Week 1- Navigating Principles of Psychology

- Academic adjustment can predict degree completion and academic achievement, but this comes with challenges like loneliness, financial stress, class format, freedom, social opportunities, personal and emotional problems.
- Psychology is a science just like bio, chem, physics and math. It is based on empiricism and scientific method. It often overlaps with some of the courses listed above
- Psychology can be emotionally taxing because the content deals with human processes: how we perceive, think, feel and behave
- Mental illness can reduce academic success and adjustment to university

STRATEGIES TO OVERCOME ACADEMIC CHALLENGES

- Scheduling your time: create a weekly schedule to focus on things you have to do and manage work life and school life
- Keeping Focused: use a distraction pad to write down wandering thoughts and come back to it after your task is complete
- Effective Studying: find a place to work where you will be productive
- Strategies to Overcome Emotional Challenges: Forewarned is forearmed…warn yourself about the material you are about to read so you are able to mental prepare yourself for the heavy discussion topics

Trigger Warnings:

- Psych does NOT use trigger warnings as minimal scientific evidence supports that they are effective
    - Coping and recognizing the important of Mental Hygiene
    - Self-Care *(using the resources available to you will ensure you succeed)
        - Deep breathing
        - progressive muscle relaxation
        - visualization
        - mental grounding
        - physical grounding
        - planned exercise
        - cultural, diversity and faith-based resources
        - healthy eating

WHAT IS PSYCHOLOGY?

- Psychology is the scientific study of the human mind and its functions, such as behaviour, thought, and experience.
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- Psychology can be affected by physical, mental, social and environmental factors.
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- Psychology can be broken down into different disciplines, such as: experimental psychology, clinical psychology, cognitive psychology, developmental psychology, social psychology.

➢ Experimental Psychology: involves research studies that can be applied back to the real world. Experimental psychologists (or Researchers) study humans and animals.
➢ Clinical Psychology: the study of abnormal behaviours/thought processes. Involves psychologists, who treat people with mental disorders, or psychiatrists, who manage medications and treatment plans for individuals suffering from mental illness.
➢ Cognitive Psychology: the study of the mechanisms involved in thought processes. Includes human intelligence, language, perception, attention, memory, thinking, and problem solving.
➢ Developmental Psychology: the study of human beings across the lifespan.
➢ Social Psychology: the study of human interaction. Studying the way people think about, influence, and relate to others. Studying how individuals behave depending on if they're in a group or in isolation.

WHAT CAN INFLUENCE OUR PSYCHOLOGY?
- Physical factors: sleep, diet, exercise
- Mental Factors: self-esteem, beliefs, mental disorder/illness
- Social factors: family, peers, coworkers
- Environmental factors: season, weather, location

PSYCHOLOGY AS A SCIENCE

What is science?

- The use of systematic observation in order to gain knowledge
- Systematic observation is the core of science. We record observations so memory biases are less likely to happen in our conclusions. As well as observe under controlled conditions so that we can see variation in the phenomena to understand why it did or did not happen
- Observations lead to hypothesis we can test
- Science is democratic, meaning people can question ideas and form their own hypothesis, as well as add on ideas that have already been discovered
  - ★ Psychology was considered a branch of philosophy until the mid-1800s, when it developed as a scientific discipline in Germany and the United States. Psychology became a formal and recognized scientific discipline in 1879, when Wilhelm Wundt founded the first psychology research laboratory in Leipzig, Germany. Modern psychology intersects with various other sciences, such as biology, neuroscience, sociology, and anthropology.

ETHICS OF SCIENTIFIC PSYCHOLOGY

- Scientific psychologists follow a specific set of guidelines for research called ethics
- Informed Consent: people should know what they are participating in and what will happen to them during the study
- Confidentiality: information about participant should not be revealed to the public without consent
- Benefits: researchers should way if the benefits of the study outway the risks
- Deception: some researchers need to deceive participants about what the study is on so they don't change their behaviour. At the end the researchers were required to "debrief" them.

WHY LEARN ABOUT SCIENTIFIC PSYCHOLOGY?

1. To understand other people and groups
2. To be able to influence others like socialize children or motivate employees
3. To learn about how to better help others and improve the world
4. To learn a skill that will lead to a profession ex. Social worker
5. To learn how to evaluate research claims you hear about
6. Because it is interesting

HISTORY OF PSYCHOLOGY and how it improved the world (VERY IMPORTANT FOR EXAM ESPECIALLY THE SCHOOLS OF THOUGHT LIKE FUNCTIONALISM, RATIONALISM, DUALISM AND STRUCTURALISM ETC.)

The history of psychology can be traced back to the classical Greek philosophers who studied the mind and the nature of knowledge:

- Thales of Miletus
- Socrates
- Plato
- Aristotle

These individuals thought about topics that are still researched in psychology today, including the basis of human traits (nature vs. nurture) and the causes of mental illnesses. They believed that knowledge was achieved by applying the principles of logic and reason to information that is acquired by the senses. This view is called rationalism.

- Psychology was formally proposed in late 19th century
- Precursors to psychology found in philosophy and physiology
    - Philosophers such as John Locke and Thomas Reid promoted empiricism

        - Idea that knowledge comes from experience
        - Their work emphasized the role of observation and the importance of senses in defining how the mind acquires knowledge
- Hermann von Helmholtz's measurement of the speed of the neural impulse via hearing and vision indicated that our senses are able to deceive us and hey do not mirror the external world
    - Showing that even though human sense are fallible, the mind could not be measured using the methods of science – suggesting psychology was feasible
- The development of psychology is largely credited to German physician, physiologist and philosopher Wilhelm Wundt
    - Helped to establish the field of experimental psychology by promoting the idea that psychology could be an experimental field and could be studied
    - Structuralist – used experimental methods to find the basic building blocks of thought and investigated how they interacted
- William James, G. Stanley Hall and James McKeen Cattell became identified with functionalism
    - The school of psychology that seeks to understand mental processes and behaviours in terms of their purposes or functions. Unlike structuralists, who focused on the physical makeup of the mind (what it is), functionalists focused on the adaptive properties of the mind (what it does).
        - Functionalists ask "why" questions to investigate how mental processes operate and relate to behaviour, and how particular mental processes and behaviours allow organisms to adapt to their environment. Functionalism was influenced by Darwin's theory of natural selection and served as an alternative view to structuralism. Like the early structuralists, early functionalists used introspection as an investigative tool. In both schools, introspection was criticized for its lack of empirical approaches and consistency.
    - Opened the way for he studied of a wide range of approaches – animal and comparative psychology
- Throughout the first half of the 20th century, psychology grew and accommodated various points of views on the nature of mind and behaviour
    - Gestalt psychology is a good example
        - An attempt to study the unity of experience

- Gestalt movement opposed reductionist approach, believing that the whole of any experience is richer than studying the individual aspects of that experience
- Gestalt psychologists served as a precursor to the rise of cognitive psychology
  - Women and people of colour in the history of American psychology:
    - In early 20th century Thompson concluded that woman's emotions did not influence their decisions any more than men's emotions influenced their decisions
    - Segregation negatively impacted the self-esteem of African American children which helps the Supreme Court to end school segregation in 1954

KEY IDEAS ABOUT THE HISTORY OF PSYCHOLOGY

Functionalism

Defined Above

Empiricism:

Defined Above

Rationalism

- Rationalism serves as a basis for research in psychology, because modern psychologists use logic and reason to develop predictions and draw conclusions about observed phenomena.
- This process is based on empiricism, the view that knowledge is gained from sensory experience and observation.
- Empiricists emphasize the importance of quantification and the principle of parsimony or simplicity.

Dualism

- From its beginnings, the church held the view that the mind and body were distinct entities, and that the mind was beyond study.
- In the 17th century, the French philosopher René Descartes formalized this idea in the concept of dualism. Dualism states that the physical, measurable body and the spiritual, immeasurable mind are separate entities, and that they interact only through a small brain structure called the pineal gland.
- Around the same time, the English philosophers Thomas Hobbes and John Locke disagreed with dualism and suggested that the body and mind are not separate entities. They suggested that mental activities are simply physical processes that occur in the brain, and can be studied.

Structuralism

- Wundt was a reductionist, meaning that he believed that consciousness could be broken down into its basic elements. Wundt and his student, Edward Titchener, developed structuralism, the school of psychology that seeks to understand the mind and behaviour through analyzing its most simple and definable components, and how they interact to form experience.
- Structuralists believe that the whole could be understood by understanding the constituent parts. Structuralists ask “how” questions to understand the fundamental mechanisms underlying experiences. Structuralists systematically studied attention, reaction times, and perception.
- The primary investigative tool used by early structuralists was introspection, or concentrating and reporting on one’s conscious experiences in response to external stimuli to determine the components of consciousness.

Behaviourism:

- Because of the subjectivity associated with introspection, many early psychologists chose to focus their research entirely on observable behaviour. This led to the formation of the behaviourism school of psychology.
- The founding parent of behavioural psychology is John B. Watson. The behaviourism branch of psychology is based on the principle that only behaviour is worthwhile to investigate, because it is the only thing that can be objectively and systematically measured.
- The development of behaviourism paved the way for the establishment of the scientific method in psychological research.

Modern Psychology

- Modern psychology is still based on structuralism and functionalism, and emphasizes the methods of rationalism (logic) and empiricism (observation) using the scientific method

Interpretation of Research Results

- Inductive reasoning is based of probability
- Deductive reason is based of general principles
- Inaccurate results are not always the consensus of the general population
- Anecdotal evidence: derived from personal experiences and unsystematic observations
    - Limited by quality and representativeness of observations and memory shortcomings
- Well-designed research relies on systematic observations and must be representative of the population

Week 2 Notes- Statistical Thinking

- Planning the study: ask a testable research question and deciding how to collect data
- Examining the data: ways to examine the data like graphs and describe what they show. What descriptive stats can be calculated to summarize relevant parts of the data? What patterns do you see?
- Inferring from the data: what are valid statistical methods for drawing inferences "beyond" the data collected?
- Drawing conclusions: based on what you learned form the data what can you conclude? Who do these conclusions apply to? Can you draw a cause-and-effect conclusion about the treatments?

DISTRIBUTIONAL THINKING

- It is important to think of a meaningful way to organize and examine your data
- The fundamental principle of statistics is data varies. The pattern of the variation is essential to capture and to understand
- Often how the data is presented can answer many research questions or pose more questions

- Two fundamental aspects of statistical thinking
- Data varies – values of variables vary
- Analyzing pattern of variation, distribution of variable, reveals insights

The **p-value** tells you how often a random process would give a result at least as extreme as what was found in the actual study

- Tossing a coin (heads/tails)
- **Confidence Interval**: interval computed from sample data by a method that has probability C of producing and interval containing the true vale of the parameter

- We often compare p-value to a cut-off value (level of significance)
- If the p-value is smaller than level of significance, hat hypothesis is rejected
- This is because only random chance was at play

STATISTICAL SIGNIFICANCE

- Even when we find patterns in data there are still uncertainty in various aspects of the data.
- For example, there maybe measurement errors or only a bit of observations from a long term process. Or only a small subset of individuals from a pop. In this case we would see if the patterns in the small set of data is convincing evidence of a systematic phenomenon in the larger process or population?

- In a study reported in the November 2007 issue of Nature infants were shown a climber character being pushed up the hill by a “helper” and then where the climber was pushed down the hill by a “hinderer”. They were shown this several times then presented the helper and hinder and asked to pick one to play with. 16 infants made a clear choice. 14 chose to play with the helper toy. This research is accurate because the researchers eliminated possible errors.

