and respond by engaging in risky behaviours that they feel will lead to social acceptance.

Definitions:

- **Activation–synthesis hypothesis:** Suggests that dreams arise from brain activity originating from bursts of excitatory messages from the pons, a part of the brainstem.
- **Brain death:** A condition in which the brain, specifically including the brainstem, no longer functions.
- **Circadian rhythms:** Internally driven daily cycles of approximately 24 hours affecting physiological and behavioural processes.
- **Coma:** A state marked by a complete loss of consciousness.
- **Consciousness:** A person's subjective awareness, including thoughts, perceptions, experiences of the world, and self-awareness.
- **Default mode network:** A network of brain regions including the medial prefrontal cortex, posterior cingulate gyrus, and medial and lateral regions of the parietal lobe that is most active when an individual is awake but not responding to external stimuli.
- **Déjà vu:** A distinct feeling of having seen or experienced a situation that is impossible or unlikely to have previously occurred.
- **Dependence:** A need to take a drug to ward off unpleasant physical withdrawal symptoms; often referred to as addiction.
- **Dissociation theory:** Explains hypnosis as a unique state in which consciousness is divided into two parts: a lower-level system involved with perception and movement and an "executive" system that evaluates and monitors these behaviours.

- **Ecstasy/MDMA:** A drug that is typically classified as a stimulant, but also has hallucinogenic effects.
- **Endogenous rhythms:** Biological rhythms that are generated by our body independent of external cues such as light.
- **Entrainment:** When biological rhythms become synchronized to external cues such as light, temperature, or even a clock.
- **Hallucinogenic drugs:** Substances that produce perceptual distortions.
- **Hypnosis:** A procedure of inducing a heightened state of suggestibility.
- **Insomnia:** A disorder characterized by an extreme lack of sleep.
- **Jet lag:** The discomfort a person feels when sleep cycles are out of synchronization with light and darkness.
- **Latent content:** The actual symbolic meaning of a dream built on suppressed sexual or aggressive urges.
- **Locked-in syndrome:** A disorder in which the patient is aware and awake but, because of an inability to move his or her body, appears unconscious.
- **Manifest content:** The images and storylines that we dream about.
- **Marijuana:** A drug comprising the leaves and buds of the Cannabis plant that produces a combination of hallucinogenic, stimulant, and relaxing (narcotic) effects.
- **Meditation:** Any procedure that involves a shift in consciousness to a state in which an individual is highly focused, aware, and in control of mental processes.
- **Mind-wandering:** An unintentional redirection of attention from one's current task to an unrelated train of thought.
- **Minimally conscious state (MCS):** A disordered state of consciousness marked by the ability to show some behaviours that suggest at least partial consciousness, even if on an inconsistent basis.
- **Narcolepsy:** A disorder in which a person experiences extreme daytime sleepiness and even sleep attacks.
- **Neurocognitive hypothesis of dreaming:** Prediction that dreaming is not a completely random by-product of brain stem activity but rather reflects waking preoccupations and emotional experiences.
- **Nightmares:** Particularly vivid and disturbing dreams that occur during REM sleep.
- **Night terrors:** Intense bouts of panic and arousal that awaken the individual, typically in a heightened emotional state.
- **Opiates/Narcotics:** Drugs such as heroin and morphine that reduce pain and induce extremely intense feelings of euphoria.
- **Persistent vegetative state (PVS):** State of minimal to no consciousness in which the patient's eyes may be open, and the individual will develop sleep–wake cycles without clear signs of consciousness.
- **Physical dependence:** The need to take a drug to ward off unpleasant physical withdrawal symptoms.
- **Polysomnography:** A set of objective measurements used to examine physiological variables during sleep.

- **Positive sleep state misperception:** A condition in which an individual substantially overestimates the amount of sleep the person is getting.
- **Preserve and protect hypothesis:** Suggests that two adaptive functions of sleep are preserving energy and protecting the organism from harm.
- **Problem-solving theory:** The theory that thoughts and concerns are continuous from waking to sleeping, and that dreams may function to facilitate finding solutions to problems encountered while awake.
- **Psychological dependence:** Occurs when emotional need for a drug develops without any underlying physical dependence.
- **Psychoactive drugs:** Substances that affect thinking, behaviour, perception, and emotion.
- **REM sleep:** A stage of sleep characterized by quickening brain waves, inhibited body movement, and rapid eye movements (REM).
- **REM sleep behavior disorder:** People with this condition do not show the typical restriction of movement during REM sleep; in fact, they appear to be acting out the content of their dreams.
- **Restless legs syndrome:** A persistent feeling of discomfort in the legs and the urge to continuously shift them into different positions.
- **Restore and repair hypothesis:** The idea that the body needs to restore energy levels and repair any wear and tear experienced during the day's activities.
- **Sedative drugs:** Sometimes referred to as "downers." They depress activity of the central nervous system.
- **Sleep apnea:** A disorder characterized by the temporary inability to breathe during sleep.
- **Sleep deprivation:** Occurs when an individual cannot or does not sleep.
- **Sleep displacement:** Occurs when an individual is prevented from sleeping at the normal time although she or he may be able to sleep earlier or later in the day than usual.
- **Sleep state misperception (SSM):** A condition in which a person substantially underestimates the amount of sleep she gets.
- **Social-cognitive theory:** Explains hypnosis by emphasizing the degree to which beliefs and expectations contribute to increased suggestibility.
- **Somnambulism:** A disorder that involves wandering and other activities while asleep; also known as sleepwalking.
- **Stimulants:** A category of drugs that speed up the nervous system, typically enhancing wakefulness and alertness.
- **Tolerance:** When repeated use of a drug results in a need for a higher dose to get the intended effect.

October 30:

- In psychology, **learning** occurs when behaviour or knowledge changes as a result of experience.
- **Cognitive learning** is a type of learning that is active, constructive, and long-lasting. It engages students in the learning processes, teaching them to use their brains more effectively to make connections when learning new things.
- **Associative learning** is the process by which a person or animal learns an association between two stimuli or events.
- Through evolution, stimulus-response pairings have developed, wherein certain stimuli trigger specific involuntary responses.
- **Unconditioned stimuli (UCS)** elicit **unconditioned responses (UCR)**, and these pairings are innate and somehow serve towards survival.
- If UCS repeatedly occurs without any positive or negative consequences, UCR stops.
- **Classical conditioning** is an extension of stimulus-response mappings, wherein a neutral stimulus becomes associated with a pre-existing stimulus-response pair, resulting in a new conditioned stimulus-response pair.
- Classical conditioning was first discovered by Ivan Pavlov. He was a Russian physiologist who won a Nobel Prize in Physiology or Medicine in 1904 for his work on digestive processes.
- Pavlov noticed that his lab dogs would salivate when his lab assistants turned on the machine that distributed food. Importantly, the dogs salivated before the food was distributed.
- Pavlov's work in classical conditioning prompted a wave of **behaviourism** in the early 20th century, which rules psychology for many years.
- Conditioned stimulus-response pairings are not static and change with experience.
- For successful conditioning, the UCS must reliably follow the CS over multiple trials. One exception to this is **conditioned taste aversion**. Conditioned taste aversion is an acquired dislike for a food or drink because it was paired with an illness. It can happen just after one CS-UCS pairing.
- **Extinction** is when the association between CS-UCS ends, the CR will eventually not occur in response to the CS.
  I.e. The CS–CR pair fades.
- However, after a delay, the response returns. This is called **spontaneous recovery**. Spontaneous recovery occurs when an extinct CS–UCS association which elicits the CR may become active again after a delay.

November 4:

- Pavlov was about learning through association.
- **Classical conditioning:**
  - Learning by association
  - CS predicts UCS
  - Builds on existing SR Relations
- **Operant conditioning:**
  - Learning by consequence

    - E.g. Behaving in way X within context Y leads to Z
    - Can create complete new SR relations
- The term “operant” refers to the notion that humans learn from operating on their environment. We behave, then note the consequences and use them to modulate future behaviour.
- Edward Thorndike was one of the first to study operant conditioning. Early on, his research focused on “learning by trial and accidental success.” Through this, he formed the **Law of Effect** which states that a behaviour that is followed by a positive consequence will tend to be repeated. This is similar to evolution theory.
- B.F. Skinner strongly championed the experimental study of the Law of Effect, and he made strong claims to its application to human behavior.
- He invented a number of devices for studying operant conditioning, the most famous being the operant chamber or “Skinner Box”.
- Behaviour is often measured in terms of rate of responding.
- Skinner came up with a response recorder apparatus that allowed him to record each response over time. This device is called a cumulative recorder because it keeps track of the total number of responses over time. Thus, the effects of variables on the response rate could be measured allowing one to see if certain variables strengthen the response of interest, or weaken the response of interest.
- Skinner described any behavioural event in terms of three parts:
    1. The preceding event, which usually involves the presentation of a discriminative stimulus
    2. The behavioural response to the discriminative stimulus
    3. The following event, which represents the consequence of our behaviour
- **Shaping** is teaching an organism to learn a new behavior through successive approximation.

November 6:

- The pleasure centre in our brain is near the basal ganglia.
- Doing activities that are pleasurable for us will stimulate our dopamine production.
- In general, most addictive drugs impersonate some neurotransmitter that naturally occurs in the brain. With repeated use the brain begins to assume that external sources of the drug will exist so it produces less of the natural version. In addition, via classical condition, it also learns the contexts in which an external sources tends to occur, and it really reduces natural production when in those contexts.
- Gambling is very addictive because there’s a lot of randomness to it. The most powerful rewards, the ones that affect us the most and addict us the most, have a randomness about them.
- **Primary reinforcers** are innately satisfying stimuli or activities like eating food, having sex, feeling safe, being comfortable, drinking when thirsty, etc.
- **Secondary reinforcers** gained their reinforcement abilities through association with primary reinforcers … that is via classical conditioning. They include things like money, positive social gestures, grades, etc.

- **Characteristics of Addiction:**
    - The person becomes obsessed about the object, activity or substance.
    - Over time, a person needs more of the substance or activity to feel the same euphoric effects. As tolerance increases, so do consequences and negative effects that intensify the feeling of isolation and fear of discovery.
    - They will seek out and engage in the behaviour even though it is causing harm.
    - The person will engage in the activity over and over again.
    - Ceasing the substance or activities results in physical and emotional symptoms of withdrawal. These can include irritability, craving, restlessness or depression.
    - The person does not appear to have control as to when, how long, or how much he or she will continue the behaviour.

Textbook Notes:

- **Module 6.1 Classical Conditioning Learning by Association:**
- **Learning** is a process by which behaviour or knowledge changes as a result of experience.
- **Pavlov's Dogs Classical Conditioning of Salivation:**
- Research on associative learning has a long history in psychology, dating back to Ivan Pavlov (1849–1936), a Russian physiologist.
- Pavlov and his assistants noticed that as they prepared dogs for procedures, even before any meat powder was presented, the dogs would start salivating. This curious observation led Pavlov to consider the possibility that digestive responses were more than just simple reflexes elicited by food. If dogs salivate in anticipation of food, then perhaps the salivary response can also be learned. Pavlov began conducting experiments in which he first presented a sound from a metronome and then presented meat powder to the dogs. After pairing the sound with the food several times, Pavlov discovered that the metronome could elicit salivation by itself.
- Pavlov's discovery began a long tradition of inquiry into what is now called **classical conditioning**/**Pavlovian conditioning**, which is a form of associative learning in which an organism learns to associate a neutral stimulus with a biologically relevant stimulus, which results in a change in the response to the previously neutral stimulus.
- You can think about classical conditioning in mechanical terms—that is, one event causes another. A stimulus is an external event or cue that elicits a perceptual response; this occurs regardless of whether the event is important or not. Some stimuli, such as food, water, pain, or sexual contract, elicit responses instinctively.
- An **unconditioned stimulus (US)** is a stimulus that elicits a reflexive response without learning.
- An **unconditioned response (UR)** is a reflexive, unlearned reaction to an unconditioned stimulus.
- URs could include hunger, drooling, expressions of pain, and sexual responses.
- The link between the US and the UR is, by definition, unlearned.