GENERALIZABILITY

- In order to make these claims about the larger population, the sample must represent the population (choose a random sample)
- Must give every member of the population and equal chance of being selected for sample
- Using a computer to randomly select is a good way to go

- Margin of error – expected amount of random variation in a statistic
- Non-random samples are often suspect to bias

Describe the **role of random assignment** in drawing cause-and-effect conclusions…

- Produce groups that are as similar as possible except for the type of motivation
  - Presumably eliminated all those other variables as possible explanations for the observed tendency for higher scores in the intrinsic group

Cons of Statistical Studies:

- Uncertainty in various aspects of the data
- Potential for measurement errors
- May only have "snapshot" of observations
- Small subset of individuals from population of interest
- "random luck" : babies guess their answer …

SUMMARY

- Statistical thinking involves careful design of a study to collect meaningful data to answer a focused research question
- Random sampling – essential to generalizing results
- Probability models help determine how much random variation we can expect in our results

Articulate the difference between correlation and experimental designs:

- Correlational studies look for associations among naturally occurring variables whereas in experimental studies a change is introduced then the effects are monitored

- Correlation – measured variables as they naturally occur in people and are computed to the degree at which they go together
  - Experiments – researchers make changes in a variable and watch changes in the other variable
- Allows researches to make casual inferences
  - Many different ways to test hypotheses in psychological research
- Method is chosen based on questions you are asking

How to Interpret Correlations:

- We can plot relation between two scores on a scatterplot
- Summarize statistical analysis using correlation coefficient
  - Positive correlation means the variables go up/down together (the r value is also positive)
  - Negative correlation, the variables move in opposite directions (the r value is also negative)

EXPERIMENTAL RESEARCH

- Psychologists measure many abstract concepts – happiness, intelligence – by beginning with operational definitions of the concepts
  - How researchers specifically measure a concept
  - A clear definition where all researchers obtain the same answer to questions
- Researchers manipulate independent variable and measure change in dependent
- Random assignment – most important thing about experiments
  - Using a probability-based method to divide sample into treatment groups
    - The groups will generally have consistent factors or characteristics

OTHER CONSIDERATIONS

- Avoid confounds in experiments
- Things that could undermine your ability to draw casual inferences
- Ex: if some participants are aware of something being tested, their attitudes will change
- i.e. participation demand
  - Participant acts how researcher wants them to
- One way to prevent confounds – double-blind procedure
  - Where neither the participant nor experimenter know which condition, participant is in
    - Researchers' expectations cannot influence data
    - Participation demand doesn't happen to participants

CORRELATION DESIGNS

- When scientists passively observe and measure phenomena – correlation research
- We do not change and intervene behaviour

- In correlation research, we identify patterns of relationships, but cannot infer what causes what
- You can only examine 2 variables at one

- To find how well 2 variables correspond, plot relation between them on a scatter plot
    - Strength of correlation depends on how well variables align
- If an association has many exceptions – weak correlation
- If both variables increase it is a positive correlation
- If one variable increases and the second variable decreases it is negative correlation
- Strong correlation= closer to 1
- Weak correlation= closer to 0

How experiments help us to infer causality

- From a correlation alone, we can't be certain
- A third variable might cause both happiness and generosity creating an illusion of a link between the two
- CORRELATION DOES NOT MEAN CAUSATION – correlations aren't certainty

QUALITATIVE DESIGNS

- Includes; participation observation, case studies and narrative analysis are examples of methodologies
- Participation observation – involves researcher embedding themselves in the group to study its dynamics
- Case study – intensive examination of specific individuals or specific contexts
- Narrative analysis – study of stories and personal accounts of people, groups, or cultures
    - Rather than engaging with participants directly, or quantifying behaviours, researchers analyze theme, structure and dialogue of individual's narratives (their responses)

QUASI-EXPERIMENTAL DESIGNS

- An experiment that doesn't require random assignment to conditions
- Similar to experimental research
    - No random assignment to conditions is used
- Relies on group memberships, how groups are formed
    - Ex: group of married individuals vs. single
    - Treat these as the independent variables and are not manipulated
- Causal inference is more difficult

Understand how surveys relate to correlational and experimental research.

- Larger number of participants at a much lower cost
- Typically used for correlational research
  - Wanted to see whether happy people were judged as more likely to get into heaven compared to unhappy people
- Correlational research can be conducted without the use of surveys

Longitudinal Study:

- Track the same people over time
- Provide valuable evidence for testing many theories in psychology
- Unfortunately, quite costly especially if they follow people for many years

Research Designs:

- Correlational Research
  - Can reveal if relationship exists but cannot prove that changes to one variable lead to changes to another variable
- Descriptive Research
  - Can provide in depth view of topic at question but cannot determine cause and effect relationship
- Experimental Research
  - Provides specific conclusion but are highly subjective due to the possibility of human error

Types of Observation:

- Naturalistic Observation: passive
  - Observers do not intentionally change or alter ongoing behaviour.
- Participant Observation: active
  - The researchers is actively involved
- Laboratory Observation: systematic
  - Observations are made within a laboratory setting as opposed to the “real world”

CONDUCTING PSYCH RESEARCH IN THE REAL WORLD

- Only lab experiments can clearly separate cause from effect – establish causality
- Scientific field that is mainly based on controlled experiments can end up lopsided
- Focusing on what <u>can</u> happen, little to say about what <u>does</u> happen

RATIONALE FOR CONDUCTING PSYCHOLOGY IN REAL WORLD

- Important challenge – finding balance between internal validity and external validity
  - Internal Validity – extent to which a piece of evidence supports a claim about a cause and effect, within the context of a particular study

    - External Validity – applying the conclusions of a scientific study outside the context of that study
- Both types of validity are hard to achieve in the same study
    - Because creating a controlled environment where every variable is controlled doesn't replicate a natural environment
    - The degree to which the conditioned environment is comparable to real-world situation determines how generalizable potential findings will be
- One validity tends to be favoured as they are usually incompatible
    - Internal over external
        - Due to importance of identifying true, casual, relationships
- Field studies allow for the important test of how psychology variables and processes behave under real-world circumstances
- Ecological validity – refer to the degree to which an effect has been obtained under conditions that are reflective of everyday life

Limitations of Traditional Laboratory Experiments:

- Achieving internal (study allows unambiguous causal inferences) and external validity (potential findings apply to settings and samples other than the ones being studied) tends to be difficult to achieve at the same time in one study
- Ecological validity is used to obtain results un every day life conditions …
- How useful are the findings if they are not similar to everyday life scenarios

Explain ways in which daily life research can further psychological science.

- the basic idea behind all of them is to collect in-the-moment (or, close-to-the-moment) self-report data directly from people as they go about their daily lives
- over time, experience sampling and related momentary self-report methods have become very popular, and, by now, they are effectively the gold standard for studying daily life
- Day Reconstruction Method has shed light on what situations lead to moments of positive and negative mood throughout the course of a normal day.

RESEARCH METHODS FOR STUDYING DAILY LIFE

- Capturing natural responses has been a strong goal for some researchers
- Overview of methodologies;
    1. Studying Daily experiences
    2. Studying daily behaviour
    3. Studying daily physiology
    4. Studying online behaviour
    5. "Smartphone Psychology"

Studying Daily Experiences

- Mid-1970s – growing skepticism towards highly-controlled laboratory studies
    - Researchers developed set of new methods known as
        1. Experience-sampling method – methodology where participants report their momentary thoughts, feelings and behaviours at different points in time over a day
        2. Ecological momentary assessment – term of methodologies that repeatedly sample participant's real-world experiences, behaviours and physiology in real-time
        3. Diary method – participants complete questionnaire about their thoughts, feelings of that day at the end of the day
    - Goal to collect data in the moment (or near) from people
    - Self-regulated by the participants
    - Gold standard for studying daily life

Studying Daily Behaviour

- Best studied using direct behavioural observation (e.g., video recordings) in labs
- Rather than following participants, they equip them with portable audio recorder that records 30 seconds of ambience every 12 minutes
    - Method called <u>electronically activated recorder (EAR)</u>
- Time lapses have also been used to study the flow of people

Studying Daily Physiology

- Subjective feelings
    - one person could find something boring, other, engaging
- Researchers have found limited correspondence between how people respond physiologically to a standardized lab stressor
- White coat hypertension – having high blood pressure in hospital but not in home environment
- Ambulatory physiological monitoring – monitoring physiological reactions as people go about their daily lives
- Studying daily physiology is a rapidly advancing field

Studying Online Behaviour

- Rise of social media – researchers beginning to think of virtual behaviour as an "actual" behaviour
- Everything we do online leaves direct (permanent) verbal traces
- Differences in the ways people use their words have been found to carry psychological information
    - Good way to study virtual social behaviour is to study virtual language

"Smartphone Psychology"

- Smartphones will not only stay as devices for online communication, but will become devices for scientific data collection and intervention
- Automatically store vast amounts of data and have sensors to track physical and social context of interactions
- Big data collection poses as challenge
- Many other methods will become integrate with smartphones

Full-cycle psychology – researchers start with observational study lab experiment field research

Week 3- Nature V.S. Nurture Debate

Behavior has been viewed as arising from two possible ways

1. Nativism (from the genes): you were born with knowledge already present
   - Certain abilities are hard wired, present at birth not learned through experience
2. Empiricism (from the environment): we obtain all knowledge through observable facts and experiences
   - All behavior results from our individual experiences

- Difficult to study empirically because through observation everyone acts differently
- Some aspects of behavior feel genetically influenced; others feel like our upbringing influenced them
- Genes and environment make up our behavior – discovering how they combine for a given behaviour

- 3 related problems at intersection of philosophy and science fundamental to understanding our relation to world
- Mind-body problem
- Free will problem
- Nature-nurture problem
- Our relationship with physical / biological world is often seen as incomplete
- We have control sometimes, but other times – mercy of others and environment
- Our consciousness is related to brain, but at same time, awareness must go beyond the physical, brain
- Incompleteness of our knowledge with nature
- Major problem in nature vs nurture questions – how do you set up experiments?
- Eugenics – shaping of human characteristics through intentional breeding
- In typical families, biological parents raise children – hard to determine if qualities are nature or nurture

Major Research Designs that can be used to study nature-nurture questions

- Behavioral Genetics – the study of genetic influences on behavior
- How genes and environments work together to influence behaviour
- Adoptive study is easiest opportunity to observe it
    - Behaviour genetic research method comparing children to their biological + adoptive parents
- E.g., individual born to parents who are alcoholics, they may be more subject to that disorder, but if they choose never to drink, they may "override" that gene
- Heritability coefficient
- Amount of variability in a given trait in a given population at a given time due to genetic factors, a statistic that ranges from 0-1
- it can be misunderstood for a few reasons

1. Heritability tells us about a population's measure, not individual. A heritability of .40 indicates that about 40% of the individual's differences, say extroversion, may be in some way attributable to genetic individual differences
2. Heritability results depend on the population studies. If the environment experienced by individuals is pretty uniform (Iceland) then the heritability will be high, but if the range of environments is very large (NYC) heritability may be low

- heredity is estimated to be responsible for 45-75% of variability in intelligence

Quantitative Genetics

- Branch of population genetics that deals with phenotypes that vary continuously (ie. height/mass)
- Discipline in which similarities among individuals are analyzed bbased on how biologically related they are
- Opposed to discretely identifiable phenotypes and gene-products (ie eye-colour)
- Twin study and adoptive study are instances of broader methods for observing nature-nurture, called quantitative genetics
- Contentions about nature-nurture intensified because quantitative genetics produced a number called a heritability coefficient from 0 to 1
- Easily misinterpreted statistical construct that purports to measure the role of genetics in the explanation of differences among individual
- Meant to provide a single measure of genetical influence on a trait
- Measures how strongly differences among individuals are related to differences among their genes

Twin Study

Monozygotic: identical twins, developed some one egg but separated. Because one egg they have same genetic material (most of the time)

Dizygotic: fraternal twins, developed from 2 different eggs, share an average of 50% of the same genes

→ some studies have gone further and examined MZ and DZ twins who were separated at birth (raised in different families)
→ they compare these cases to twins who were raised together

WHAT HAVE WE LEARNED ABOUT NATURE-NURTURE?