- A defining characteristic of classical conditioning is that a neutral stimulus comes to elicit a response. It does so because the neutral stimulus is paired with, and therefore predicts, an unconditioned stimulus.
  E.g. In Pavlov's experiment, the sound of the metronome was originally a neutral stimulus because it did not elicit a response, least of all salivation. However, over time, it began to influence the dogs' responses because of its association with food.
- A **conditioned stimulus (CS)** is a once-neutral stimulus that later elicits a conditioned response because it has a history of being paired with an unconditioned stimulus.
- A **conditioned response (CR)** is the learned response that occurs to the conditioned stimulus.
- What distinguishes the UR from the CR is the stimulus that elicits them. A UR is a naturally occurring response whereas a CR must be learned.
  E.g. Salivation is a UR if it occurs in response to a US (food). Salivation is a CR if it occurs in response to a CS (the clicking of the metronome). A CS can have this effect only if it becomes associated with a US.
- **Evolutionary Function of the CR:**
- It is important to note that the UR and CR do not have to be identical.
- Many animals have an instinct to freeze when they are scared. You see this when deer are caught in headlights. They remain motionless. The reason is that many of their predators, such as the wolf, have perceptual systems that are quite sensitive to detecting movement; so remaining still has an evolutionary survival advantage. However, if the wolf were to begin to stalk the deer, it should immediately stop freezing and run. So, there are two different defensive responses associated with fear: freezing and fleeing.
- Psychologists have spent decades trying to study these defensive responses in the lab. For instance, many conditioning experiments have studied the ability of rats to associate a cue with a painful electric shock to their feet. Some of the URs to shock include flinching, jumping, and pain. However, once the rat has learned to associate the tone with the shock, the rat's primary learned response to the tone is to freeze. The freezing CR has served many species well for millions of years, so it is the natural response to a fear-inducing signal in the laboratory. The lesson from this experimental situation is that UR and the CR are often quite different responses. The CR has been selected by evolution to be a helpful response.
- Classical conditioning has a dramatic effect on an organism's survival.
- **Classical Conditioning and the Brain:**
- At its heart, classical conditioning is a simple biological process. The connections between specific groups of neurons or specific axon terminals and receptor sites on neurons become strengthened during each instance of classical conditioning.
- According to the Hebb Rule, when a weak connection between neurons is stimulated at the same time as a strong connection, the weak connection becomes strengthened.

- During conditioning, weak synapses fire at the same time as related strong synapses. The simultaneous activity strengthens the connections in the weaker synapse.
- **Processes of Classical Conditioning:**
- Although classically conditioned responses typically involve reflexive actions, there is still a great deal of flexibility in how long they will last and how specific they will be.
- Conditioned responses may be very strong and reliable, which is likely if the CS and the US have a long history of being paired together. Conditioned responding may diminish over time, or it may occur with new stimuli with which the response has never been paired.
- **Acquisition, Extinction, and Spontaneous Recovery:**
- Learning involves a change in behaviour due to experience, which can include acquiring a new response.
- **Acquisition** is the initial phase of learning in which a response is established.
- In classical conditioning, acquisition is the phase in which a neutral stimulus is repeatedly paired with the US.
- A critical part of acquisition is the predictability with which the CS and the US occur together.
- Of course, even if a conditioned response is fully acquired, there is no guarantee it will persist forever. **Extinction** is the loss or weakening of a conditioned response when a conditioned stimulus and unconditioned stimulus no longer occur together.
- A number of studies have shown that classically conditioned behaviours that had disappeared due to extinction could quickly reappear if the CS was paired with the US again. This tendency suggests that the networks of brain areas related to conditioning were preserved in some form. Additionally, some animals (and humans) show **spontaneous recovery**, or the reoccurrence of a previously extinguished conditioned response, typically after some time has passed since extinction.
- Acquisition of a conditioned response occurs over repeated pairings of the CS and the US. If the US no longer occurs, conditioned responding diminishes—a process called extinction. Often, following a time interval in which the CS does not occur, conditioned responding rebounds when the CS is presented again—a phenomenon called spontaneous recovery.
- Extinction and spontaneous recovery are evidence that classically conditioned responses can change once they are acquired. Further evidence of flexibility of conditioned responding can be seen in some other processes of classical conditioning, including generalization and discrimination.
- **Stimulus Generalization and Discrimination:**
- **Generalization** is a process in which a response that originally occurred for a specific stimulus also occurs for different, though similar, stimuli.
- At the cellular level, generalization may be explained, at least in part, by the Hebb rule. When we perceive a stimulus, it activates not only our brain's representation of that item, but also our representations of related items. Some of

these additional representations may become activated at the same time as the synapses involved in conditioned responses. If this did occur, according to the Hebb rule, the additional synapse would become strengthened and would therefore be more likely to fire along with the other cells in the future.

- Generalization allows for flexibility in learned behaviours, although it is certainly possible for behaviour to be too flexible.
- **Discrimination** occurs when an organism learns to respond to one original stimulus but not to new stimuli that may be similar to the original stimulus.
- This point is critical: If stimuli that are similar to the CS are presented without a US, then it becomes less likely that these stimuli will lead to stimulus generalization. Instead, these other tones would have their own memory representation in the brain.
- **Conditioned Classical Conditioning:**
- **Conditioned emotional responses** consist of emotional and physiological responses that develop to a specific object or situation.
- When an organism learns a fear-related association such as a tone predicting the onset of a startling noise, activity occurs in the amygdala, a brain area related to fear.
- If an organism learns to fear a particular location, such as learning that a certain cage is associated with an electrical shock, then context-related activity in the hippocampus will interact with fear-related activity in the amygdala to produce contextual fear conditioning.
- Importantly, the neural connections related to conditioned fear remain intact, even after extinction has occurred. Instead, other neurons suppress the activity of the brain areas related to the fear responses. If the CS is paired with the US again, this suppression will be removed and the fear-conditioned response will quickly reappear.
- During fear conditioning, a neutral stimulus (NS) such as a tone or a picture of a human face is briefly presented, followed by an unconditioned stimulus (US), such as a mild electric shock. The result is a conditioned fear response to the CS.
- **Evolutionary Role for Fear Conditioning:**
- A healthy fear response is important for survival, but not all situations or objects are equally dangerous.
- **Preparedness** is the biological predisposition to rapidly learn a response to a particular class of stimuli.
- **Conditioned Taste Aversions:**
- Another example of an evolutionarily useful conditioned fear response comes from food aversions. Chances are there is a food that you cannot stand to even look at because it once made you ill. This new aversion isn't due to chance; rather, your brain and body have linked the taste, sight, and smell of that food to the feeling of nausea.
- Aversion is not simply a case of feeling gross. Instead, it involves both a feeling of disgust and a withdrawal or avoidance response. When the CS and US are

linked, the taste of the food or fluid soon produces aversion responses (the CR), even in the absence of physical illness.

- This acquired dislike or disgust for a food or drink because it was paired with illness is known as **conditioned taste aversion**.
- Classical conditioning can account for the development of taste aversions. Falling ill after eating a particular food can result in conditioned feelings of disgust as well as withdrawal responses when you are later re-exposed to the taste, smell, or texture of the food. Conditioned taste aversions are another example of conditioning occurring even though the UR and the CR are not identical responses. Importantly, these conditioned aversions only occur for the flavour of a particular food rather than to other stimuli that may have been present when you became ill.
- Neurons in reward centres in the brain show altered patterns of activity to the food associated with illness. These different brain responses suggest that illness triggers a strong emotional response that causes the reward centres to update their representation of the illness-causing food, thus making that food less rewarding.
- Although these studies may explain how some aspects of conditioned taste aversions are maintained, there are still some riddles associated with this phenomenon. For instance, the onset of symptoms from food poisoning may not occur until several hours have passed after the tainted food or beverage was consumed. As a consequence, the interval between tasting the food (CS) and feeling sick (UR) may be a matter of hours, whereas most conditioning happens only if the CS, US, and the UR occur very closely to each other in time. Another peculiarity is that taste aversions are learned very quickly—a single CS–US pairing leading to illness is typically sufficient. These special characteristics of taste aversions are extremely important for survival. The flexibility offered by a long window of time separating food (CS) and the illness (UR), as well as the requirement for only a single exposure, raises the chances of acquiring an important aversion to the offending substance.
- One potential explanation for these characteristics involves the food stimuli themselves. Usually, a conditioned taste aversion develops to something we have ingested that has an unfamiliar flavour. Such flavours stick out when they are experienced for the first time and are therefore much easier to remember, even after considerable time has passed. In contrast, if you have eaten the same ham and Swiss cheese sandwich at lunch for years, and you become ill one afternoon after eating it, you will be less prone to develop a conditioned taste aversion.This scenario can be explained by **latent inhibition**, which occurs when frequent experience with a stimulus before it is paired with a US makes it less likely that conditioning will occur after a single episode of illness.
- **Working the Scientific Literacy Model Conditioning and Negative Political Advertising:**
- An attempt to use negative emotions to alter people's opinions of political candidates is similar to a psychology research technique known as **evaluative conditioning**. In an evaluative conditioning study, experimenters pair a stimulus

with either positive or negative stimuli. The repeated association of a stimulus with an emotion leads participants to develop a positive or negative feeling toward that stimulus.

- In the laboratory, evaluative conditioning works. This phenomenon has been found with visual, auditory, olfactory (smell), taste, and tactile (touch) stimuli. It has been used to alter feelings toward objects ranging from snack foods to consumer brands to novel shapes.
- **Drug Tolerance and Conditioning:**
- In addition to influencing overt behaviours such as salivating and emotional behaviours such as phobias, classical conditioning can influence how the body regulates its own responses to different stimuli. Cues that accompany drug use can become conditioned stimuli that elicit cravings. For example, classical conditioning can help explain some drug-related phenomena, such as cravings and tolerance.
- Conditioning can also influence drug tolerance, or a decreased reaction that occurs with repeated use of the drug. When a person takes a drug, his or her body attempts to metabolize that substance. Over time, the setting and paraphernalia associated with the drug-taking begin to serve as cues (a CS) that a drug (US) will soon be processed by the body (UR). As a result of this association, the physiological processes involved with metabolizing the drug will begin with the appearance of the CS rather than when the drug is actually consumed. In other words, because of conditioning, the body is already braced for the drug before the drug has been snorted, smoked, or injected. This response means that, over time, more of the drug will be needed to override these preparatory responses so that the desired effect can be obtained; this change is referred to as **conditioned drug tolerance**.
- This phenomenon can have fatal consequences for drug abusers.
- **Module 6.2 Operant Conditioning Learning through Consequences:**
- Very few of our behaviours are random. Instead, people tend to repeat actions that previously led to positive or rewarding outcomes. Conversely, if a behaviour previously led to a negative outcome, people are less likely to perform that action again. These types of stimulus-response relationships are known as **operant conditioning**, a type of learning in which behaviour is influenced by consequences.
- The term operant is used because the individual operates on the environment before consequences can occur. In contrast to classical conditioning, which typically affects reflexive responses, operant conditioning involves voluntary actions such as speaking or listening, starting and stopping an activity, and moving toward or away from something.
- In classical conditioning a response is not required for a reward or unconditioned stimulus to be presented.
- In classical conditioning, learning has taken place if a conditioned response develops following pairings of the conditioned stimulus and the unconditioned stimulus.

- In operant conditioning, a response and a consequence are required for learning to take place. Without a response of some kind, there can be no consequence.

	Classical Conditioning	**Operant Conditioning**
Target response is	Automatic	Voluntary
Reinforcement is	Present regardless of whether a response occurs	A consequence of the behaviour
Behaviour mostly depends on	Reflexive and physiological responses	Skeletal muscles

- **Basic Principles of Operant Conditioning:**
- The concept of **contingency** is important to understanding operant conditioning; it simply means that a consequence depends upon an action.
  E.g. Earning good grades is generally contingent upon studying effectively.
- The key distinction between reinforcement and punishment is that reinforcers, no matter what they are, increase behaviour. Punishment involves a decrease in behaviour, regardless of what the specific punisher may be. Thus both reinforcement and punishment are defined based on their effects on behaviour.
- **Reinforcement and Punishment:**
- **Reinforcement** is a process in which an event or reward that follows a response increases the likelihood of that response occurring again.
- The **law of effect** is the idea that responses followed by satisfaction will occur again in the same situation whereas those that are not followed by satisfaction become less likely.
- A **reinforcer** is a stimulus that is contingent upon a response and that increases the probability of that response occurring again.
- **Punishment** is a process that decreases the future probability of a response.
- A **punisher** is a stimulus that is contingent upon a response, and that results in a decrease in behaviour.
- Like reinforcers, punishers are defined not based on the stimuli themselves, but rather on their effects on behaviour.
- **Positive and Negative Reinforcement and Punishment:**
- Both reinforcement and punishment can be accomplished by removing a stimulus as well.
- Reinforcement: This increases the chances of a behaviour occurring again.
- Punishment: This decreases the chances of a behaviour occurring again.
- Positive: This means that a stimulus is added to a situation. Positive can refer to reinforcement or punishment.
- Negative: This means that a stimulus is removed from a situation. Negative can refer to reinforcement or punishment.

- These terms can be combined to produce four different subtypes of operant conditioning. **Positive reinforcement**, is the strengthening of behaviour after potential reinforcers such as praise, money, or nourishment follow that behaviour.
- Behaviour can also be reinforced by the removal of something that is unpleasant. This form of reinforcement, **negative reinforcement**, involves the strengthening of a behaviour because it removes or diminishes a stimulus. Negative reinforcement can be further classified into two subcategories:
    1. **Avoidance learning** is a specific type of negative reinforcement that removes the possibility that a stimulus will occur.
       Examples of avoidance learning include leaving a sporting event early to avoid crowds and traffic congestion, and paying bills on time to avoid late fees. In these cases, negative situations are avoided.
    2. **Escape learning** occurs if a response removes a stimulus that is already present.
       Covering your ears upon hearing overwhelmingly loud music is one example
- **Positive punishment** is a process in which a behaviour decreases in frequency because it was followed by a particular, usually unpleasant, stimulus.
- **Negative punishment** occurs when a behaviour decreases because it removes or diminishes a particular stimulus.

	Consequence	**Effect on Behaviour**	**Example**
Positive reinforcement	Stimulus is added or increased.	Increases the response	A child gets an allowance for making her bed, so she is likely to do it again in the future.
Negative reinforcement	Stimulus is removed or decreased.	Increases the response	The rain no longer falls on you after opening your umbrella, so you are likely to do it again in the future.
Positive punishment	Stimulus is added or increased.	Decreases the response	A pet owner scolds his dog for jumping up on a house guest, and now the dog is less likely to do it again.
Negative punishment	Stimulus is removed or	Decreases the response	A parent takes away TV privileges to stop the

	decreased.		children from fighting.

- **Shaping:**
- **Shaping** is the reinforcing successive approximations of a specific operant response.
- Shaping is done in a step-by-step fashion until the desired response.
- These techniques can also be used to help people develop specific skill sets.
- **Chaining** is a process that involves linking together two or more shaped behaviours into a more complex action or sequence of actions.
- **Applying Operant Conditioning:**
- **Applied behaviour analysis** (ABA) is a method which involves using close observation, prompting, and reinforcement to teach behaviours, often to people who experience difficulties and challenges owing to a developmental condition such as autism.
- People with autism are typically nonresponsive to normal social cues from a very early age. This impairment can lead to a deficit in developing many skills, ranging from basic, everyday ones to complex skills such as language. For example, explaining how to clear dishes from the dinner table to a child with autism could prove difficult. Psychologists who specialize in ABA often shape the desired behaviour using prompts (such as asking the child to stand up, gather silverware, stack plates, and so on) and verbal rewards as each step is completed. These and more elaborate ABA techniques can be used to shape a remarkable variety of behaviours to improve the independence and quality of life for people with autism.
- **Processes of Operant Conditioning:**
- Reinforcers can come in two main forms:
    1. **Primary reinforcers** consist of reinforcing stimuli that satisfy basic motivational needs—needs that affect an individual's ability to survive and reproduce.
       E.g. Food, water, shelter, and sexual contact
    2. **Secondary reinforcers** consist of stimuli that acquire their reinforcing effects only after we learn that they have value. They are more abstract and do not directly influence survival-related behaviours.
       E.g. Money
- Both primary and secondary reinforcers satisfy our drives.
- Research points to a specific brain circuit including a structure called the nucleus accumbens that underlies the motivation to seek out these reinforcers.
- The nucleus accumbens becomes activated during the processing of all kinds of rewards.
- Variations in this area might also account for why individuals differ so much in their drive for reinforcers. For example, scientists have discovered that people who are prone to risky behaviours such as gambling and alcohol abuse are more likely to have inherited particular copies of genes that code for dopamine and other reward-based chemicals in the brain.

- Researchers have also found that individuals who are impulsive, and therefore vulnerable to gambling and drug abuse, release more dopamine in brain areas related to reward, and have trouble removing dopamine from the synapses in these areas.
- The nucleus accumbens is one of the brain's primary reward centres.
- Secondary reinforcers also trigger the release of dopamine in reward areas of the brain.
- When a behaviour is rewarded for the first time, dopamine is released; this reinforces these new, reward-producing behaviours so that they will be performed again. These dopamine-releasing neurons in the nucleus accumbens and surrounding areas help maintain a record of which behaviours are, and are not, associated with a reward. Interestingly, these neurons alter their rate of firing when you have to update your understanding of which actions lead to rewards; so, they are involved with learning new behaviour–reward associations as well as with reinforcement itself.
- **Discrimination and Generalization:**
- Once a response has been learned, the individual may soon learn that reinforcement or punishment will occur under only certain conditions and circumstances.
- A **discriminative stimulus** is a cue or event that indicates that a response, if made, will be reinforced.
  I.e. A discriminative stimulus is a type of stimulus that is used consistently to gain a specific response and that increases the possibility that the desired response will occur.
  E.g. Before we pour a cup of coffee, we might check whether the light on the coffee maker is on—a discriminative stimulus that tells us the beverage will be hot and, presumably, reinforcing.
- Discriminative stimuli demonstrate that humans and animal subjects can use cues from our environment to help us decide whether to perform a conditioned behaviour.
- The idea of a discriminative stimulus should not be confused with the concept of discrimination. **Discrimination** occurs when an organism learns to respond to one original stimulus but not to new stimuli that may be similar to the original stimulus.
- In contrast to discrimination, **generalization** takes place when an operant response occurs in response to a new stimulus that is similar to the stimulus present during original learning.
- **Delayed Reinforcement and Extinction:**
- Reinforcement is more effective if there was very little time between the action and the consequence.
- Interestingly, neuroscientists have found that neural activity decreases during this time as well. In fact, delays of as little as half a second decrease the amount of neural activity in dopamine-releasing neurons.
- This effect of delayed reinforcement influences a number of human behaviours as well. For instance, drugs that have their effect soon after they are taken are

generally more addictive than drugs whose effects occur several minutes or hours after being taken. This difference is due, in part, to the ease with which one can mentally associate the action of taking the drug with reinforcement from the drug.

- Sometimes, however, a reinforcer is not just delayed; it doesn't occur at all.
- This change is known as **extinction**, the weakening of an operant response when reinforcement is no longer available.

Process	Classical Conditioning	Operant Conditioning
Discrimination	A CR does not occur in response to a different CS that resembles the original CS.	There is no response to a stimulus that resembles the original discriminative stimulus used during learning.
Generalization	A different CS that resembles the original CS used during acquisition elicits a CR.	Responding occurs to a stimulus that resembles the original discriminative stimulus used during learning.
Extinction	A CS is presented without a US until the CR no longer occurs.	Responding gradually ceases if reinforcement is no longer available.

- **Reward Devaluation:**
- Scientists have found that behaviours change when the reinforcer loses some of its appeal.
- Reward devaluation can also occur by making one of the rewards less appealing.
- **Schedules of Reinforcement:**
- The exact timing of the action and reinforcement or punishment differs across situations. Typically, a given behaviour is rewarded according to some kind of schedule. These **schedules of reinforcement**, rules that determine when reinforcement is available, can have a dramatic effect on both the learning and unlearning of responses.
- Reinforcement may be available at highly predictable or very irregular times. Also, reinforcement may be based on how often someone engages in a behaviour, or on the passage of time.
- During **continuous reinforcement**, every response made results in reinforcement. As a result, learning initially occurs rapidly.
- In other situations, not every action will lead to reinforcement. We also encounter situations where reinforcement is available only some of the time. In this kind of **partial (intermittent) reinforcement**, only a certain number of responses are

rewarded, or a certain amount of time must pass before reinforcement is available.

- Four types of partial reinforcement schedules are possible. These schedules have different effects on rates of responding. They are:
    1. Ratio schedule: This means that the reinforcements are based on the amount of responding.
    2. Interval schedule: This means that the reinforcements are based on the amount of time between reinforcements, not the number of responses an animal or human makes.
    3. Fixed schedule: This means that the schedule of reinforcement remains the same over time.
    4. Variable schedule: This means that the schedule of reinforcement, although linked to an average, varies from reinforcement to reinforcement.
- In a **fixed-ratio schedule**, reinforcement is delivered after a specific number of responses have been completed.
- In a **variable-ratio schedule**, the number of responses required to receive reinforcement varies according to an average.
- In contrast to ratio schedules, interval schedules are based on the passage of time, not the number of responses. A **fixed-interval schedule** reinforces the first response occurring after a set amount of time passes.
- The final reinforcement schedule is the **variable-interval schedule**, in which the first response is reinforced following a variable amount of time. The time interval varies around an average.
- One general characteristic of schedules of reinforcement is that partially reinforced responses tend to be very persistent. The effect of partial reinforcement on responding is especially evident during extinction. The **partial reinforcement effect** refers to a phenomenon in which organisms that have been conditioned under partial reinforcement resist extinction longer than those conditioned under continuous reinforcement. This effect is likely due to the fact that the individual is accustomed to not receiving reinforcement for every response; therefore, a lack of reinforcement is not surprising and does not alter the motivation to produce the response, even if reinforcement is no longer available.
- **Applying Punishment:**
- People tend to be more sensitive to the unpleasantness of punishment than they are to the pleasures of reward.
- It is also important to note that, while punishment may suppress an unwanted behaviour temporarily, by itself it does not teach which behaviours are appropriate. As a general rule, punishment of any kind is most effective when combined with reinforcement of an alternative, suitable response.

Principle	Description and Explanation
Severity	Should be proportional to the offence. A small fine is suitable for parking illegally or littering, but inappropriate for someone who commits assault.
Initial punishment level	The initial level of punishment needs to be sufficiently strong to reduce the likelihood of the offence occurring again.
Contiguity	Punishment is most effective when it occurs immediately after the behaviour. Long delays in punishment are known to reduce its effectiveness.
Consistency	Punishment should be administered consistently.
Show alternatives	Punishment is more successful, and side effects are reduced, if the individual is clear on how reinforcement can be obtained by engaging in appropriate behaviours.

- **Are Classical and Operant Learning Distinct Events:**
- It is tempting to think of behaviour as being due to either classical conditioning or operant conditioning. However, it is possible, even likely, that a complex behaviour is influenced by both types of learning, each influencing behaviour in slightly different ways.
- **Module 6.3 Cognitive and Observational Learning:**
- **Latent Learning:**
- **Latent learning** is learning that is not immediately expressed by a response until the organism is reinforced for doing so. Humans experience latent learning. I.e. Latent learning refers to knowledge that only becomes clear when a person has an incentive to display it.
- **S-O-R Theory of Learning:**
- Latent learning suggests that individuals engage in more thinking than is shown by operant conditioning studies. Instead, cognitive theories of learning suggest that an individual actively processes and analyzes information; this activity influences observable behaviours as well as our internal mental lives. Because of the essential role played by the individual, this early view of cognitive learning was referred to as the **S-O-R theory (stimulus-organism-response theory)**.
- Stimulus–response (S–R) and S–O–R theorists both agreed that thinking took place; however, they disagreed about the content and causes of the thoughts. S–R psychologists assumed that thoughts were based on the S–R contingencies

that an organism had learned throughout its life; in other words, thinking was a form of behaviour. Individual differences in responding would therefore be explained by the different learning histories of the individuals. S–O–R psychologists, on the other hand, assumed that individual differences were based on people's cognitive interpretation of that situation—in other words, what that stimulus meant to them. In this view, the same stimulus in the same situation could theoretically produce different responses based on a variety of factors including an individual's mood, fatigue, the presence of other organisms, and so on.