- Everything has turned out to have some footing in genetics
    - Height, weight, intelligence, personality, mental illness
- Genetic influence on behaviour is a relatively recent discovery
    - Middle of 20th century
- Psychology was dominated by behaviourism
    - Said that behaviour could only be explained in terms of environmental factors
- Psychiatry concentrated on psychoanalysis, which probed for roots of behaviour in individuals' early life-histories
    - Neither behaviourism or psychoanalysis are compatible with genetic influences on behaviour
- In the past:
    - Children's behaviours were thought to mirror their parents
    - Schizophrenia caused by certain kinds of "pathological mothering"
- It is never safe to interpret a behaviour as wholly the result of nurture without evidence
- Genes and environment are both crucial to *every* trait
    - Without genes, the environment has nothing to work on
    - Genes cannot develop in a vacuum – i.e. no environment to live in

EVOLUTIONARY THEORIES OF PSYCHOLOGY

- Certain actions are "biologically programmed" into us
- Other actions were also evolved as they are advantageous to our survival
- Evolutionary theory helps us piece together the story of how humans have prospered
- Explains many of the actions we do now
- Ex: why we get jealous, cravings, why we protect children etc.

BASICS OF EVOLUTIONARY THEORY

Evolution: process by which different kinds of living organisms are thought to have developed and diversified from earlier forms during the history of the earth

- Evolution takes place from natural selection and adaptation – through processes of natural and sexual selection
    - Ensuring survival and reproduction
    - Natural selection is differential reproductive success as a consequence of differences in heritable attributes (reproductive success not survival success)
    - Adaptations: evolved solution to problems that historically contributed to reproductive success
        - Survival adaptations: mechanisms that helped our ancestors handle "hostile forces of nature"

    - Reproductive adaptations: help us compete for mates
- Physical survival is only important if it eventually contributes to successful reproduction
- In order for our genes to endure over time – we have inherited adaptive, psychological processes
- Broadest level, organisms have 2 classes of adaptation
    - Survival adaptations
- Mechanisms that help ancestors handle “hostile forces of nature”
- Ex: adapting to warm temperature with sweat glands
    - Reproductive adaptations
- Help us compete for mates
- Described in evolutionary theory – sexual selection

Misunderstanding about Evolution

- naturalistic fallacy: mistaken belief that characteristics produced by evolution are either natural and good or unnatural and morally bad
- are actually neither, simply result of reproductive success
    - genetic deterministic fallacy: mistaken belief that if an organism evolves, that evolution is determined by genes rather than an interaction of genes and environment
    - not true i.e. Someone with a predisposition for depression will not necessarily become depressed
    - **humans are not more highly evolved than other animals**

Sexual Selection Theory

- Darwin noticed many traits and behaviours of organisms couldn’t be explained by “survival selection”
    - Ex: peacock’s feathers – they decrease survival rate
- How evolution has shaped us to provide a mating advantage rather than a survival advantage
- the evolution of characteristics, not because of survival advantage, but because of mating advantage
- Occurs through 2 processes:
- Intrasexual competition
    - Process of sexual selection by which members of one sex compete with each other, and the victor gain preferential mating access to members of opposite sex
- Intersexual competition
    - Process of sexual selection by which evolution (change) occurs as a consequence of the mate preferences of one sex exerting selection pressure on members of the opposite sex
    - Members of one sex are attracted to certain qualities in mates
- Those qualities get passed on in greater number simply cause their possessors mate more often
- Adaptations in both sexes exist due to survival selection and sexual selection

- Humans have “mutual mate choice” – choosing who they mate with

Gene Selection Theory

- adaptive evolution occurs through the differential survival of competing genes
- All evolutionary processes boil down to an organism’s genes
- Gene – basic “units of heredity”, information passed along in DNA
- Genes can boost their own replicative success in 2 basic ways
    - Influence odds for survival and reproduction of the organism they’re in (individual reproductive success or fitness)
    - Influence organism to help other organisms who also likely contain those genes – genetic relatives – to survive and reproduce (inclusive fitness)
- Occurs through the desire for gene replication
    - Modern explanation behind evolutionary biology
- Gene replication is the key to understanding modern evolutionary theory

Evolutionary Psychology

- Aims focus of modern evolutionary theory on workings of the human mind
- Focuses on psychological adaptations:
    - Mechanisms of the mind that evolved to solve specific reproductive problems
    - Contrast with physiological adaptation which are adaptations that occur within the body in response to environment
- Connects evolutionary principles and psychology
    - Focuses on changes in the way we think in order to improve our survival
- Culture has a major effect on psychological adaptations
    - Ex: status in group or society
        - Makes individual more attractive to mates
- Evolutionary psychology doesn’t predict rigid “instinct”
    - Studies flexible, environmentally-connected and culturally-influenced adaptations
- 2 major evolutionary psychological theories:
    - Sexual Strategies Theory
    - Error Management Theory

Sexual Strategies Theory

- humans have evolved a list of different mating strategies; short/long term, vary depending on culture, social context, parental influence and personal mate value
- Based on sexual selection theory
- Psychology of human mating strategies, ways which men and women are similar and differ in those strategies
    - Short- and long-term strategies
- Higher risks for women – make wiser mating decisions
    - Women are “pickier” when choosing men because of high risk

Parental Investment

- any parental expenditure (i.e. time, energy, resources) that benefits offspring
- can be performed by females and males together (biparent care), females alone (exclusive maternal care), or males alone (exclusive paternal care)

Parental Investment Theory

- predicts that the sex that invests more in its offspring will be more selective when choosing a mate
- influential theory in explaining sex differences in sexual selection and mate preferences, throughout the animal kingdom and humans

Female vs Male Investment

- the only type of male investment for many species is that of the sex cells
- female investment typically greatly exceeds that of male investment, and are often (but not always) the more investing parent
    - Gestation
    - nursing
- Overall main role of males is often for protection of female and offspring
    - However this is not *always* the case (e.g. male seahorses get pregnant and carry offspring)

Error Management Theory

- how we think, make decisions and evaluate uncertain situations - that is, situations where there's no clear answer how we should behave
    - Situations where there's no clear answer – how we should behave
- Evolution of biases in the way we think about everything
- Cost asymmetries
    - Where there is a choice of low cost + great reward and high cost + low reward
- Over time adaptive bias would be created; we would pick less costly choices
- EMT predicts that whenever we are confronted with a safer or more dangerous option, we take safer

Psychological Adaptations: mechanisms of the mind that evolved to solve specific problems of survival or reproduction; conceptualized as information processing devices

Adaptive Biases: the human brain has evolved to reason adaptively rather than truthfully
Cognitive Biases: a mechanism to reduce the overall cost of cognitive errors as opposed to merely reducing the number of cognitive errors (ie. Bandwagon Effect)

EPIGENETICS IN PSYCHOLOGY

- Early life experiences have long-lasting influences on physical and mental health throughout life

- **Epigenome** – missing piece in etiological puzzle for understanding how development of psychological disorders may be influenced by environment in terms of genome
- Distribution of regulators of gene expression throughout genome
    - Genome sequence – static and same in almost all cells
    - Epigenome sequence – highly dynamic, differing among cell types, tissues and brain regions
- Mechanisms of
    - Initiation
    - Maintenance
    - Heritability of epigenetic states – important aspects in research of biology – particularly in memory, emotion and social behaviour in humans
- **Epigenetics** – the study of heritable changes in gene expression or cellular phenotype cause by mechanisms other than changes in the underlying DNA sequence (*include: covalent DNA modifications
- Provides framework for understanding how expression of genes are influenced by experiences and environment
    - Experience and environment produce individual differences in behaviour, cognition, personality and mental health
    - In other words it is, **Study of heritable changes that occur without a mutation in the DNA sequence**
    - Heritable traits without DNA (de)activated by the environment
      Modification due to environmental experience
    - Raise possibility that acquired characteristics could be acquired by offspring
    - An external factor changes how cell expresses its instructions, this method of expression is passed on
    - Change in phenotype without change in genotype
    - Bad diet, smoking, stress can change epigenome
- Refers to transmission of phenotype in terms of gene expression in absence of changes in DNA sequence
- Molecular machinery involved??

INTRODUCTION

- Early childhood period of physical and mental development
- Brain development more rapid during childhood
- Cognitive abilities – learning, memory, reasoning, problem solving all emerge
- Complex gene environments increase number of possible contacts between neurons
- [Why brains are fastest at this age – why we learn / are more adept to learning]
- Any weak connections undergo remodeling where connections vanish and only strong remain
- These changes (**plasticity**) may be crucial for development of mature neural networks
- Generation of different morphology, physiology, behaviour outcomes come from single genome responding to changes in environment
- Forms basis of “phenotypic plasticity”

    - Fundamental to the way organisms cope with environmental variation, navigate present and solve future problems

- Challenge for psychology – integrate genetic findings and environmental (bio, social, chem) findings
- Ex: including infant-mother attachment into studies of personality and understanding of emergence of mental illness
- These studies show that common DNA sequence variation and rare mutations account for small fraction (~1-2%) of total risk for mental illness
- Large unaccounted heritability of traits and mental health suggest additional molecular and cellular mechanisms involved
- Examination of genetic-epigenetic-environment interactions from a developmental perspective may determine nature of genetic mis-regulation of psychological disorders

Neural & Developmental Pathways

- Previously associated with mental illness

MOLECULAR CONTROL OF GENETIC EXPRESSION: THE DYNAMIC EPIGENOME

- Almost all cells are genetically identical
- Epigenetic variation emerges across a lifespan
    - Ex: identical twins, who are genetically identical and share common genome, become epigenetically dissimilar after time through behavioural, personality or physical differences
- Understanding structure of nucleosome is key to understanding control of gene expression and regulation – providing molecular interface between genes and environmentally induced changes in cell activity

THE PRIMARY EPIGENETIC MARK: DNA MODIFICATION

- DNA methylation – process which methyl groups are added to the DNA molecule without changing the sequence
- Effect on genetic function varies on period of development during the methylation and location of methylated cytosine
- Methylation of DNA in regulatory regions (promoters) usually result in genetic silencing and reduced genetic expression
- Ensures genes are expressed only when needed

HISTONE MODIFICATION AND HISTONE CODE

- Comprises important epigenetic mark related to gene expression
- One modification thoroughly studied – histone acetylation
    - Associated with gene activation and increased gene expression
- Acetylation of histone tails mediated by opposing enzymatic activities of histone acetyltransferases (HATs) and histone deacetylases (HDACs)
    - Acetylation of histone in gene regulatory regions by HAT enzymes associated with DNA demethylation, gene activation and increased gene expression

    - Removal of acetyl group by HDAC enzymes associated with DNA methylation, gene silencing, decreased gene expression
- Relationship between patterns of histone modifications and gene activity provides evidence for existence of “histone code”
    - Determines cell-specific gene expression programs

EARLY CHILDHOOD EXPERIENCE

- Development of an individual – process of adaptation that occurs within social and economic context
- Process provides offspring with ability to psychologically adjust gene expression profiles that contribute to organization and function of neural circuits and molecular pathways that support;
- Biological defense systems for survival (e.g., stress resilience)
- Reproductive success to promote establishment and persistence in present environment
- Adequate parenting in next generation