- **Observational Learning:**
- Not all learning requires direct experience.
- Many species, including humans, are able to learn new skills and new associations without directly experiencing them.
- **Observational learning** involves changes in behaviour and knowledge that result from watching others.
- For observational learning to occur, some key processes need to be in place if the behaviour is to be successfully transmitted from one person to the next.
- **Processes Supporting Observational Learning:**
- There are four processes involved in observational learning: attention to the act or behaviour, memory for it, the ability to reproduce it, and the motivation to do so. Without any one of these processes, observational learning would be unlikely—or at least would result in a poor rendition of the behaviour.
- For observational learning to occur, several processes are required: attention, memory, the ability to reproduce the behaviour, and the motivation to do so.
- First, consider the importance of attention. Observational learning can extend to operant conditioning as well. Observing someone being rewarded for certain behaviours facilitates imitation of the same behaviours that bring about rewards.
- Second, memory is an important facet of observational learning. When we learn a new behaviour, there is often a delay before the opportunity to perform it arises.Interestingly, memory for how to reproduce a behaviour or skill can be found at a very early age.
- Third, observational learning requires that the observer can actually reproduce the behaviour. This can be very challenging, depending on the task. Research indicates that observational learning is most effective when we first observe, practise immediately, and continue practising and observing soon after acquiring the response. For example, one study found that the optimal way to develop and maintain motor (movement) skills is by repeated observation before and during the initial stages of practising. It appears that watching someone else helps us practise effectively, and allows us to see how errors are made. When we see a model making a mistake, we know to examine our own behaviour for similar mistakes.
- Finally, motivation is clearly an important component of observational learning.
- Observational punishment is also possible, but appears to be less effective at changing behaviour than reinforcement. Witnessing others experience negative consequences may decrease your chances of copying someone else's

behaviour. Even so, we are sometimes surprisingly bad at learning from observational punishment.

- **Imitation and Mirror Neurons:**
- One of the primary mechanisms that allows observational learning to take place is **imitation**—recreating someone else's motor behaviour or expression, often to accomplish a specific goal.
- However, it is currently unclear what imitation actually is, although a number of theories exist. Some researchers suggest that children receive positive reinforcement when they properly imitate the behaviour of an adult and that imitation is a form of operant learning. Others suggest that imitation allows children to gain a better understanding of their own body parts versus the "observed" body parts of others. Finally, imitation might involve a more cognitive representation of one's own actions as well as the observed actions of someone else. It is likely that all three processes are involved with imitation at different points in human development.
- Italian researchers discovered that groups of neurons in parts of the frontal lobes associated with planning movements became active both when a monkey performed an action and when it observed another monkey performing an action. These cells, now known as **mirror neurons**, are also found in several areas in the human brain and have been linked to many different functions ranging from understanding other people's emotional states to observational learning.
- Additionally, groups of neurons appear to be sensitive to the context of an action.
- Research suggest that the mirror neuron system, a key part of our ability to imitate, is sensitive to the purpose or goal of the imitated action.

Definitions:

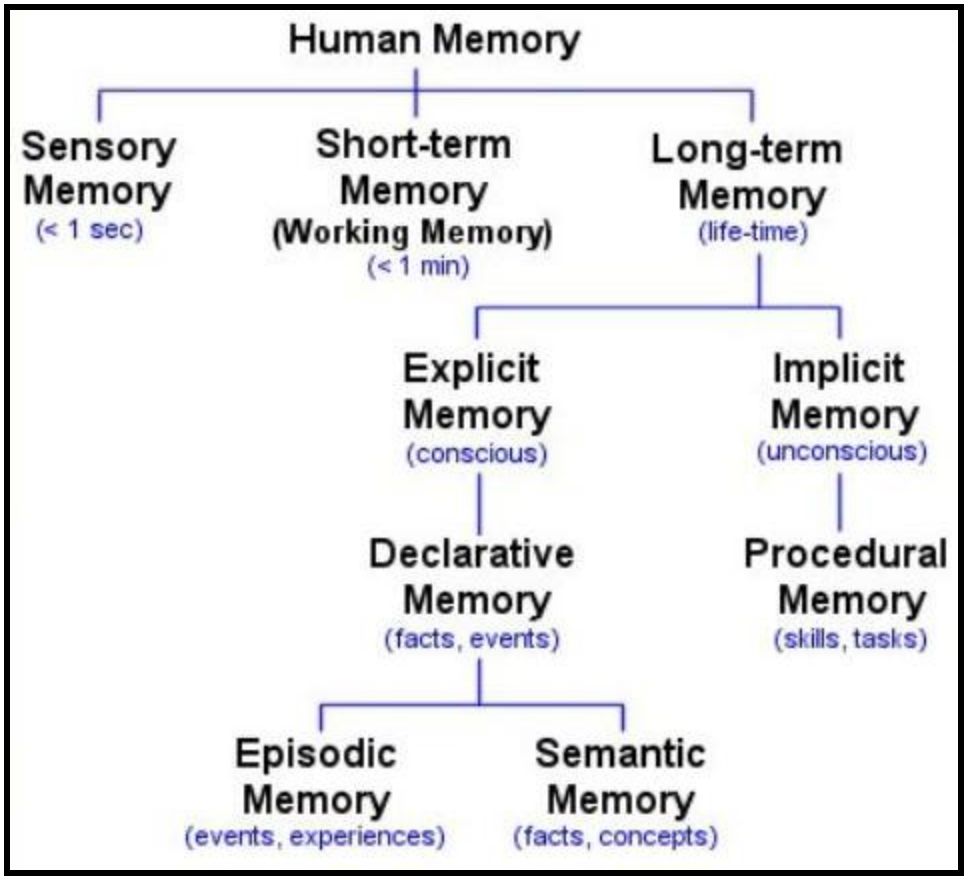
- **Acquisition:** The initial phase of learning in which a response is established.
- **Avoidance learning:** A specific type of negative reinforcement that removes the possibility that a stimulus will occur.
- **Classical conditioning/Pavlovian conditioning:** A form of associative learning in which an organism learns to associate a neutral stimulus with a biologically relevant stimulus which results in a change in the response to the previously neutral stimulus.
- **Conditioned emotional responses:** Consist of emotional and physiological responses that develop to a specific object or situation.
- **Conditioned response (CR):** The learned response that occurs to the conditioned stimulus.
- **Conditioned stimulus (CS):** A once-neutral stimulus that later elicits a conditioned response because it has a history of being paired with an unconditioned stimulus.
- **Conditioned taste aversion:** Acquired dislike or disgust for a food or drink because it was paired with illness.
- **Continuous reinforcement:** Every response made results in reinforcement.
- **Discrimination:** Occurs when an operant response is made to one stimulus but not to another, even if the stimuli are similar.

- **Discriminative stimulus:** A cue or event that indicates that a response, if made, will be reinforced.
- **Escape learning:** Occurs if a response removes a stimulus that is already present.
- **Extinction:** In classical conditioning, the loss or weakening of a conditioned response when a conditioned stimulus and unconditioned stimulus no longer occur together.
- **Extinction:** In operant conditioning, the weakening of an operant response when reinforcement is no longer available.
- **Fixed-interval schedule:** Reinforces the first response occurring after a set amount of time passes.
- **Fixed-ratio schedule:** A schedule in which reinforcement is delivered after a specific number of responses have been completed.
- **Generalization:** Takes place when an operant response occurs in response to a new stimulus that is similar to the stimulus present during original learning.
- **Imitation:** Recreating someone else's motor behaviour or expression, often to accomplish a specific goal.
- **Latent inhibition:** Occurs when conditioning a response can take longer if the subject experiences the conditioned stimulus repeatedly before it is actually paired with a US.
- **Latent learning:** Learning that is not immediately expressed by a response until the organism is reinforced for doing so.
- **Law of effect:** The idea that responses followed by satisfaction will occur again in the same situation whereas those that are not followed by satisfaction become less likely.
- **Learning:** A process by which behaviour or knowledge changes as a result of experience.
- **Negative punishment:** Occurs when a behaviour decreases because it removes or diminishes a particular stimulus.
- **Negative reinforcement:** Involves the strengthening of a behaviour because it removes or diminishes a stimulus.
- **Observational learning:** Involves changes in behaviour and knowledge that result from watching others.
- **Operant conditioning:** A type of learning in which behaviour is influenced by consequences.
- **Partial (intermittent) reinforcement:** A schedule in which only a certain number of responses are rewarded, or a certain amount of time must pass before reinforcement is available.
- **Partial reinforcement effect:** A phenomenon in which organisms that have been conditioned under partial reinforcement resist extinction longer than those conditioned under continuous reinforcement.
- **Positive punishment:** A process in which a behaviour decreases in frequency because it was followed by a particular, usually unpleasant, stimulus.
- **Positive reinforcement:** The strengthening of behaviour after potential reinforcers such as praise, money, or nourishment follow that behaviour.

- **Preparedness:** The biological predisposition to rapidly learn a response to a particular class of stimuli.
- **Primary reinforcers:** Reinforcing stimuli that satisfy basic motivational needs—needs that affect an individual's ability to survive (and, if possible, reproduce).
- **Punisher:** A stimulus that is contingent upon a response, and that results in a decrease in behaviour.
- **Punishment:** A process that decreases the future probability of a response.
- **Reinforcer:** A stimulus that is contingent upon a response, and that increases the probability of that response occurring again.
- **Reinforcement:** A process in which an event or reward that follows a response increases the likelihood of that response occurring again.
- **Schedules of reinforcement:** Rules that determine when reinforcement is available.
- **Secondary reinforcers:** Stimuli that acquire their reinforcing effects only after we learn that they have value.
- **Shaping:** Reinforcing successive approximations of a specific operant response.
- **Spontaneous recovery:** The reoccurrence of a previously extinguished conditioned response, typically after some time has passed since extinction.
- **Unconditioned response (UR):** A reflexive, unlearned reaction to an unconditioned stimulus.
- **Unconditioned stimulus (US):** A stimulus that elicits a reflexive response without learning.
- **Variable-interval schedule:** The first response is reinforced following a variable amount of time.
- **Variable-ratio schedule:** The number of responses required to receive reinforcement varies according to an average.

November 11:

- The brain has a number of different memory systems which sometimes do their own things and sometimes interact.



- There are 2 ways for a person to not have any memory:
    1. **Retrograde amnesia:** Losing your memory of past events.
    2. **Interior brain amnesia:** Inability to lay down any new memories.
- **Sensory Memory:**
    - Very short term.
    - Has the ability to retain impressions of sensory information after the original stimuli have ended.
    - Acts as a kind of buffer for stimuli received through the five senses of sight, hearing, smell, taste and touch, which are retained accurately, but very briefly.
    - Sensory memory was most extensively studied by a cognitive psychologist named George Sperling. Sperling's studies focused on visual sensory memory which he termed **iconic memory**.

- **Iconic Memory:**
  - A type of sensory memory.
  - Iconic memory involves the memory of a visual stimuli.
    I.e. It is how the brain remembers an image you have seen in the world around you.
  - Typically, iconic memories are stored for slightly shorter periods of time than echoic memories. While iconic memory disappears in approximately 1 second, echoic memory seems to last about 4 seconds.
- **Echoic Memory:**
  - A type of sensory memory.
  - Echoic memory involves the memory of an auditory stimuli.
  - Typically, echoic memories are stored for slightly longer periods than iconic memories. While iconic memory disappears in approximately 1 second, echoic memory seems to last about 4 seconds.
- **Short term Memory:**
  - Short term memory is very fragile and capacity limited.
  - It seems to require a great deal of mental effort to keep things in working memory and, once the leave, they are gone.
  - Sometimes we use this memory for short-term storage, though it also seems necessary for transferring information to long-term memory.

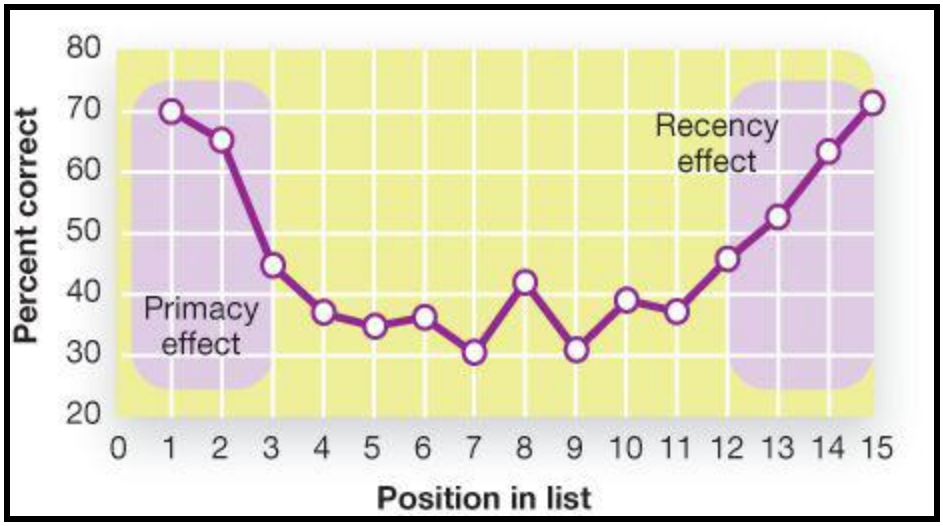
November 13:

- **Working Memory:**
  - The place where information and long term memory is being processed. We can take a variety of information from our long-term memory and combine it in our working memory to answer questions.
    E.g. Imagine you're in a library and putting books, that you'll need to read to write an essay, on a desk. In this analogy, the desk is your working memory and the books are your long-term memory.
  - Working memory also helps transfer information into long-term memory.
  - **Encoding** is the term we use when we're trying to get information into long-term memory.
  - **Retrieval** refers to the subsequent re-accessing of events or information from the past, which has been previously encoded and stored in the brain.
  - How quickly you find something in your memory depends on how you organize the information in your memory.
  - **Dual coding** is the process of combining verbal materials with visual materials.
- The frontal lobe is lateralized. The left hemisphere of the frontal lobe does encoding while the right hemisphere deals with retrieval.
- You do better on memory tests when your state during the test matches your state during studying.