CHILD NUTRITION AND EPIGENOME

- Food you choose (even what parents and grand-parents choose) is reflected in your own personal development and risk for disease in adult life
- Nutrition can reverse or change DNA methylation and histone modifications
- Thereby, affects expression of critical genes
    - Ex: embryonic development, aging
- Nutrition can influence epigenome by directly inhibiting enzymes that catalyze DNA methylation or histone modification or by altering availability of substrates necessary for enzymatic reactions
- Early life nutrition has potential to influence epigenetic programming in brain during early development and adult life

EPIGENETIC REGULATION OF LEARNING AND MEMORY

- Epigenetic mechanisms influence genome activities in the brain to produce long-term changes in synaptic signaling, organization, morphology – support memory and learning
- DNA methylation implicated in maintenance of long-term memories
- Changes in histone modifications influence long-term memory formation
- Alter chromatin accessibility and expression of genes relevant to learning and memory
- Memory formation and associated enhancements in synaptic transmission accompanied by increases in histone acetylation and alterations in histone methylation – promote gene expression
    - Neuronal increase in histone deacetylase activity, which promotes gene silencing – reduced synaptic plasticity and impairs memory
- Genetic defects encoding the DNA methylation and chromatin machinery exhibit profound effects on cognitive function and mental health
    - Ex: Rubinstein-Taybi syndrome (RTS), Rhett Syndrome

- Rhett Syndrome patients – mutation in DNA sequence called MECP2
    - MECP2 plays many roles;
        - Reading the DNA sequence
        - Checking for DNA methylation
        - Bind areas that contain methylation
    - Preventing wrong proteins from being present
- RTS patients – mutation in DNA sequence called CBP
    - CBP roles
        - Bind to specific histones and promote histone acetylation
            - Promotes gene expression
    - RTS patients exhibit genome-wide decrease in histone acetylation and cognitive dysfunction in adulthood

EPIGENETIC MECHANISMS IN PSYCHOLOGICAL DISORDERS

- Epigenome-wide studies have identified dozen sites with DNA methylation alterations in genes involved in brain development and neurotransmitter pathways
    - Previously associated with mental illness
- Disorders are complex and start at young ages causing lifelong disability
- Identification of primary causes of complex psychiatric disorders benefit from studies linking environmental effects with changes observed within cells
- Epigenetic events that alter chromatin structure to regulate programs of gene expression have been associated with depression – related behaviour and action / use of antidepressants
- Level of histone markers of increased gene expression were down regulated in post-mortem brain samples of people with history of clinical depression
    - Administration of antidepressants increase histone markers of increased gene and reversed gene repression induced by defeat stress

EPIGENETIC STRATEGY TO UNDERSTANDING GENE-ENVIRONMENT INTERACTIONS

- Cellular and molecular mechanisms influence physical and mental health
    - Long time central focus on neuroscience
    - Attention turned to epigenetic mechanisms behind dynamic changes in gene expression responsible for normal cognitive function and increased risk for mental illness
- Links between environment and epigenetic modifications suggest a mechanism underlying gene-environment interactions
- Glucocorticoid gene receptor moderate effects of childhood adversity on mental illness
- Epigenetic DNA modifications have been identified that may underlie long-lasting effects of environment on biological functions
- Epigenome is not static
    - Can be molded by developmental signals, environmental perturbations, disease statistic

Week 4 Notes -Learning

- Learning much broader domain than expected
- Listening to music – form of learning?
- Brain's response to auditory information changes experience with information
    - Perpetual learning – when aspects of our perception change as a function of experience
- When there are changes in behaviour without having intention of learning – implicit learning
    - When we acquire information without intent that we cannot easily express
- When there are changes in behaviour that reveal the influence of past experience, even though we aren't attempting to use that experience – implicit memory
    - Long-term memory that does not require conscious thought to encode
        - Memory made without intent
- Non-associative learning – single repeated exposure leads to change in behaviour
- Habituation – when our response lessens with exposure
    - becoming used to a stimulus
    - learn not to respond to something, and adaptive process, allows focus on more important things
    - neurons will no longer fire in reaction to stimulus
    - a slow process
    - stimulus produced nothing
    - long term: when stimuli are spread out
    - short term: many rapid stimuli
- Sensitization – when our response increases with exposure
- Spatial Learning:environment facilitates navigation through encoding information.
- Observational learning: involves changes in behaviour and knowledge that results from watching others.
    - by observing others we gain behaviour potential that we can later apply
    - **4 processes**
    - attention to the act or behaviour
    - memory (for the act or behaviour)
    - ability to reproduce it
    - motivation to perform act or behaviour
    - i.e. Bobo the doll experiment
- Learned Irrelevance: habituation to a certain stimuli in that it is learned to be of no importance, will not elicit a response (selective learning)

- Latent Learning: when something is learned but does not manifest as a behaviour until later on
    - learning that is not immediately expressed by a response until the organism is reinforced for doing so
    - ie. Rats in a maze: rats given no food for 1st ten trials navigated the maze just as well on the 11th trial when given food as rats given food throughout, made a cognitive map of maze
    - Cognitive map: mental representation of physical feature
- Classical conditioning – stimulus-stimulus associative learning
    - Teaching the association of an unconditioned stimulus with an unrelated neutral stimulus, so that the neutral stimulus produces the same result as the unconditioned stimulus
        - ex: Dog associating bell sound with food
- Operant conditioning – stimulus-response learning
    - Type of learning in which behaviour is influenced by consequences
    - Relationship between environmental stimuli and our own behaviour
    - Consequence of behaviour more important than behaviour itself
    - Using the removal and introduction of positive and negative stimuli to elicit a desired response
    - **BF Skinner:** devised operant chamber for rats-pressing lever to get piece of food
    - **3 term contingency**
    - Antecedent -> Behaviour -> Contingency (punishing or rewarding)
        - Ex: Dog rolls over for treat
- positive punishment: introducing something undesirable, decrease probability if presented
- negative punishment: taking away something desirable, decreases probability is removed
- positive reinforcement: introducing something desirable, increase behaviour when present
- negative reinforcement: taking away something undesirable, stimulus increases behaviour when absent

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

LEARNERS

- Many variables affect learning
    - Motivation
    - Incentives
- Pre-existing skills matter
    - Self-guided
    - Organized
- Working memory – memory used to hold onto information temporarily, usually for purpose of manipulation
    - Important variable for learning
        - Ex: used to keep track of where we are in the course of a complicated math problem
    - Higher working memory predicts better reasoning skills, reading comprehension, better control of attention
- Anxiety levels affect learning
    - Higher levels of anxiety = smaller capacity for remembering
- Probably a finite capacity on ability to store information – idea misleading
    - Usual bottleneck to remember – ability to access memories / information, not space to store them
        - Having more knowledge or expertise enhances ability to learn new information
- Expertise allows people to chunk multiple pieces into smaller number of pieces of information – but only when said information was structured in such a way so as to allow application of expertise
    - Chunk – process of grouping information together using knowledge

ENCODING ACTIVITIES

- How we go about encoding information determines a lot about how much we remember
    - Encoding – the act of putting information into memory
- There are cases in which incidental learning is more effective than intentional learning
    - Incidental learning – learning without intention of learning
    - Intentional learning – any learning that happens when motivated by learning
- Intending to learn something isn't enough
- *How* leaner actively processes material plays a large role
- Individual differences in motivation will not have large effect on learning unless learner has ideas as to effectively learn material
- Learners who review material to restudy learn more

- Scheduling repetitions to study is effective and a big factor
- Self-testing is an effective factor

THE VALUE OF EFFECTIVE METACOGNITION

- To guide own learning must be able to:
    - Evaluate progress of our learning accurately
    - Choose activities that enhance learning efficiently
- Metacognition – the knowledge and skills people have in monitoring and controlling own learning and memory

TRANSFER-APPROPRIATE PROCESSING

- Principle that states that memory performance is superior when a test taps the same cognitive processes as the original encoding activity

- Some forgetting of information is the prerequisite for more learning

<u>CONDITIONING AND LEARNING</u>

- 2 types of learning have powerful effects on behaviour
- Classical (Pavlovian) conditioning
- Instrumental (Operant) conditioning

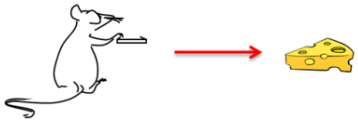
TWO TYPES OF CONDITIONING

Classical (Pavlovian) Conditioning

- One of the fundamental ways of learning
- Arguably theory of identity
        - Once you understand classical conditioning, your favourite music, clothes, political opinion may all be a result of what made the Pavlov dog drool
    - Stimulus-stimulus associative learning
- Pavlov rang bell then gave dog food, after repeating, the dog treated bell as signal for food
    - Dog begins salivating when hearing bell
    - <u>Unconditioned stimulus (US)</u> – elicits the response (UR) before conditioning occurs
        - ex: dog food in Pavlov's experiment
    - <u>Unconditioned response (UR)</u> – innate response elicited by stimulus before conditioning
    - <u>Conditioned stimulus (CS)</u> – initially neutral stimulus that elicits a CR after it has been associated with a US

        - No importance until paired with something of importance
    - Conditioned response (CR) – response elicited by CS after classical conditioning has taken place
        - Ex: drooling
        - Usually same as UR

Classical or Pavlovian Conditioning



Instrumental or Operant Conditioning

Instrumental (Operant) Conditioning

- Associated with the occurrence of an event
- "Skinner Box"
- Rat in a lab learns to press lever in a cage to receive food
- No "natural" association between lever and food
- Rat must learn this connection
- i.e., when exploring, hits lever, food drops in
        - Operant behaviour – "operates" an environment (action that animal itself makes)
    - When rat learns lever = food, reinforced
        - Food pellet = reinforcer – strengthens behaviour or increases likeliness the action will be performed again
    - Studies effects of a behaviour influence the probability that it will occur again
- Thorndike's law of effect – when behaviours have positive (satisfying) effects, likely to be repeated
    - When negative effect, less likely
    - Effects that increase behaviours – reinforcers
    - Effects that decrease behaviours – punishers

USEFUL THINGS TO KNOW ABOUT INSTRUMENT CONDITIONING

- Things that affect strength of classical conditioning affect strength of instrumental learning
    - We learn to associate actions with outcomes
- Bigger the reinforcer or punisher, stronger the learning

- If instrumental behaviour no longer reinforced, will be **extinguished**

INSTRUMENT RESPONSES COME UNDER STIMULUS CONTROL

- Stimulus control – when operant behaviour is controlled by stimulus that precedes it
    - Ex: lever pressing can be reinforced when a stimulus is present – when a light is on, rat can press, when light is off, no food can be dispensed
- Discriminative stimulus – stimulus controlling the operant response – "set occasion" for operant response
    - Can be associated with response or reinforcer
    - Usually doesn't elicit response the way a classical CS does

OPERANT CONDITIONING INVOLVES CHOICE

- To investigate choice: Skinner made 2 levers available to rat
    - Each had own reinforcement or pay off rate
- Study of choice led to rule – <u>quantitative law of effect</u>
    - States that effectiveness of a reinforcer at strengthening an operant response depends on the amount of reinforcement earned for all alternative behaviours

TYPES OF REINFORCEMENT

<u>Continuous Reinforcement</u>

- Every response made results in reinforcement

<u>Partial/intermittent reinforcement:</u>

- Only a certain number of responses are rewarded, or a certain amount of time must pass before reinforcement is available
- Occasional reinforcement
- Organisms that have been conditioned under these conditions resist extinction longer than those conditioned under continuous reinforcement

Reinforcement Schedule	Description	Result	Example
Fixed interval	Reinforcement is delivered at predictable time intervals (e.g., after 5, 10, 15, and 20 minutes).	Moderate response rate with significant pauses after reinforcement	Hospital patient uses patient-controlled, doctor-timed pain relief
Variable interval	Reinforcement is delivered at unpredictable time intervals (e.g., after 5, 7, 10, and 20 minutes).	Moderate yet steady response rate	Checking Facebook
Fixed ratio	Reinforcement is delivered after a predictable number of responses (e.g., after 2, 4, 6, and 8 responses).	High response rate with pauses after reinforcement	Piecework—factory worker getting paid for every x number of items manufactured
Variable ratio	Reinforcement is delivered after an unpredictable number of responses (e.g., after 1, 4, 5, and 9 responses).	High and steady response rate	Gambling

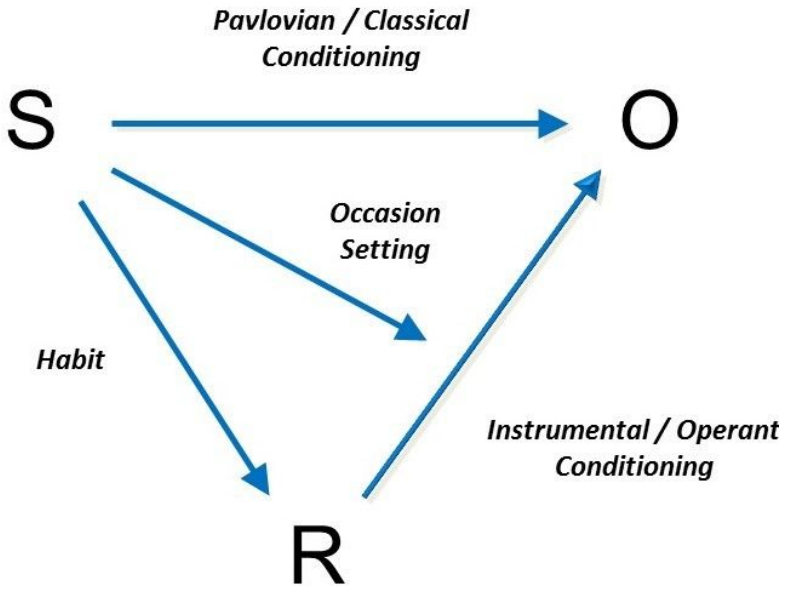
Reinforcement Schedules

COGNITION IN INSTRUMENTAL LEARNING

- Reinforcers do more than merely strength or “stamp in” the behaviours they are a consequence of
    - Instead, animals learn about specific consequences of each behaviour and will perform it depending on how much they want / value the consequence associated
- Reinforcer devaluation effect – an animal will stop performing an instrumental response that once led to a reinforcer if the reinforcer is separately made aversive or undesirable

PUTTING CLASSICAL AND INSTRUMENTAL CONDITIONING TOGETHER

- Classical and operant condition occur at sometime but are studied separately
- Behaviours are learnt in present stimuli



- Instrumental / Operant conditioning – organism will learn to associate response and outcome (R-O)
    - Organism will repeat response if outcome is desired or valuable
- Organism can learn to associate stimulus with the outcome (S-O)
    - Classical conditioning component – can have many consequences on behaviour
    - Stimulus will evoke a system of responses that help organisms prepare for reinforcer
        - Stimulus will evoke approach (if outcome is positive) or retreat (if outcome is negative)
    - Presenting stimulus will prompt instrumental response
- After a lot of practice, stimulus may begin to elicit the response directly (S-R)
- Final link [S-(R-O)] where the stimulus can signal the R-O relationship
    - This is what is meant in stimuli "setting the occasion" for operant response

OBSERVATIONAL LEARNING

- Learning by observing the behaviours of others
- Not entirely classical and operant conditioning
- Component of the social learning theory

    - Individuals can learn new responses via observation of others' key behaviours
- Doesn't require reinforcement
    - Hinges on the presence of others, referred to as social models
- Authorities that are the targets for observation and who model behaviours
    - Ex: parents, teachers, police officers
- Bandura theorizes that observational learning processes consists of 4 parts:
    1. Attention – what one is observing to learn
    2. Retention – retaining behaviour observed
    3. Initiation – learner must be able to execute learned behaviour
    4. Motivation – to engage in observational learning
- One of the most famous experiments to explore observational learning – Albert Bandura's "Bobo doll experiment"
- Children would observe adult's interactions with Bobo, one group of adults would be aggressive, others displayed no aggression
- The adults then left and let the kids interact with Bobo
- The kids observing aggressive adults were significantly more likely to be aggressive to Bobo
- In a later experiment, kids were less likely to be aggressive if the aggressive adult got punished for their actions

KNOWING EMOTIONS: FEELINGS THAT FOSTER LEARNING, EXPLORING, AND REFLECTING

- Knowledge emotions – family of emotions associated with learning, exploring, and reflecting
- Family of knowledge has 4 main members:
    1. Surprise
    2. Interest
    3. Confusion
    4. Awe
- Considered knowledge emotions because:
- Events that bring these emotions involve knowledge: emotions happen when something violates their expectations or beliefs
- Fundamental to learning: overtime, build useful knowledge about world

BACKGROUND ABOUT EMOTIONS

- According to functionalist theories of emotion, emotions help people manage important tasks

- Theories of emotions that emphasize the adaptive role of an emotion in handling common problems throughout history
- Knowledge emotions motivate learning
- Fear – mobilizes body to fight or flight
- Happiness – rewards achieving goals
- Surprise – makes people stop, pay attention to surprising thing, and evaluate if dangerous
    - After, people have learned what they need to know and can return to what they were doing
- Emotion theories contend that emotions come from how we think about what's happening in the world – not necessarily what is happening
    - If events directly caused emotions, everyone would feel something
- Appraisal theories propose each emotion is caused by group of appraisals, which are evaluations and judgements of what events in world mean to individuals
    - This relevant to me?
    - Does it hinder my goals?

SURPRISE

- Emotion rooted in expectancy violation that orients people toward the unexpected event
- Hijacks a person's mind and body and focuses them on a source of possible danger
- Minds wiped clean; people usually can't remember what they were talking about pre-startle
- Focuses all the body's resources on unexpected event, surprise helps people respond quickly
- Only one appraisal
- A single "expectedness check"
- When an event is "high contrast" – sticks at against background pre-scare

INTEREST

- Emotion that motivates exploration and learning – one of the most commonly experienced emotions in human life
- To engage people with new, odd, unfamiliar things
- Counterweight to anxiety
- Making unfamiliar things appealing, motivating people to experience new things
- Interest is an intrinsically motivated form of learning
    - Learning that is "for its own sake"
- 2 appraisals create interest

    - Appraisal of novelty – things that are unexpected, unfamiliar, novel and complex
    - Appraisal of coping potential – ability to manage what is happening
- Primary effect – exploration
    - People can reflect and learn once stimulated
- Differences in interest are captured by <u>trait curiosity</u>
    - Stable individual-differences in how easily and often people become curious
    - Less curious people prefer familiarity
    - More curious – thing that are new and off-beat
- Trait curiosity is a facet of openness of experience – a broader trait, 1 of 5 major factors of personality

CONFUSION

- Happens when people are learning something both unfamiliar and hard to understand
- 2 appraisals
    - Appraisal high in novelty, complexity and unfamiliarity
    - Appraisal in hardness to comprehend
- Promotes thinking and learning
    - Confusion motivates to think through problems, thus, learning material more deeply

AWE

- State of fascination and wonder
    - Deepest and least common knowledge emotion
- Comes from 2 appraisals
    - Appraisal of something vast, beyond normal scope of experience
    - Appraisal of an event as inconsistent with one's knowledge
    - To a huge degree – where its never been seen before
- People engage in accommodation – changing their beliefs to fit new experience
    - When something is massive, and people change their beliefs to accommodate it, they experience awe
- Chills – mild, everyday awe
- Awe motivates to engage with the unordinary
    - Thus, powerful education tool

Week 5- Neurons

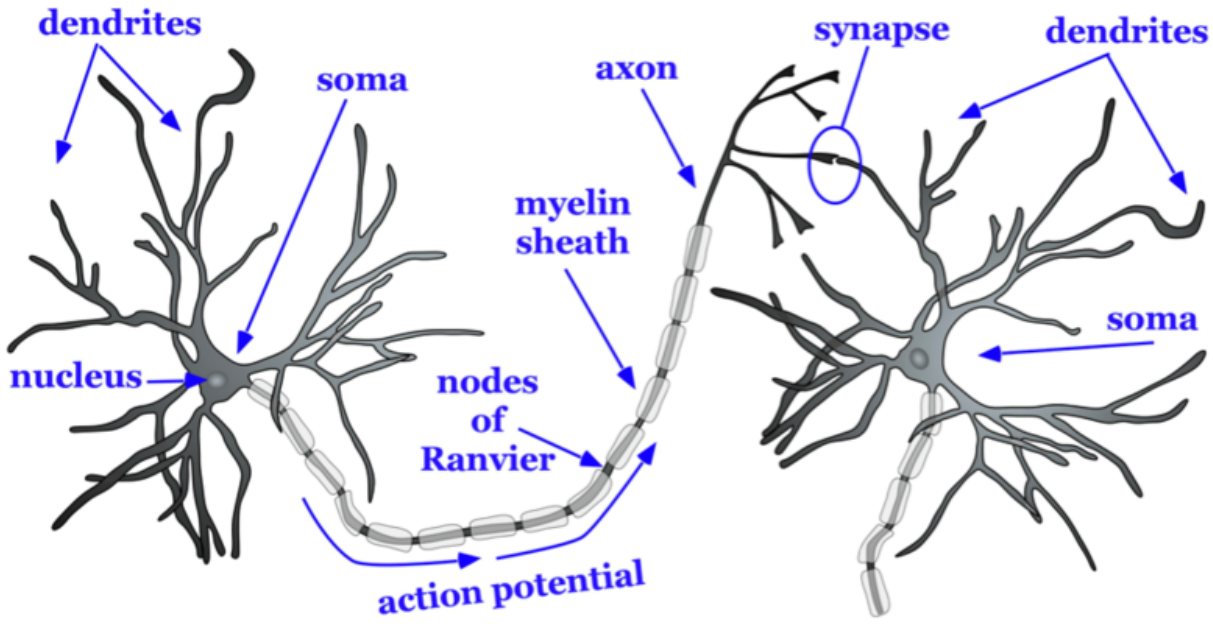
NEURONS

- Neurons – brain cells have an underlying structure that provides the foundation for their functional purpose
- In 1911, Santiago Ramón y Cajal concluded that neurons are the structure functional units of nervous system
- Based his conclusion on drawings made of Golgi stain tissue
    - Allowed Cajal to examine anatomical structure of individual neurons for the first time
    - Based on observations of Golgi, he suggested neurons were distinguishable processing units rather than continuous structures
- This work paved pathway to our current understanding of the basic structure of the nervous system

THE STRUCTURE OF THE NEURON

Basic Nomenclature

- Approximately 100 billion neurons in human brain
- Main components:
- Dendrites
- The Soma
- The Axon
    - Dendrites are processes that extend outwards from the soma, or cell body, and typically branch several times
- Nucleus is located within soma, contains generic information directs protein synthesis, supplies energy and resources the neuron needs to function
- Main source of output – axon
    - Process that extends far from the soma, carrying important signal called and **action potential** to another neuron
- **Synapse** – place at which the axon of one neuron comes in close contact to dendrite of another neuron