Textbook:

- **Module 7.1 Memory Systems:**
- **The Atkinson-Shiffrin Model:**
- The Atkinson-Shiffrin model includes three memory stores.
- **Stores** retain information in memory without using it for any specific purpose. They essentially serve the same purpose as hard drives serve for a computer.
- The three stores include sensory memory, short-term memory (STM), and long-term memory (LTM). In addition, **control processes** shift information from one memory store to another.
- An important point is that our memory systems, although stunningly powerful, are not perfect. We lose, or forget, information at each step of this model. Information enters the sensory memory store through all of the senses and the control process we call **attention** selects which information will be passed on to STM. This is highly functional: the attention process selects some elements of our environment that will receive further processing and add to our experience and understanding of the world. However, this functionality comes at a cost, because a vast amount of sensory information is quickly forgotten, almost immediately replaced by new input. We selectively narrow the information we receive in STM even further through **encoding**, the process of storing information in the LTM system. We retain only some information and lose the rest. **Retrieval** brings information from LTM back into STM; this happens when you become aware of existing memories.
- **Sensory Memory:**
- **Sensory memory** is a memory store that accurately holds perceptual information for a very brief amount of time—how brief depends on which sensory system we talk about.
- **Iconic memory**, the visual form of sensory memory, is held for about one-half to one second.
- **Echoic memory**, the auditory form of sensory memory, is held for considerably longer, but still only for about 5–10 seconds. It is this form of sensory memory that will allow you to repeat back the words you just heard, even though you may have been thinking about something else.
- Attention allows us to move a small amount of the information from our sensory memory into STM for further processing. This information is often referred to as being within the “spotlight of attention”. Information that is outside of this spotlight of attention is not transferred into STM and is unlikely to be remembered.
- **Short-Term Memory and the Magical Number 7:**
- Although transferring information from sensory memory into short-term memory increases the chances that this information will be remembered later, it is not guaranteed. This is because **short-term memory (STM)** is a memory store with limited capacity and duration (approximately 30 seconds).
- Study after study showed that participants were able to remember seven units of information, give or take a couple and that STM can rehearse only seven units of information at once before forgetting something.

- **Chunking** is organizing smaller units of information into larger, more meaningful units. These larger units are referred to as chunks.
- **Long-Term Memory:**
- Encoding allows information to enter the final memory store in the Atkinson-Shiffrin model. This store, **long-term memory (LTM)**, holds information for extended periods of time, if not permanently.
- Unlike short-term memory, long-term memory has no capacity limitations that we are aware of. All of the information that undergoes encoding will be entered into LTM.
- Once entered into LTM, the information needs to be organized. Researchers have identified at least two ways in which this organization occurs:
    1. One way is based on the semantic categories that the items belong to. E.g. The mental representation of cat would be connected to and stored near the mental representation of other animals such as dog and mouse.
    2. A second way that LTM is organized is based on the sounds of the word and how the word looks. This explains part of the **tip-of-the-tongue (TOT) phenomenon**, when you are able to retrieve similar sounding words or words that start with the same letter but can't quite retrieve the word you actually want.
- It is important to note that having the information in LTM doesn't necessarily mean that you can access it whenever you want to. Instead, the likelihood that a given piece of information will undergo **retrieval**, the process of accessing memorized information and returning it to short-term memory, is influenced by a number of different factors including the quality of the original encoding and the strategies used to retrieve the information.
- There are many instances in which information that we didn't pay much attention to still seems to influence our later behaviour, suggesting that this information entered our memory without us putting effort into encoding it.
- **Working the Scientific Literacy Model Distinguishing "Short-Term from Long-Term Memory Stores":**
- Your STM lasts for approximately 30 seconds and usually contains 7 ± 2 units of information while your LTM has no fixed time limits or capacity.
- The distinction between STM and LTM can be revealed with a simple experiment. Imagine a group of people studied a list of 15 words and then immediately tried to recall the words in the list. The serial position curve, the image shown below, shows what the results would look like according to the **serial position effect**: In general, most people will recall the first few items from a list and the last few items, but only an item or two from the middle. The first few items are remembered relatively easily because they have begun the process of entering our LTM. The last few items are also remembered well because those items are still within our STM.

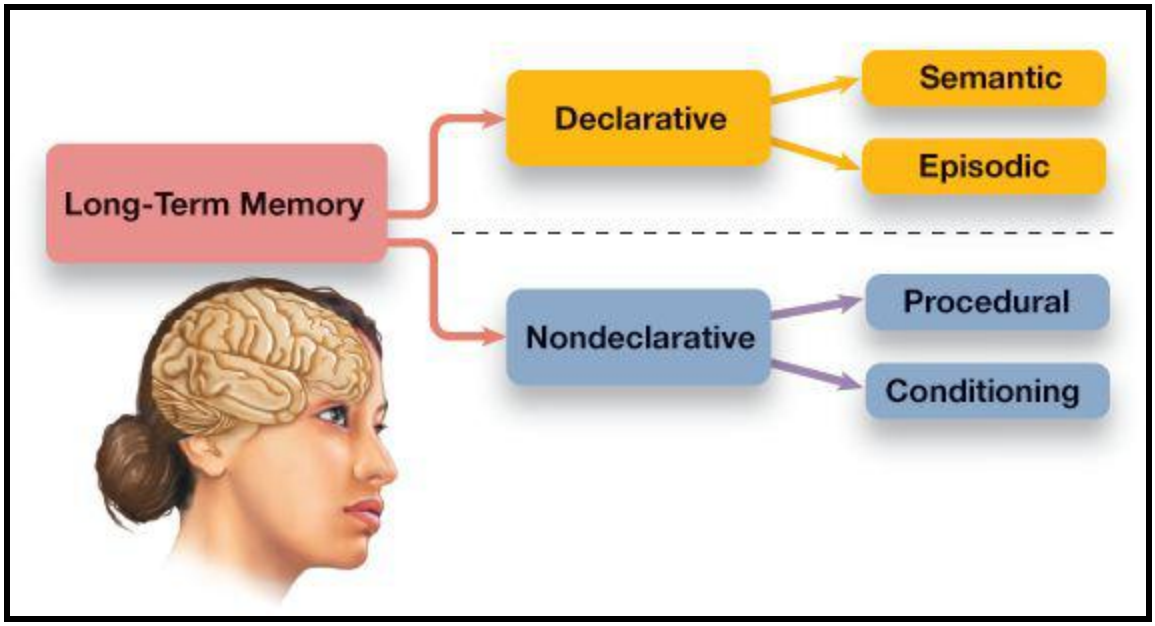


- Memory for the order of events is often superior for original items (the primacy effect) and later items (the recency effect). The serial position effect provides evidence of distinct short-term and long-term memory stores.
- Memory researchers suggest that the dip in the middle of the serial position curve is caused by two different mechanisms:
    1. The items that were at the beginning of the list produce **proactive interference**, a process in which the first information learned occupies memory, leaving fewer resources left to remember the newer information.
    2. The last few items on the list create **retroactive interference**, a process in which the most recently learned information overshadows some older memories that have not yet made it into long-term memory.
- The hippocampus becomes active when information from early in the serial position curve is remembered. This area is associated with the formation of LTM. By comparison, the brain areas associated with sensory information becomes more active when people recalled items at the end of the serial position curve.
- **The Working Memory Model An Active STM System:**
- **Rehearsal** is the repeating of information until you do not need to remember it anymore.
- **Working memory** is a model of short-term remembering that includes a combination of memory components that can temporarily store small amounts of information for a short period of time.
- A key feature of working memory is that it recognizes that stimuli are encoded simultaneously in a number of different ways, rather than simply as a single unit of information.
- The classic working memory model for short-term remembering can be subdivided into three storage components, each of which has a specialized role:
    1. The phonological loop
    2. The visuospatial sketchpad
    3. The episodic buffer
- These storage components are coordinated by a control centre known as the central executive. The central executive helps decide which of the

working-memory stores is most important at any given moment. It can also draw from older information that is stored in a relatively stable way to help organize or make sense of the new information.

- **The Phonological Loop:**
- The **phonological loop** is a storage component of working memory that relies on rehearsal and that stores information as sounds, or an auditory code.
- It engages some portions of the brain that specialize in speech and hearing, and it can be very active without affecting memory for visual and spatial information.
- Psychologists have found that working memory can only store as many syllables as can be rehearsed in about two seconds, and that this information is retained for approximately 15 to 30 seconds.
- **The Visuospatial Sketchpad:**
- The **visuospatial sketchpad** is a storage component of working memory that maintains visual images and spatial layouts in a visuospatial code.
- It keeps you up to date on where objects are around you and where you intend to go. To do so, the visuospatial sketchpad engages portions of the brain related to perception of vision and space and does not affect memory for sounds. Just as the phonological store can be gauged at several levels, such as in terms of the number of syllables, the number of words, or the number of chunks, items stored in visuospatial memory can be counted based on visual features such as shape, colour, and texture.
- Feature binding is the process of combining visual features into a single unit.
- After visual feature binding, visuospatial memory can accurately retain approximately four whole objects, regardless of how many individual features one can find on those objects.
- **The Episodic Buffer:**
- Recent research suggests that working memory also includes an **episodic buffer**, a storage component of working memory that combines the images and sounds from the other two components into coherent, story-like episodes. These episodes allow you to organize or make sense of the images and sounds.
- The episodic buffer is the most recently hypothesized working memory system. It seems to hold 7 to 10 pieces of information, which may be combined with other memory stores.
- **The Central Executive:**
- Finally, working memory includes one component that is not primarily used for storing information. Instead, the **central executive** is the control centre of working memory; it coordinates attention and the exchange of information among the three storage components. It does so by examining what information is relevant to the person's goals, interests, and prior knowledge and then focusing attention on the working memory component whose information will be most useful in that situation.
- **Long-Term Memory Systems Declarative and Nondeclarative Memories:**
- One way to categorize LTM is based on whether or not we are conscious of a given memory.

- **Declarative memories/explicit memories** are memories that we are consciously aware of and that can be verbalized, including facts about the world and one's own personal experiences.
- **Nondeclarative memories/implicit memories** include actions or behaviours that you can remember and perform without awareness.



- **Declarative Memory:**
- Declarative memory comes in two varieties:
    1. **Episodic memories** are declarative memories for personal experiences that seem to be organized around episodes and are recalled from a first-person perspective.
       Examples of episodic memories would be your first day of university, the party you went to last month, and that time you remember watching the Olympics on TV.
    2. **Semantic memories** are declarative memories that include facts about the world.
       An example of semantic memories would include knowing that Fredericton is the capital of New Brunswick.
- **Nondeclarative Memory:**
- Nondeclarative memory occurs when previous experiences influence performance on a task that does not require the person to intentionally remember those experiences.
- **Procedural memory** is a pattern of muscle movements such as how to walk, play piano, tie your shoes, or drive a car.
- **Memory At the Cellular Level:**
- Memory at the cellular level can be summed up in the following way: Cells that fire together, wire together. When neurons fire at the same time, it leads to chemical and physical changes in the neurons, making them more likely to fire together again in the future. This process, **long-term potentiation (LTP)**,

demonstrated that there is an enduring increase in connectivity and transmission of neural signals between nerve cells that fire together.

- However, this does not mean that LTP is memory.
- Lasting memories require **consolidation**, the process of converting short-term memories into long-term memories in the brain, which may happen at the level of small neuronal groups or across the cortex. When neurons fire together a number of times, they will adapt and make the changes caused by LTP more permanent, a process called **cellular consolidation**. This process involves physical changes to the synapse between the cells so that the presynaptic cell is more likely to stimulate a specific postsynaptic cell. Without the consolidation process, the initial changes to the synapse (LTP) eventually fade away, and presumably so does the memory.
- The initial strengthening of synapses (LTP) and longer-term consolidation of these connections allow us to form new memories, thus providing us with an ability to learn and to adapt our behaviour based on previous experiences. However, these processes are not performed in all areas of the brain.
- **Memory, the Brain, and Amnesia:**
- **Amnesia** is a profound loss of at least one form of memory.
- **Anterograde amnesia**, a subtype of amnesia, is the inability to form new memories for events occurring after a brain injury.
- Another subtype of amnesia is **retrograde amnesia**, a condition in which memory for the events preceding trauma or injury is lost.
- When the hippocampus is damaged, the injury interferes with consolidation, the formation of long-term memories. However, such damage does not prevent recall of pre-existing memories.
- The hippocampus is also essential for spatial memories.
- **Stored Memories and the Brain:**
- **Memory storage** refers to the time and manner in which information is retained between encoding and retrieval.
- Memory storage is an active process. Stored memories can be updated regularly, such as when someone reminds you of an event from years ago, or when you are reminded of information you learned as a child. In this way, memories undergo a process called **reconsolidation**, in which the hippocampus functions to update, strengthen, or modify existing long-term memories. These memories then form networks in different regions of the cortex, where they can be retrieved when necessary. These long-term declarative memories are distributed throughout the cortex of the brain, rather than being localized in one region, a phenomenon known as **cross-cortical storage**. With enough use, some of the memory networks will no longer need input from the hippocampus. The cortical networks themselves will become self-sustaining. The more that memory is retrieved, the larger and more distributed that network will become.
- Memories that were recently formed and have not had time to develop extensive cross-cortical networks are much more likely to be lost following a head injury than are older memories. Many people who have experienced a brain injury, including concussions, report that they cannot recall some of the events leading

up to their accident. This type of memory deficit is known as **retrograde amnesia**, a condition in which memory for the events preceding trauma or injury is lost.

- **Module 7.2 Encoding and Retrieving Memories:**
- **Rehearsal, The Basics of Encoding:**
- It is not how long we rehearse information, but rather how we rehearse it that determines the effectiveness of memory.
- **Maintenance rehearsal**, prolonging exposure to information by repeating it, does relatively little to help the formation of long-term memories. By comparison, **elaborative rehearsal**, prolonging exposure to information by thinking about its meaning, significantly improves the process of encoding.
- Although maintenance rehearsal helps us remember for a very short time, elaborative rehearsal improves long-term learning and remembering.
- **Levels of Processing:**
- Not all elaborative encoding is created equal. Instead, different types of elaborative encoding can produce markedly different levels of recall. The details surrounding this variability were first described by researchers at the University of Toronto, and led to a framework for memory known as **levels of processing (LOP)**.
- The LOP framework begins with the understanding that our ability to recall information is most directly related to how that information was initially processed. Differences in processing can be described as a continuum ranging from shallow to deep processing. **Shallow processing** involves more superficial properties of a stimulus, such as the sound or spelling of a word. **Deep processing** is generally related to an item's meaning or its function.
- The **self-reference effect** occurs when you think about information in terms of how it relates to you or how it is useful to you. This type of encoding will lead to you remembering that information better than you otherwise would have and is a type of deep processing.
- STM memory rates are unaffected by shallow or deep processing. They only affect LTM memory rates.
- **Retrieval:**
- There are two forms of intentional memory retrieval, both of which are familiar to long-suffering students like the readers of this textbook.
    1. **Recognition** involves identifying a stimulus or piece of information when it is presented to you. Examples of recognition memory would be identifying someone you know on the bus or answering standard multiple-choice test questions.
    2. **Recall** involves retrieving information when asked, but without that information being present during the retrieval process. Examples of this would be describing a friend's appearance to someone else or answering short-answer or essay questions on an exam.
- Recall is helped substantially when there are hints, or retrieval cues, that help prompt our memory. The more detailed the retrieval cue, the easier it is for us to produce the memory. Researchers have found that retrieval is most effective

when it occurs in the same context as encoding, a tendency known as the **encoding specificity principle**.

- The encoding specificity principle can take many forms. It can include internal contexts such as mood and even whether a person is intoxicated or not. It is usually not difficult to spot these context effects while they are occurring. Almost everyone has had the experience of walking into a room to retrieve something—maybe a specific piece of mail or a roll of tape—only to find that they have no idea what they intended to pick up. We might call this phenomenon **context-dependent forgetting**, if we believe the change in the environment influenced the forgetting. It is certainly frustrating, but can be reversed by the **context reinstatement effect**, which occurs when you return to the original location and the memory suddenly comes back. Research shows that your internal environment can serve as a retrieval cue for your memory as well.
- One of the most intuitive forms of encoding specificity is **context-dependent memory**, the idea that retrieval is more effective when it takes place in the same physical context as encoding.
- **State-Dependent Memory:**
- Research suggests that retrieval is more effective when your internal state matches the state you were in during encoding, a phenomenon known as **state-dependent memory**.
- **Mood-Dependent Memory:**
- Research of **mood-dependent memory** indicate that people remember better if their mood at retrieval matches their mood during encoding.
- As with context- and state-dependent memory, mood-dependent memory has some limitations. Mood has a very small effect on recognition memory; it has much larger effects on recall-based tests. Additionally, it produces larger effects when the participant must generate the to-be-remembered information (e.g., “an example of a musical instrument is a g_____“) than if the stimuli are externally generated (e.g., “remember this word: guitar”).
- **Emotional Memories:**
- Emotions act as a highlighter for memories, making them easier to retrieve than neutral memories, because emotional stimuli and events are generally self-relevant and are associated with arousal responses such as increased heart rate and sweating.
  I.e. Emotion leads to deep processing of information and involves powerful stimuli that can serve as retrieval cues.
- However, although it is intuitive to think that emotion will boost all forms of memory, psychology researchers have found that emotion has fairly specific effects. For example, people often focus their attention on the emotional content of a scene. This information, which typically forms the centre of one’s field of vision, is more likely to be remembered than peripheral information.
- Research has shown that the memory enhancing effect of emotion is strongest after a long period of time rather than short delays. This suggests that emotion’s largest influence is on the process of **consolidation**, when information that has recently been transferred from STM into LTM is strengthened and made

somewhat permanent. Emotion has less of an effect on STM and on recognition memory because these types of memory have much less variability than LTM and leaves less room for emotion to influence accuracy levels.

- Emotions can still influence memory consolidation even if the stimuli themselves are not emotional in nature.
- Brain imaging shows that emotional memories often activate the amygdala, whereas non-emotional memories generated at the same time do not. These studies have also shown that the amygdala can alter the activity of several temporal-lobe areas that send input to the hippocampus. As a result, the cells in these brain regions fire together more than they normally would, which may lead to more vivid memories. However, this coordinated neural activity still does not guarantee that all of the details of an experience will be remembered with complete accuracy.
- Activity in the amygdala influences the activity of nearby regions in the temporal lobes, increasing the degree to which they fire together. This alters the type of input received by the hippocampus from regions of the cortex.
- **Flashbulb Memories:**
- A **flashbulb memory** is an extremely vivid and detailed memory about an event and the conditions surrounding how one learned about the event.
- These highly charged emotional memories typically involve recollections of location, what was happening around oneself at the time of the event, and the emotional reactions of self and others.
- Although flashbulb memories are very detailed and individuals reciting the details are very confident of their accuracy, it might surprise you to learn that they are not necessarily more accurate than many other memories.
- **Mnemonics Improving Your Memory Skills:**
- A **mnemonic** is a technique intended to improve memory for specific information.
- The **method of loci** is a mnemonic that connects words to be remembered to locations along a familiar path. To use the method of loci, one must first imagine a route that has landmarks or easily identifiable spaces. Once the path is identified, the learner takes a moment to visually relate the each word on the list to a landmark encountered. The image doesn't need to be realistic, it just needs to be distinct enough to be memorable. When it is time to recall the items, the learner simply imagines the familiar drive, identifying the items as they relate to each location along the path.
- However, the method of loci can become a bit cumbersome. A more practical mnemonic is the use of **acronyms**, pronounceable words whose letters represent the initials of an important phrase or set of items.
- A related mnemonic, the **first-letter technique**, uses the first letters of a set of items to spell out words that form a sentence.
- A number of mnemonic devices are based on the premise of dual coding. **Dual coding** occurs when information is stored in more than one form, such as a verbal description and a visual image, or a description and a sound, and it regularly produces stronger memories than the use of one form alone. Dual coding leads to the information receiving deeper processing because the

additional sensory representations create a larger number of memory associations.

- The **testing effect** is the finding that taking practice tests can improve exam performance, even without additional studying.
- **Module 7.3 Constructing and Reconstructing Memories:**
- **The Schema An Active Organization Process:**
- The gist of a story gives us a general structure for the memory and details can be added around that structure. The gist is often influenced by **schemas**, organized clusters of memories that constitute one's knowledge or beliefs about events, objects, and ideas.
- Schemas affect encoding, storage and retrieval.
- Whenever we encounter familiar events or objects, these schemas become active and affect what we expect, what we pay attention to, and what we remember. Because we use these patterns automatically, it may be difficult to understand what they are, even though we use them throughout our lives.
- Schemas about the self are based on past experiences and are used to organize the encoding of self-relevant information in a way that can influence our responses. Furthermore, self-schemas may serve an additional role during development. Some evidence suggests that the ability to form schemas, particularly self-schemas, plays a critical role in our ability to form memories about our lives.
- **Infantile amnesia** is the inability of adults to retrieve episodic memories before the age of two to four years.
- Research indicates that self-schemas begin to develop around the ages of 18 to 24 months. Without these schemas, it is difficult and maybe even impossible to organize and encode memories about the self. This is not a universal phenomenon, however. Researchers have found that a sense of self emerges earlier among European Americans than among people living in eastern Asia, because European Americans put emphasis on developing a sense of self, which encourages thinking about personal experiences. In contrast, Asian cultures tend to emphasize social harmony and collectiveness over individualism, resulting in a schema that is more socially integrated than in Westerners.
- Research indicates that we remember events using **constructive memory**, a process by which we first recall a generalized schema and then add in specific details. The schemas are products of culture and experience.
- Recent brain-imaging studies suggest that schemas exist and likely help with the process of memory consolidation. Both encoding and retrieving information that was consistent with a schema learned during an experiment led to greater activity in a network involving parts of the medial temporal lobes and the frontal lobes. Additionally, adding new information to an existing schema actually changes the expression of genes in the frontal lobes in order to strengthen connections between this region and the hippocampus.
- **Memory Reconstruction:**
- While our memories are organized to a large degree by our schemas, including self-schemas, there is no guarantee that these schemas are 100% accurate.

Different motivations can influence which schemas are accessible to us in a given moment, thereby biasing our memory reconstruction. As a result of these motivational influences, the past that we remember is actually influenced by our mental state and by our view of ourselves in the present.