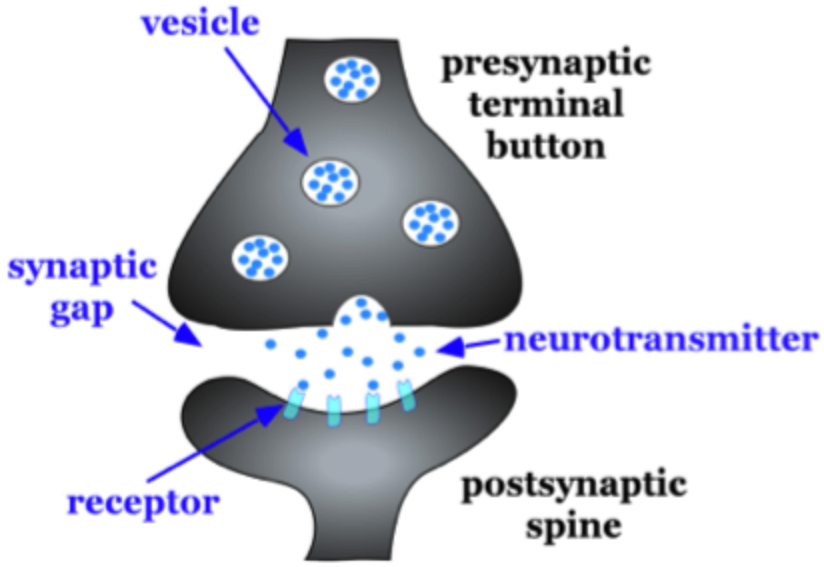


- The axon is typically covered with an insulating substance called **myelin sheath**, allows signal and communication of one neuron to travel rapidly to another
- Axon splits many times, so that it can communicate, or synapse, with several other neurons
- At the end of the axon is a **terminal button**, which forms synapses with spines or protrusion on the dendrites of neurons
    - Spines are protrusions on the dendrite of neuron
- Synaptic gap exists between the presynaptic terminal button and the postsynaptic dendrite spine
- Synaptic vesicles package together groups of chemicals called **neurotransmitters**
    - Neurotransmitters are released from presynaptic terminal button, travel across gap and activate ion channels on postsynaptic spine by binding to receptor sites

TYPES OF CELLS IN THE BRAIN

- Not all neurons are the same
    - Sensory neurons – help us receive information about world around us

    - Motor neurons – allow us to initiate movement and behaviour, allowing us to interact with world
    - Interneurons – process sensory input from our environment into meaningful representations, plan the appropriate behavioural response, and connect to the motor neurons to execute these behavioural plans
- 3 main categories of neurons, defined by its specific structure;
    - Unipolar neurons – structured in a way that is ideal for relaying information forward, they have 1 neurite (axon) and no dendrites
    - Involved in transmission of physiological information from body's periphery such as communicating body temperature through spinal cord to brain
- Bipolar neurons – involved in sensory perception such as perception of light, have 1 axon and 1 dendrite which help acquire and pass sensory information to various centers of the brain
- Multipolar neurons – most common neuron, communicating sensory and motor information in the brain
    - 1 axon and many dendrites allowing communication with other neurons
    - Ex: pyramidal neuron
- Glia cells – brain cells
    - Types of glial cells
        - Oligodendroglia – forms myelin sheaths
            - Wrap their dendritic processes around the axon of neurons – forming myelin
        - Microglia
        - Astrocytes – digest debris of dead neurons, carry nutritional support from blood vessels to the neurons and regulate ionic composition of the extracellular fluid
    - Glial cells do not play role in communication between cells
    - Vital role in neurological support

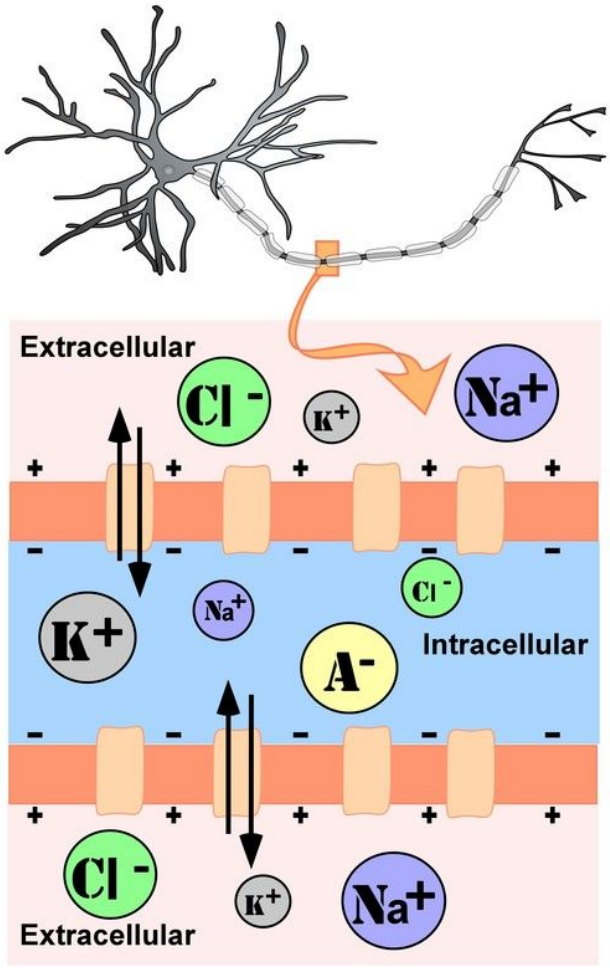


COMMUNICATION WITH AND BETWEEN NEURONS

- 2 stages of electrochemical action in neurons;
- First stage – electrical conduction of dendritic input to the initiation of an action potential within a neuron
- Second stage – a chemical transmission across the synaptic gap between the presynaptic neuron and the postsynaptic neuron of the synapse
- To understand these processes, we must first need to consider what occurs within a neuron when it is at a steady state, called **resting membrane potential**

RESTING MEMBRANE POTENTIAL

- The intracellular fluid and extracellular fluid of neurons is composed of a combination of ions
    - Cations are positively charged ions
    - Anions are negatively charged ions
    - Intracellular and extracellular fluid is similar, containing sodium (Na+), potassium (K+), chloride (CL-), and anions (A-)
- Cell membrane – a bi-lipid layer of molecules that separates the cell from the surrounding extracellular fluid



- There are proteins that span the membrane, forming ion channels that allow particular ions to pass between the intracellular fluid and extracellular fluid
- Ions are in different concentrations inside the cell than outside of the cell, and the ions have different electrical charges
    - Due to this difference in concentration and charge, two forces act to maintain a steady state when the cell is at rest: diffusion and electrostatic pressure
- Diffusion – the force on molecules to move from areas of high concentration to areas of low concentration
- Electrostatic pressure – the force on two ions with similar charge to repel each other and the force of two ions with opposite charge to attract to one another
    - There is a membrane potential at which the force of diffusion is equal and opposite of the force of electrostatic pressure
    - Called equilibrium potential – voltage at which no ions flow
- Resting membrane potential – voltage inside cell relative to the voltage outside the cell while the cell is at rest (~ -70mV)
- How diffusion and electrostatic pressures act on the 4 ions:

    - Anions (A-)
        - Highly concentrated inside cell
        - Contribute to negative charge of resting membrane potential
        - Diffusion and electrostatic pressure don't determine A- concentration because they are impermeable to cell membrane
    - No ion channels that allow for A- to move between intracellular and extracellular fluid
- Potassium (K+)
    - Cell membrane very permeable to K+ at rest, but K+ remains in high concentration inside the cell
    - Diffusion – pushes Cl- inside the cell because it is in high concentration outside cell
    - Electrostatic pressure pushes Cl- outside the cell because the negative charge of Cl- is attracted to positive charge outside the cell
- Sodium (Na+)
    - Cell membrane is not very permeable to Na+ at rest
    - Diffusion – pushes Na+ inside cell because it is in high concentration outside cell
    - Electrostatic pressure – pushes Na+ inside the cell because the positive charge of Na+ is attracted to negative charge inside cell
        - Both push Na+ inside the cell: however, Na+ cannot permeate the cell membrane and remains in high concentration outside the cell
    - Sodium-potassium pump – uses neuron's energy (ATP) to pump 3 Na+ ions out of the cell in exchange for bringing 2 K+ ions inside the cell

ACTION POTENTIAL

- Hodgkin and Huxley that began work in 1930s
- Studied axon in squids
- They noticed that, if applied, an electrical stimulus to the axon, a large, transient electrical current conducted down the axon
- Known as an **action potential**
    - When there is a change in charge of the cell from resting potential to a more positive direction – *depolarizing*
- Threshold of excitation (around -50mV)
    - If the threshold of excitation is reached, then action potential is triggered

- Each neuron is receiving hundreds of inputs from cells that synapse with it
- The inputs can cause several types of fluctuations in the neuron's membrane potentials:

1. Excitatory postsynaptic potentials (EPSPs) – a depolarizing current that causes the membrane potential to become more positive and closer to the threshold of excitation; or
2. Inhibitory postsynaptic potentials (IPSPs) – a hyperpolarizing current that causes the membrane potential to become more negative and further away from the threshold of excitation

- EPSPs and IPSPs add together in time and space
- IPSPs make membrane potential more negative, but how negative depends on their strength
- EPSPs make membrane potential more positive; again, how much more positive depends on its strength
    - 2 small EPSPs at the same time as the same time and some synapse then the result will be a large EPSP
    - A small EPSP and IPSP will cancel each other out
- Unlike action potential, which is an all-or-nothing response, IPSPs and EPSPs are smaller and graded potentials, varying in strength
    - The change in voltage during an action potential is approximately 100mV
        - EPSPs and IPSPs are changes in voltage between 0.1mV to 40mV
    - Can be different strengths, or gradients, and they are measured by how far membrane potentials diverge from resting membrane potential
- Cells are always receiving mixed signals both EPSPs and IPSPs
    1. If EPSPs are strong enough to depolarize the membrane potential to reach the threshold of extinction, it initiates an action potential
    2. Action potential travels down axon, from the soma until it reaches end of axon (terminal button)
    3. In terminal button, action potential triggers release of neurotransmitters from presynaptic terminal button into the synaptic gap
    4. The neurotransmitters cause EPSPs and IPSPs in postsynaptic dendritic spines of the next cell
    5. The neurotransmitter released from the presynaptic terminal button binds with ionotropic receptors in a lock-and-key fashion on post-synaptic dendritic spine
- Ionotropic receptors – receptors on ion channels that open, allowing some ions to enter or exit the cell depending on presence of neurotransmitter
- Type of neurotransmitter and permeability of the ion channel it activates will determine if an EPSP or IPSP occurs in the dendrite of the postsynaptic cell