- Everyone has experienced a **false memory**, remembering events that did not occur, or incorrectly recalling details of an event. It is important to remember that these incorrect memories do not necessarily indicate a dysfunction of memory, but rather reflect normal memory processes, which are inherently imperfect.
- **The Perils of Eyewitness Testimony:**
- There are a number of minor factors can dramatically influence the details of our memories:
    1. The wording of the statement or question.
    2. The information that is encoded after the event has occurred, such as rumours, news reports, or hearing about other people's perceptions of the event. If such information was accurate, it could improve people's memories. However, this type of information is not always accurate, which explains why jury members are asked to avoid reading about or watching TV reports related to the case with which they are involved. Psychologists have shown that this legal procedure is a wise one, as a number of studies have demonstrated the **misinformation effect**, when information occurring after an event becomes part of the memory for that event.
- Children are particularly susceptible to misinformation effects and to the effects of a question's wording.
- While trying to identify the individual responsible for a crime, investigators often present a lineup of a series of individuals and ask the eyewitness to identify the suspect. Given the constructive nature of memory, it should come as no surprise to hear that an eyewitness gets it wrong from time to time. The consequences of this kind of wrongful conviction are dire, an innocent person may go to jail while a potentially dangerous person stays free. Here are the six main suggestions for reforming eyewitness identification procedures:
    1. **Employ double-blind procedures.** Elsewhere in this book, we discussed how double-blind procedures help reduce experimenter bias. Similarly, a double-blind lineup (i.e., the investigator in the room with the eyewitness has no knowledge of which person is the actual suspect) can prevent an investigator from biasing an eyewitness, either intentionally or accidentally.
    2. **Use appropriate instructions.** For example, the investigator should include the statement, "The suspect might not be present in the lineup." Eyewitnesses often assume the guilty person is in the lineup, so they are likely to choose a close match. This risk can be greatly reduced by instructing the eyewitness that the correct answer may be "none of the above."
    3. **Compose the lineup carefully.** The lineup should include individuals who match the eyewitness's description of the perpetrator, not the investigator's beliefs about the suspect.
    4. **Use sequential lineups.** When an entire lineup is shown simultaneously, this may encourage the witness to assume one of the people is guilty, so they

choose the best candidate. If the people in the lineup are presented one at a time, witnesses are less likely to pick out an incorrect suspect because they are willing to consider the next person in the sequence.

5. **Require confidence statements.** Eyewitness confidence can change as a result of an investigator's response, or simply by seeing the same suspect in multiple lineups, neither of which make the testimony any more accurate. Therefore, confidence statements should be taken in the witness's own words after an identification is made.
6. **Record the procedures.** Eyewitness researchers have identified at least a dozen specific things that can go wrong during identification procedures. By recording these procedures, expert witnesses can evaluate the reliability of testimony during hearings.

- **Imagination and False Memories:**
- Imagining events can often lead to **imagination inflation**, the increased confidence in a false memory of an event following repeated imagination of the event. The more readily and clearly we can imagine events, the more certain we are that the memories are accurate.
- Imagination inflation is very similar to **guided imagery**, a technique used by some clinicians to help people recover details of events that they are unable to remember. It involves a guide giving instructions to participants to imagine certain events. Like the misinformation effect, guided imagery can be used to alter memories for actual events, but it can also create entirely false memories.
- **Creating False Memories in the Laboratory:**
- Researchers have developed techniques that would allow them to study false memories in more detail. Several are listed below:
    1. In the **Deese-Roediger-McDermott (DRM) procedure**, participants study a list of highly related words that are associated by meaning. The word that would be the most obvious member of the list is missing. This missing word is called the **critical lure**. When the participants are given a memory test, a significant proportion of participants remember the critical lure, even though it never appeared on the list. When individuals recall the critical lure, it is called an **intrusion**, because a false memory is sneaking into an existing memory.
    2. Doctored photographs or videoes.
- **The Danger of False Remembering:**
- A **recovered memory** is a memory of a traumatic event that is suddenly recovered after blocking the memory of that event for a long period of time, often many years.
- The idea that we suppress traumatic memories is known as repression from Freudian psychoanalysis. According to this idea, a repressed memory could still affect other psychological processes, leading people to suffer in other ways, such as experiencing depression. This school of thought suggests that if a repressed memory can be recovered, then a patient can find ways to cope with the trauma. However, it is dangerous to recover these memories as people may plant false memories and recover those.

- Recovered memories, like many other types of long-term memory, are difficult to study because one can rarely determine if they are true or false. This uncertainty has led to the **recovered memory controversy**, a heated debate among psychologists about the validity of recovered memories.
- We can use brain imaging to differentiate true and false memories. Psychologists have found that when people recount information that is true, the visual and other sensory areas of the brain become more active. When revealing falsely remembered information, these same individuals have much less activity in the sensory regions because the brain is not drawing on mental imagery as it was not there in the first place. This method might be able to distinguish between true and false memories better than the participant himself. However, these studies did not use stimuli that were as emotional as the recovered memories patients report. Therefore, much more research is needed.

Definition:

- **Acronyms:** Pronounceable words whose letters represent the initials of an important phrase or set of items.
- **Amnesia:** A profound loss of at least one form of memory.
- **Anterograde amnesia:** The inability to form new memories for events occurring after a brain injury.
- **Attention:** Selects which information will be passed on to STM.
- **Central executive:** The control centre of working memory; it coordinates attention and the exchange of information among the three storage components.
- **Chunking:** Organizing smaller units of information into larger, more meaningful units.
- **Consolidation:** The process of converting short-term memories into long-term memories in the brain.
- **Constructive memory:** A process by which we first recall a generalized schema and then add in specific details.
- **Context-dependent memory:** The idea that retrieval is more effective when it takes place in the same physical context as encoding.
- **Control processes:** Shift information from one memory store to another.
- **Declarative/explicit memories:** Memories that we are consciously aware of and that can be verbalized, including facts about the world and one's own personal experiences.
- **Deep processing:** Memory processing related to an item's meaning or its function.
- **DRM procedure:** Participants study a list of highly related words that are associated by meaning.
- **Dual coding:** Occurs when information is stored in more than one form.
- **Echoic memory:** The auditory form of sensory memory.
- **Elaborative rehearsal:** Prolonging exposure to information by thinking about its meaning.
- **Encoding:** The process of storing information in the LTM system.

- **Encoding specificity principle:** Retrieval is most effective when it occurs in the same context as encoding.
- **Episodic buffer:** A storage component of working memory that combines the images and sounds from the other two components into coherent, story-like episodes.
- **Episodic memories:** Declarative memories for personal experiences that seem to be organized around “episodes” and are recalled from a first-person perspective.
- **False memory:** Remembering events that did not occur, or incorrectly recalling details of an event.
- **First-letter technique:** Uses the first letters of a set of items to spell out words that form a sentence.
- **Flashbulb memory:** An extremely vivid and detailed memory about an event and the conditions surrounding how one learned about the event.
- **Iconic memory:** The visual form of sensory memory.
- **Imagination inflation:** The increased confidence in a false memory of an event following repeated imagination of the event.
- **Long-term memory (LTM):** Holds information for extended periods of time, if not permanently.
- **Long-term potentiation (LTP):** Demonstrated that there is an enduring increase in connectivity and transmission of neural signals between nerve cells that fire together.
- **Maintenance rehearsal:** Prolonging exposure to information by repeating it.
- **Memory storage:** The time and manner in which information is retained between encoding and retrieval.
- **Method of loci:** A mnemonic that connects words to be remembered to locations along a familiar path.
- **Misinformation effect:** When information occurring after an event becomes part of the memory for that event.
- **Mnemonic:** A technique intended to improve memory for specific information.
- **Mood-dependent memory:** People remember better if their mood at retrieval matches their mood during encoding.
- **Nondeclarative/implicit memories:** Include actions or behaviours that you can remember and perform without awareness.
- **Phonological loop:** A storage component of working memory that relies on rehearsal and that stores information as sounds, or an auditory code.
- **Proactive interference:** A process in which the first information learned occupies memory, leaving fewer resources to remember the newer information.
- **Procedural memories:** Patterns of muscle movements.
- **Recall:** Retrieving information when asked but without that information being present during the retrieval process.

- **Recognition:** Identifying a stimulus or piece of information when it is presented to you.
- **Recovered memory:** A memory of a traumatic event that is suddenly recovered after blocking the memory of that event for a long period of time.
- **Recovered memory controversy:** A heated debate among psychologists about the validity of recovered memories.
- **Rehearsal:** Repeating information until you do not need to remember it anymore.
- **Retroactive interference:** The most recently learned information overshadows some older memories that have not yet made it into long-term memory.
- **Retrieval:** Brings information from LTM back into STM.
- **Retrograde amnesia:** A condition in which memory for the events preceding trauma or injury is lost.
- **Schema:** Organized clusters of memories that constitute one's knowledge about events, objects, and ideas.
- **Self-reference effect:** Occurs when you think about information in terms of how it relates to you or how it is useful to you; this type of encoding will lead to you remembering that information better than you otherwise would have.
- **Semantic memories:** Declarative memories that include facts about the world.
- **Sensory memory:** A memory store that accurately holds perceptual information for a very brief amount of time.
- **Serial position effect:** In general, most people will recall the first few items from a list and the last few items, but only an item or two from the middle.
- **Shallow processing:** Encoding more superficial properties of a stimulus, such as the sound or spelling of a word.
- **Short-term memory (STM):** A memory store with limited capacity and duration (approximately 30 seconds).
- **State-dependent memory:** Memory retrieval is more effective when your internal state matches the state you were in during encoding.
- **Stores:** Retain information in memory without using it for any specific purpose.
- **Testing effect:** The finding that taking practice tests can improve exam performance, even without additional studying.
- **Tip-of-the-tongue (TOT) phenomenon:** When you are able to retrieve similar sounding words or words that start with the same letter but can't quite retrieve the word you actually want.
- **Visuospatial sketchpad:** A storage component of working memory that maintains visual images and spatial layouts in a visuospatial code.
- **Working memory:** A model of short-term remembering that includes a combination of memory components that can temporarily store small amounts of information for a short period of time. It is composed of the phonological loop, the visuospatial sketchpad, and the episodic buffer.

Textbook:

- **Module 8.1 The Organization of Knowledge:**
- **Concepts and Categories:**
- A **concept** is a mental representation of an object, event, or idea.
- A **category** is a cluster of interrelated concepts. We form these groups using a process called **categorization**.
- **Classical Categories Definitions and Rules:**
- Categorization is difficult to define in that it involves elements of perception, memory, and "higher-order" processes like decision making and language.
- The earliest approach to the study of categories is referred to as **classical categorization**. This theory claims that objects or events are categorized according to a certain set of rules or by a specific set of features.
- Classical categorization does not tell the full story of how categorization works, however. We use a variety of cognitive processes in determining which objects fit which category. One of the major problems we confront in this process is **graded membership**, the observation that some concepts appear to make better category members than others.
- **Prototypes Categorization by Comparison:**
- **Prototypes** are mental representations of an average category member.
- Prototypes allow for classification by resemblance. When you encounter a little creature you have never seen before, its basic shape can be compared to your prototype of a bird. A match will then be made and you can classify the creature as a bird. Notice how different this process is from classical categorization: No rules or definitions are involved, just a set of similarities in overall shape and function.
- The main advantage of prototypes is that they help explain why some category members make better examples than others.
- We can use either categorization or prototypes to make a choice. The choice really depends on how complicated a category or a specific example might be. If there are a few major distinctions between items, we use prototypes; if there are complications, we switch to categorization.
- **Networks and Hierarchies:**
- A **semantic network** is an interconnected set of nodes or concepts and the links that join them to form a category.
- Semantic networks are usually arranged in a hierarchy and usually moves from general (top of the hierarchy) to very specific (bottom of hierarchy).
- This organization is important because different levels of the category are useful in different situations. The most frequently used level, in both thought and language, is the **basic-level category**. The basic-level category is the most frequently used level because:
    1. Basic-level categories are the terms used most often in conversation.
    2. They are the easiest to pronounce.
    3. They are the level at which prototypes exist.
    4. They are the level at which most thinking occurs.

- **Working the Scientific Literacy Model, Priming and Semantic Networks:**
- **Priming** is the activation of individual concepts in long-term memory.
  E.g. Hearing the word fruit might lead you to think of an apple, and the apple may lead you to think of a computer, which may lead you to think of a paper that is due tomorrow.
- Research has shown that priming can also occur without your awareness.
- Psychologists can test for priming through reaction time measurements, such as through a method called the **lexical decision task**. With the lexical decision method, a volunteer sits at a computer and stares at a focal point. Next, a string of letters flashes on the screen. The volunteer responds yes or no as quickly as possible to indicate whether the letters spell a word. Using this method, a volunteer should respond faster that “apple” is a word if it follows the word “fruit” (which is semantically related) than if it follows the word “bus” (which is not semantically related).
- **Memory, Culture, and Categories:**
- People integrate new stimuli into categories based on what they have experienced before. When we encounter a new item, we select its category by retrieving the item(s) that are most similar to it from memory.
- **Categories, Memory, and the Brain:**
- The fact that our ability to make categorical decisions is influenced by previous experiences tells us that this process involves memory.
- Some patients with damage to the temporal lobes have trouble identifying objects such as pictures of animals or vegetables despite the fact that they were able to describe the different shapes that made up those objects. The fact that these deficits were for particular categories of objects was intriguing, as it suggested that damaging certain parts of the brain could impair the ability to recognize some categories while leaving others unaffected. Because these problems were isolated to certain categories, these patients were diagnosed as having a disorder known as **category specific visual agnosia (CSVA)**.
  I.e. Several patients with CSVA had difficulties identifying fruits, vegetables, and/or animals but were still able to accurately identify members of categories such as tools and furniture.
- Researchers have noted that it would be physically impossible for our brains to have specialized regions for every category we have encountered because there isn’t enough space for this to occur. They proposed that evolutionary pressures led to the development of specialized circuits in the brain for a small group of categories that were important for our survival. These categories included animals, fruits and vegetables, members of our own species, and possibly tools. This theory is in agreement with brain-imaging studies showing that different parts of the temporal lobes are active when people view items from different categories including animals, tools, and people. Thus, although different people will vary in terms of the exact location that these categories are stored, it does appear that some categories are stored separately from others.