THE CHANGE IN MEMBRANE POTENTIAL DURING AN ACTION POTENTIAL

- Some ions are involved in maintaining the resting membrane potential

    - Some of these are involved in action potential
- When a cell becomes depolarized (more positively charged), reaching the threshold of excitation, causing a voltage-dependent Na+ channel to open
    - A channel that opens, allowing some ions to enter or exit the cell, depending on when a particular membrane potential is reached in cell
- Closed when cell is at resting membrane potential
        - Na+ cannot permeate the membrane when cell is at rest
    - When opened, Na+ rushes inside cell, causing inside of cell to become very positively charged relatively to outside of cell
        - Responsible for rising or depolarizing phase of the action potential
- The inside of cell becomes very positively charged (+40mV), Na+ channels close and become refractory (meaning they cannot reopen until after the cell returns to resting membrane potential)
- New action potential cannot occur during the refractory period
    - Refractory period also ensures that action potential can only move in one direction down axon, away from soma
- As a cell becomes more depolarized, a second type of voltage-dependent channel opens; permeable to K+
- With the cell is very positive relative to the outside of the cell (depolarized) and the high concentration of K+ within the cell, both the force of diffusion and of electrostatic pressure drive K+ out of cell
    - The movement of K+ out of the cell causes the cell potential to return back to resting membrane potential
- Short hyperpolarization occurs partially due to the gradual closing of the K+ channels
    - With Na+ closed, electrostatic pressure continues to push K+ out of cell, cell returns to resting membrane potential and excess K+ diffuse away
- Myelin sheaths speed up process of the action potential
    - There are gaps in myelin sheath – **Nodes of Ranvier**
    - Myelin insulates the axon, does not allow any fluid to exist between myelin and cell membrane
    - Under myelin action potential degrades some, but is still large enough in potential to trigger new action potential at next Node de Ranvier
        - Saltatory conduction – the action of jumping node to node
    - Under myelin, when Na+ and K+ channels open, no ions flow between intracellular and extracellular fluid
        - Saving the cell from having to spend energy necessary to regain resting membrane potential
- In presynaptic terminal button, action potential triggers release of neurotransmitters

- Cross synaptic gap
- Open subtypes of receptors in a lock-and-key fashion
    - Neurotransmitters that open Na+ or Ca+ channels cause an EPSP
        - Ex: NMDA receptors activated by glutamate (main excitatory neurotransmitter in brain)
    - Neurotransmitters that open Cl- or K+ channels cause an IPSP
        - Ex: gamma-aminobutryic acid (GABA) receptors, which are main inhibitory neurotransmitter in brain

HORMONES AND BEHAVIOURS

- Endocrinology – study of the interaction between hormones and behaviour
- Interaction is bidirectional
    - Hormones can influence behaviour and behaviour can sometime influence hormone concentrations
- Hormones are chemical message released from endocrine glands that travel through the blood system, influencing nervous system to regulate behaviours

INTRODUCTION

- Artificial steroid use sometimes results in a violent behaviour known as “roid rage”
- Behavioural endocrinologists are interested in how the general physiological effects of hormones alter development and expression of behaviour
- Hormones – organic chemical messengers produced and released by specialized glands called endocrine glands
- Released from glands into the blood
- Similar in function to neurotransmitters
    - However, hormones can operate over a great distance
- Types of hormones:
    - Testosterone – androgen secreted by the testes of most vertebrate animals, men
    - Estradiol – common type of estrogen
    - Progesterone – common type of progestin
    - Cortisol – type of glucocorticoid

NEURAL TRANSMISSION VS. HORMONAL COMMUNICATION

Similarities / Differences

- *Both rely on chemical signals*
- Communication in nervous system is analogous to travelling on a train
    - Can use train as long as tracks exist between point of origin and destination

        - Neural messages can only travel to destination along existing nerve tracts
    - Hormonal communication – driving in car – many more roads than train tracts
        - Hormonal messages can travel anywhere in body via the circulatory system
    - Neural messages are “digital” – rapid onset and offset – taking place in milliseconds
    - Hormonal messages are “analog” graded events that may take seconds, minutes, hours
        - Can mediate long-term processes such as growth, development, reproduction and metabolism
    - *Both chemical in nature, released by cells in a similar manner*
        - Important differences
            - Neurotransmitters travel a distance of only 20-30 nanometers – to the membrane of postsynaptic neuron – binding to receptors
            - Hormones enter the circulatory system travelling from 1mm – 2m before arriving at target cell-binding specific receptors
    - The degree of voluntary control that can be exerted over their functioning
        - More voluntary control over neural than hormonal

- The division between nervous and endocrine system is blurring as we learn more of how the nervous system regulates hormonal communication
- Neuroendocrinology – understanding of the interface between endocrine and nervous system

Steroid Hormones	
Cortisol	Increases carbohydrate metabolism; mediates stress response
Estradiol	Uterine and other female tissue development; regulates sexual motivation and performance in females and males
Testosterone	Promotes sperm production and male secondary characteristics; promotes sexual motivation and behaviour, typically by being converted to estradiol
Peptides and Protein Hormones	

Oxytocin	Stimulates milk letdown and uterine contractions during birth; promotes social bonding
Prolactin	Many actions relating to reproduction water balance, and behaviour associated with parental care
Thyroxine	Increases oxidation rates in tissue and affects neural development
Vasopressin	Increases water reabsorption in the kidney and affects learning and memory

- Hormones coordinate the physiology and behaviour of individuals by regulating, integrating and controlling bodily functions
- Hormones have been co-opted by nervous system to influence behaviour and ensure reproductive success
- Hormones can only affect / influence cells that have the specific hormone receptor
    - The cells with these receptors are called <u>target cells</u>
- Interaction of a hormone and its receptor causes a series of cellular events that lead to activation of enzymatic pathways or turns gene activation, that regulates protein synthesis, on or off
    - These synthesized proteins can activate or deactivate other genes
- In terms of behaviour, humans and animals are comprised of 3 interacting components:
    - Input systems (sensory systems)
    - Integrators (control nervous system)
    - Output systems, or effectors (muscles)
- Hormones don't cause behavioural changes
    - They influence these 3 systems so that specific stimuli are more likely to elicit certain responses in the appropriate behavioural or social context
- Hormones change the probability that certain behaviours will be emitted in proper situation
    - Critical distinction that can affect how we think of hormonal-behaviour relationships
- Male-like behaviours are associated with actions of estrogens
    - Ex: zebra finches sing, if testes of adult male finches are removed, reduced singing
    - The finch will resume singing if testes are re-implanted of if treated with testosterone or estradiol

        - It's common for testosterone to be converted to estradiol in nerve cells
        - Cell estrogens must first be converted from androgens because of biochemical synthesis process
- By examining input systems, we could determine whether estrogens alter the birds' sensory capabilities,
- Estrogen also could influence the control nervous system
- Neuronal architecture or speed of neural processing could change in the presence of estrogens
    - Higher neural processes (e.g., motivation, attention, or perception) could also be affected
    - The effector organs, muscles, could also be affected
- Testosterone concentrations are affected, not only in humans involved in physical combat, but also those in stimulated battles
    - Ex: elevated in winners
- Hormones can be affected by anticipation of behaviours
    - Ex: testosterone concentrations also influence sexual motivation and behaviour in women
        - The interaction between sexual intercourse and testosterone was compared with other activities (cuddling or exercise) in women
        - Women's saliva pre and post intercourse was tested, and pre-intercourse was determined to have elevated level of testosterone
            - Testosterone values – higher post-intercourse compared to exercise, suggesting that engaging in sexual behaviour may also influence hormone concentrations in women

SEX DIFFERENCES

- Human, like many animals are sexually dimorphic in size and shape of their bodies, physiologically, and their behaviour
- Behaviour between boys and girls differ
    - Girls excel in verbal abilities, boys are almost 2x more likely to be dyslexic etc.
- Hormonal differences between men and women may account for adult sex differences that develop during puberty
- Hormonal secretions from the development of gonads determine whether the person develops in a male or female manner – prior to puberty
- Hormonal exposure in early life has organizational effects

    - Early steroid treatment causes relatively irreversible and permanent masculinization of rodent behaviours (mating and aggression)
- Activational effects – reversible behavioural influences of steroid hormones provided in adulthood
    - Activational effects of hormones on adult behaviour may decrease in effectiveness soon after hormone is metabolized
    - Thus, typical male behaviour requires exposure to androgens during gestation to somewhat mascinulize the brain, also requires androgens during or after puberty to activate neural circuits
    - Typical female behaviour requires lack of exposure to androgens, early in life which leads to feminization of brain, also requires estrogens to activate neural circuits in adulthood
- Because male and females differ in ratio of androgenic and estrogenic steroid hormone concentrations, behavioural endocrinologists are interested in the extent to which behavioural sex differences are mediated by hormones
- **Sexual differentiation** – process of becoming female or male
    - Primary step occurs in fertilization, ovum (containing X chromosome) is fertilized by sperm (containing X or Y) – process called sex determination
- The chromosomal sex of homogametic mammals (XX) is female, chromosomal sex of heterogametic mammals (XY) is male
- Chromosomal sex determines gonadal sex
    - All subsequent sexual differentiation is typically the result of differential exposure to gonadal steroid hormones
        - Gonadal sex determines hormonal sex, which regulates morphological sex
- Source of androgen may be internal (secreted by adrenal glands) or external (exposure to environmental estrogens)
- Turner syndrome – when second X chromosome is missing or damaged; individuals possess dysgenic ovaries
- Females are considered “neutral” sex, as additional physiological steps are required for male differentiation
- **Aromatase** – enzyme that converts androgens to estrogens
- Sex differences in a number of cognitive functions have been reported

AGGRESSIVE BEHAVIOURS

- Possibility exists when 2 or more people are in conflict
- Conflicts arise over resources
    - Social interactions decide which animal gains access to the contested resource

- Androgenic steroid hormones mediate aggressive behaviour across many species
    - Seasonal variations in blood plasma concentrations of testosterone and seasonal variations in aggression coincide
    - Aggressive behaviours increase at the time of puberty, when testes become active and blood concentrations of androgens arise
    - In many given species, males are generally more aggressive than females
    - Castrations typically reduces aggression in males, and testosterone replacement therapy restores aggression to pre-castration levels
- Possible that men are more aggressive because androgens promote aggressive behavior and boys have higher blood concentration of androgens
- Possible that boys and girls differ in their aggressiveness because the brains of boys are exposed to androgens prenatally and the “wiring” of their brains is wired in a way that facilitates aggression
- Boys are encouraged by surroundings
- Usually difficult to separate the influences of environment and physiology on the development of behaviours in humans
    - [Nature vs. Nurture]

PARENTAL BEHAVIOURS

- Considered to be any behaviour that contributes directly to the survival of fertilized eggs or offspring
- Concaveation – exposing parents to offspring, they soon begin to behave maternally
- Hormonal correlations of maternal behaviour
- Fast decline of blood concentrations of progesterone in late pregnancy after sustained high concentrations of this hormone, in combination with high concentration of estradiol, prolactin and oxytocin induces female rates to behave maternally instantly
- This pattern at parturition overrides the usual fear response of adult rates towards pups
        - Maternal “instinct” requires hormones to increase the approach tendency
    - Mothers can be quite aggressive toward animals that venture too close to their litter
        - Progesterone is the primary hormone that induces this maternal aggression
- Responses such as cuddling or kissing – **affectionate behaviours**
- Talking, singing – **vocal behaviours**

- Studies have shown no relationship between hormone concentrations and maternal responsiveness
- When behaviour was compared with hormone concentrations, different results
    - Blood plasma concentrations of cortisol were positively associated with approach behaviours
        - Women who had high concentrations of blood cortisol, engaged in more physically affectionate and talked more to babies
            - Additional studies showed that mothers who had positive maternal regard (during gestation) had even greater correlation
- Cortisol does not induce maternal behaviours directly, but may act indirectly on the quality of maternal care by evoking an increase in responsiveness to infant-generated ___
- The amygdala ionically inhibits the expression of maternal behaviour
- Lesions of the amygdala or afferent sensory pathways from the vomeronasal organ to the amygdala disinhibit the expression of maternal behaviour
    - Hormones likely act to disinhibit the amygdala, permitting the occurrence of maternal behaviour

PSYCHOPHARMACOLOGY

- Study of how drugs affect behaviour
    - If a drug changes your perception, or the way you feel or think, the drug affects your brain and nervous system
- Psychoactive or psychotropic drugs – change the way you think or feel