- **Categories and Culture:**
- The human brain is wired to perceive similarities and differences and to categorize items based on these comparisons as well as on our previous experiences with members of different categories. However, how we categorize objects depends to a great extent on what we have learned about those objects from others in our culture.
- Cultural differences in how people think and categorize items have led to the idea of **linguistic relativity/ Whorfian hypothesis**, the theory that the language we use determines how we understand and categorize the world.
- Research on linguistic relativity suggests that language can have some effects on categorization, but the effects are limited.
- **Module 8.2 Problem Solving, Judgment, and Decision Making:**
- **Defining and Solving Problems:**
- **Problem solving** means accomplishing a goal when the solution or the path to the solution is not clear.
- **Problem-Solving Strategies and Techniques:**
- There are two main strategies for problem solving. One strategy for problem solving is more objective, logical, and slower, whereas the other is more subjective, intuitive, and quicker.
- When we think logically, we rely on **algorithms**, problem-solving strategies based on a series of rules. As such, they are very logical and follow a set of steps, usually in a pre-set order. While computers are very good at using algorithms because they can follow a preprogrammed set of steps and perform thousands of operations every second, people are not always so rule-bound. We tend to rely on intuition to find strategies and solutions that seem like a good fit for the problem. These are called **heuristics**, problem-solving strategies that stem from prior experiences and provide an educated guess as to what is the most likely solution. Heuristics are often quite efficient, accurate and allow us to find solutions and to make decisions quickly.
- **Cognitive Obstacles:**
- While having a routine solution available for a problem generally allows us to solve that problem with less effort than we would use if we encountered it for the first time, sometimes, routines may impose cognitive barriers that impede solving a problem if the circumstances change so that the routine solution no longer works.
- A **mental set** is a cognitive obstacle that occurs when an individual attempts to apply a routine solution to what is actually a new type of problem.
- A type of mental set, **functional fixedness**, occurs when an individual identifies an object or technique that could potentially solve a problem, but can think of only its most obvious function.
- **Judgment and Decision Making:**
- Like problem solving, judgments and decisions can be based on logical algorithms, intuitive heuristics, or a combination of both.

- We tend to use heuristics more often than we realize, even those of us who consider ourselves to be logical thinkers.
- **Conjunction Fallacies and Representativeness:**
- The **conjunction fallacy** is the mistaken belief that finding a specific member in two overlapping categories is more likely than finding any member of one of the larger, general categories.
- The conjunction fallacy demonstrates the use of the **representativeness heuristic**, making judgments of likelihood based on how well an example represents a specific category.
- **The Availability Heuristic:**
- The **availability heuristic** entails estimating the frequency of an event based on how easily examples of it come to mind.
  I.e. We assume that if examples are readily available, then they must be very frequent.
- **Anchoring and Framing Effects:**
- The representativeness and availability heuristics involve our ability to remember examples that are similar to the current situation.
- The **anchoring effect** occurs when an individual attempts to solve a problem involving numbers and uses previous knowledge to keep the response within a limited range. Sometimes this previous knowledge consists of facts that we can retrieve from memory.
- Decision making can also be influenced by how a problem is worded or framed.
- **Belief Perseverance and Confirmation Bias:**
- One cognitive bias is **belief perseverance**, when an individual believes he or she has the solution to the problem and will hold onto that belief even in the face of evidence against it.
- Belief perseverance seems to function by minimizing negative feelings while maximizing positive feelings.
- A second cognitive bias is the **confirmation bias**, when an individual searches for or pays attention to only evidence that will confirm his or her beliefs instead of evidence that might disconfirm them.
- **Module 8.3 Language and Communication:**
- **Early Studies of Language:**
- **Aphasia** is a language disorder caused by damage to the brain structures that support using and understanding language.
- **Broca's area** is the region of the left frontal lobe that controls our ability to articulate speech sounds that compose words. The symptoms associated with damage to this region are known as **Broca's aphasia**.
- **Wernicke's area** is the area of the brain most associated with finding the meaning of words. Damage to this area results in **Wernicke's aphasia**, a language disorder in which a person has difficulty understanding the words he or she hears.
- **Properties of Language:**
- **Language** is a form of communication that involves the use of spoken, written, or gestural symbols that are combined in a rule-based form.

- Language can involve communication about objects and events that are not in the present time and place. We can use language to talk about events happening on another planet or that are happening within atoms. We can also use different tenses to indicate that the topic of the sentence occurred or will occur at a different time.
- Languages can produce entirely new meanings. It is possible to produce a sentence that has never been uttered before in the history of humankind, simply by reorganizing words in different ways. As long as you select English words and use correct grammar, others who know the language should be able to understand it.
- Language is passed down from parents to children.
- Language requires us to link different sounds or gestures with different meanings in order to understand and communicate with other people.
- **Phonemes and Morphemes The Basic Ingredients of Language:**
- **Phonemes** are the most basic units of speech sounds.
- **Morphemes** are the smallest meaningful units of a language.
  E.g. Pig is a morpheme because it cannot be broken down into smaller units of meaning.
- Some morphemes are simple words, whereas others may be suffixes or prefixes.
- You can combine morphemes if you follow the rules of the language.
  E.g. Pigs is a combination of the morphemes “pig” and “s”.
  Our ability to combine morphemes into words is one distinguishing feature of language that sets it apart from other forms of communication. In essence, language gives us **productivity**, the ability to combine units of sound into an infinite number of meanings.
- **Semantics** is the study of how people come to understand meaning from words.
- Although phonemes, morphemes, and semantics have an obvious role in spoken language, they also play a role in our ability to read. When you recognize a word, you effortlessly translate the word’s visual form, its orthography, into the sounds that make up that word, its phonology or phonological code. These sounds are combined into a word, at which point you can access its meaning or semantics. However, not all people are able to translate orthography into sounds. Individuals with dyslexia have difficulties translating words into speech sounds. Children with dyslexia show less activity in the left fusiform cortex (at the bottom of the brain where the temporal and occipital lobes meet), a brain area involved with word recognition and with linking word and sound representations.
- **Syntax The Language Recipe:**
- **Syntax** is the rules for combining words and morphemes into meaningful phrases and sentences.
- **Pragmatics The Finishing Touches:**
- **Pragmatics** is the study of nonlinguistic elements of language use. It places heavy emphasis on the speaker’s behaviours and the social situation.
- Pragmatics reminds us that sometimes what is said is not as important as how it is said.
  E.g. A student who says, “I ate a 50-pound cheeseburger,” is most likely

stretching the truth, but you probably would not call him a liar. Pragmatics helps us understand what he implied.

- **Infants, Sound Perception, and Language Acquisition:**
- Infants as young as two months old show a preference for speech sounds over perceptually similar non-speech sounds.
- By 10 months of age, infants begin hearing sounds in a way that is consistent with their native language.
- Newborn infants can distinguish between function words, prepositions, and content words, nouns and verbs, based on their sound properties. By six months of age, infants prefer the content words, thus showing that they are learning which sounds are most useful for understanding the meaning of a statement.
- By the age of 20 months, the children are able to use the perceptual categories that they developed in order to rapidly learn new words.
- In some cases, children can perform **fast mapping**, the ability to map words onto concepts or objects after only a single exposure.
- Human children seem to have a fast-mapping capacity that is superior to any other organism on the planet. This skill is one potential explanation for the naming explosion, a rapid increase in vocabulary size that occurs at this stage of development. The naming explosion has two biological explanations:
    1. At this stage of development, the brain begins to perform language-related functions in the left hemisphere. Prior to this stage, this information was stored and analyzed by both hemispheres.
    2. The naming explosion has also been linked to an increase in the amount of myelin on the brain's axons, a change that would increase the speed of communication between neurons.
- **Producing Spoken Language:**
- Stages of children developing language skills

Average Time of Onset (Months)	Milestone
1–2	Cooing
4–10	Babbling (consonants start)
8–16	Single-word stage
24	Two-word stage
24+	Complete, meaningful phrases strung together

- **Sensitive Periods for Language:**
- Children pick up a language much more easily than adults because there is a sensitive period for language, a time during childhood in which children's brains are primed to develop language skills. Children can absorb language almost effortlessly, but this ability seems to fade away starting around age seven.

- **The Bilingual Brain:**
- Benefits of bilingualism:
    - Bilingual individuals are much better than their unilingual counterparts on tests that require them to control their attention or their thoughts. Bilinguals score better than unilinguals on tests of executive functions throughout the lifespan.
    - Being bilingual helps protect against the onset of dementia and Alzheimer's disease. Because the executive control involved with bilingualism uses areas in the frontal lobes, these regions may form more connections in bilinguals than unilinguals. As a result, these brains likely have more back-up systems if damage occurs.
- Although bilingualism leads to many benefits, bilingual children tend to have a smaller vocabulary in each language than unilingual children.
- People with the FOXP2 gene have difficulties with producing speech because this condition results from abnormalities involving parts of the brain that plan and coordinate movements of the lips, mouth, and tongue.

Definitions:

- **Algorithms:** Problem-solving strategies based on a series of rules.
- **Anchoring effect:** Occurs when an individual attempts to solve a problem involving numbers and uses previous knowledge to keep (i.e., anchor) the response within a limited range.
- **Aphasia:** A language disorder caused by damage to the brain structures that support using and understanding language.
- **Availability heuristic:** Entails estimating the frequency of an event based on how easily examples of it come to mind.
- **Belief perseverance:** Occurs when an individual believes he or she has the solution to the problem or the correct answer for a question and accepts only evidence that will confirm those beliefs.
- **Broca's area:** A region of the left frontal lobe that controls our ability to articulate speech sounds that compose words.
- **Category:** A cluster of interrelated concepts.
- **Classical categorization:** A theory that claims that objects or events are categorized according to a certain set of rules or by a specific set of features.
- **Concept:** The mental representation of an object, event, or idea.
- **Confirmation bias:** Occurs when an individual searches for only evidence that will confirm his or her beliefs instead of evidence that might disconfirm them.
- **Conjunction fallacy:** Reflects the mistaken belief that finding a specific member in two overlapping categories is more likely than finding any member of one of the larger, general categories.
- **Cross-fostered:** Being raised as a member of a family that was not of the same species.
- **Fast mapping:** The ability to map words onto concepts or objects after only a single exposure.

PSYA01 Chapter 8 Notes

- **Functional fixedness:** Occurs when an individual identifies an object or technique that could potentially solve a problem, but can think of only its most obvious function.
- **Graded membership:** The observation that some concepts appear to make better category members than others.
- **Heuristics:** Problem-solving strategies that stem from prior experiences and provide an educated guess as to what is the most likely solution.
- **Language:** A form of communication that involves the use of spoken, written, or gestural symbols that are combined in a rule-based form.
- **Linguistic relativity/Whorfian hypothesis:** The theory that the language we use determines how we understand the world.
- **Mental set:** A cognitive obstacle that occurs when an individual attempts to apply a routine solution to what is actually a new type of problem.
- **Morphemes:** The smallest meaningful unit of a language.
- **Phonemes:** The most basic unit of speech sounds.
- **Pragmatics:** The study of nonlinguistic elements of language use.
- **Priming:** The activation of individual concepts in long-term memory.
- **Problem solving:** Accomplishing a goal when the solution or the path to the solution is not clear.
- **Prototypes:** Mental representations of an average category member.
- **Representativeness heuristic:** Making judgments of likelihood based on how well an example represents a specific category.
- **Semantics:** The study of how people come to understand meaning from words.
- **Semantic network:** An interconnected set of nodes or concepts and the links that join them to form a category.
- **Syntax:** The rules for combining words and morphemes into meaningful phrases and sentences.
- **Wernicke's area:** The area of the brain most associated with finding the meaning of words.