INTRODUCTION

- Any drug that changes how you feel, alters how neurons communicate with each other
- Communicate with each other by synapse
- Neurons that release neurotransmitters are localized within specific circuits of the brain that mediate these behaviours
- Psychoactive drugs either increase activity at the synapse (agonists) or reduce activity at synapse (antagonists)
- Different drugs do this by different methods, some examples of agonist and antagonists are presented in next table

Drug	**Mechanism**	**Use**	**Agonist/Antagonist**

L-dopa	Increase synthesis of DA	Parkinson's disease	Agonist for DA
Adderall (mixed salts amphetamine)	Increase release of DA, NE	ADHD	Agonist for DA, NE
Ritalin(methylphenidate)	Blocks removal of DA, NE and lesser (5HT) form synapse	ADHD	Agonist for DA, NE mostly
Aricept (donepezil)	Blocks removal of ACh from synapse	Alzheimer's disease	Agonist for ACh
Prozac (fluoxetine)	Blocks removal of 5HT form synapse	Depression, obsessive compulsive disorder	Antagonist 5HT
Seroquel (quetiapine)	Blocks DA and 5HT receptors	Schizophrenia, bipolar disorder	Antagonist for DA, 5HT
Revia (naltrexone)	Blocks opioid post-synaptic receptors	Alcoholism, opioid addiction	Antagonist (for opioids)

- Provide drugs and their primary mechanism of action
- It's important to realize that drugs also have effects on other neurotransmitters
    - Contribute to the kinds of side effects that are observed when someone takes a particular drug
- No drug work only exactly where we would like in the brain or only on a specific neurotransmitter
    - Many psychotropic drugs may come with additional drugs to reduce the side effects

PHARMACOKINETICS: WHAT IS IT – WHY IS IT IMPORTANT?

- Refers to how the body handles a drug that we take
- Psychoactive drugs exert their effects on behaviour by altering neural communication in the brain
    - Majority of the drugs reach the brain by traveling in the blood
- ADME is often used
    - A – absorption (how drug gets into blood)
    - D – distribution (how the drug gets to the organ of interest)

    - M – metabolism (how the drug is broken down so it no longer exerts its psychoactive effects)
    - E – excretion (how drug leaves the body)

DRUG ADMINISTRATION

- Many ways to take drugs
- Most are taken orally, relatively slow, and often most variable and complex rate of administration
- Drugs enter stomach and then get absorbed by blood supply and capillaries lining small intestine
        - Rate of absorption can be affected by variety of factors including the quantity and the type of food in stomach
    - Inhalation and intravenous (IV) are two of the most rapid rates of administration in which the drug is injected directly into the vein
        - IV is the most dangerous as if there's a reaction to the drug, there is little time to administer any antidote
- If a drug activates the reward circuits in the brain and reaches brain very quickly, has a high risk for abuse and addiction
    - Psychostimulants soon as amphetamine or cocaine have high risk for abuse, they are agonists at DA neurons involved in reward and can be inhaled or injected
- For drugs that reach the brain very quickly, not only is the drug very addictive, but so are the cues associated with the drug
    - This is the reason that individuals that enroll in drug treatment programs are at significant risk of relapse if they later find themselves in proximity to triggers

DRUG METABOLISM

- Involves the breakdown of psychoactive drugs, and this occurs primarily in the liver
    - Liver produces enzymes that help catalyze a chemical reaction that breaks down psychoactive drugs
- Enzymes exist in "families" and psychoactive drugs are broken down by the same family – the cytochrome P450 superfamily
    - There is not a unique enzyme for each drug: rather, enzymes can break down a variety of drugs
- Tolerance to the effects of many drugs can occur with repeated exposure; the drug produces less of an effect over time
    - So more of the drug is needed to get the same effect

- Metabolic tolerance – a kind of tolerance and it takes place in the liver
- Some drugs and alcohol cause enzyme induction
    - An increase in the enzymes produced by the liver
- Ex: Chrome drinking results in alcohol being broken down more quickly, so the alcoholic needs to drink more to get the same effect

RECENT ISSUES RELATED TO PSYCHOTROPIC DRUGS AND METABOLISM

Grapefruit Juice and Metabolism

- Certain types of food in the stomach can alter the rate of drug absorption, and other foods can also alter rate of drug metabolism
- Ex: Grapefruit Juice
- Suppresses cytochrome P450 enzymes in liver, and these liver enzymes normally break down a large variety of drugs
- If enzymes are suppressed, drug levels can build up to potentially toxic levels – effects can persist for long periods of time

Individualized Therapy. Metabolic Differences, and Potential Prescribing Approaches for the Future

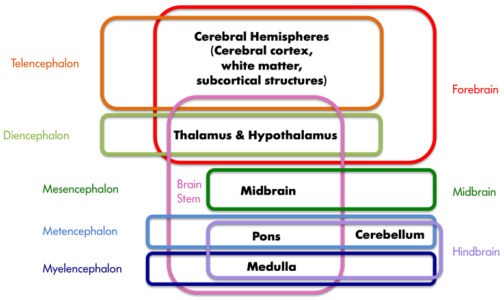
- Mental illnesses contribute to more disability in western countries than all other illnesses
- Pharmacotherapy with psychological therapy may be the most beneficial treatment approach for many psychiatric conditions
- There is ambiguity in mental illnesses and every person's unique circumstances
    - Some people aren't affected by certain drugs etc.
- As we better understand why individuals differ, the easier and more rapidly we can help them
- There are genetic differences in some of the cytochrome P450 enzymes and their ability to breakdown drugs
    - The general population falls into the following 4 categories
        1. Ultra extensive metabolizers – break down certain drugs very, very quickly
        2. Extensive metabolizers – break down drugs fairly quickly
        3. Intermediate metabolizers – break drugs down fairly quickly
        4. Poor metabolizers – break down the slowest
    - Someone receiving a prescription for an antidepressant – ultra-extensive would be given antidepressants and told it will take approximately 4-6 weeks to work, but the medication is metabolized so quickly that it will never work
    - Poor metabolizer would be given some dose may build up such high levels in their blood (because it's not breaking down) that they will have wide side effects and feel bad

- People can take tests (ex: blood test) to determine which group they fall into and plan accordingly
    - Determining methods that are effective are important, but expensive – important component for future of psychopharmacology

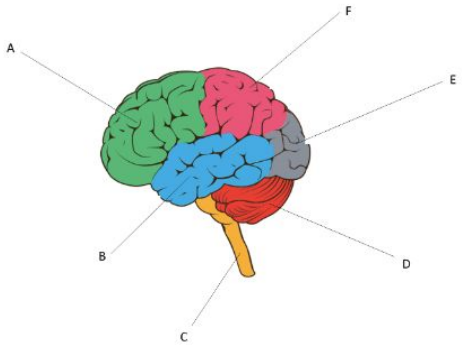
Week 6 -Neurobiology

- When one neuron fires, it suppresses the firing of other nearby neurons
- If two neurons that are hooked up in an inhibitory way both fire, neither can fire as vigorously as it would
- This competitive nature limits how much information the brain can respond to at the same time

The Anatomy of the Brain:



- Basic 3 divisions of the brain;
    - Brain stem: the “trunk” of the brain
        - Regulates breathing, heart rate, and digestion
        - Damage requires life support (loss of function = brain dead)
        - Formed by midbrain and hindbrain (Culminate in spinal cord)
        - Includes:
            - Medulla
            - Pons
            - Midbrain
            - Diencephalon (hypothalamus and thalamus)
            - Also involved in sleep-wake cycle, sensory and motor function, growth and hormonal behaviors
    - Cerebellum: distinctive structure at the back of the brain
        - Critical for coordinated movement and posture, balance, equilibrium cognitive abilities (including language)
        - Contains the greatest number of neurons of any structure in the brain
    - Cerebral Hemispheres: Responsible for cognitive abilities/ conscious experience



✓ __3__ Brain Stem	1. A
✓ __5__ Occipital Lobe	2. B
✓ __4__ Cerebellum	3. C
✓ __1__ Frontal Lobe	4. D
✓ __6__ Parietal Lobe	5. E
✓ __2__ Temporal Lobe	6. F

- Cerebral cortex: largest and most visible part of the brain
    - Consists of 2 hemispheres that are subdivided into 4 lobes
        - **Occipital:** Responsible for vision (Houses primary visual cortex)
            - very back of the cerebral cortex
            - Optic nerves travel to the thalamus, then to visual cortex
            - Where images received on the retina= projected
            - Images formed on retina= transformed, sent to the visual cortex for further processing
        - **Temporal:** Involved in auditory processing, memory, multisensory integration, and vision
        - **Parietal:** receiving/ processing sensory input i.e. touch, pressure, heat, cold, and pain.
            - Houses somatosensory cortex (TOUCH PAIN)
            - structures involved in visual attention
        - **Frontal:** Control of emotions
            - Houses motor cortex and structures involved in motor planning, language, judgement, and decision making

            - Proportionally larger in humans than other animals
        - Gives the brain gray and convoluted appearance;
        - Gray matter (neuronal cell bodies) lies outside, white matter (myelinated axons) lie inside
            - The folds and grooves of the cortex are called gyri and sulci
    - white matter
    - subcortical (under cerebral cortex, above brain stem) structure of the:
        - Basal ganglia:
            - Critical to voluntary movement and make contact with cortex, thalamus, and brain stem
        - Limbic System: Include the amygdala and hippocampal formation
            - Includes thalamus, pituitary gland, hypothalamus
            - **important role in emotion, aversion and gratification**
            - Contains nuclei that process memory, attention.

A Brain Divided:

- 2 cerebral hemispheres are connected by a dense bundle of white matter tracts called the **corpus callosum**
- Some functions are replicated in the two hemispheres
    - Both responsible for sensory and motor function, although the sensory and motor cortices have an opposite-side representation
        - left cerebral hemisphere = responsible for movements and sensations on the right side of the body and vice versa
    - Other functions are lateralized
        - They reside primarily in one hemisphere or the other
- Split-Brain Patients: 2 hemispheres that aren't connected, due to corpus callosum surgically removed or due to genetic abnormalities
    - Callosotomy: Corpus callosum surgically severed
        - If an object is placed in only the left or the right visual hemifield, then only the right or left hemisphere will see it
        - As if the patient has two brains in one head,
    - Split-brain patients can simultaneously search for something in their right and left visual fields , less competition between hemispheres

Gray Versus White Matter:

- Cerebral hemispheres contain both grey and white matter
- Gray matter
    - Composed of the neuronal cell bodies
    - Cell bodies (soma) contain genes of cell and are responsible for metabolism/ synthesizing proteins
- White matter
    - Composed of axons of the neurons covered with a sheath of myelin
    - Axons conduct electrical signals from the cell and are critical to communication
- Gray and white matter = critical to proper functioning of mind
    - Losses of either = deficits in language, memory, reasoning and other mental functions

Studying the Human Brain:

- Converging Evidence
    - strongest evidence for a specific role/function of particular brain area
    - Similar findings reported from multiple studies using different methods
- Phrenology
    - Assumed various features of the brain, ie. uneven surface= reflected on the skull
    - attempted to correlate bumps/ indentations of the skull w specific functions of the brain
- Current-day thinking
    - Different parts of brain are devoted to specific functions to be identified through specific inquiry

Neuroanatomy:

- Dissection of the brain= critical tool of neuroscientists
- method has advanced w discovery of staining techniques that can highlight particular cells
- useful for studying specific groups of neurons/ small brain structures
    - high spatial resolution
    - Dissection allows scientists to study changes in the brain that occur due to various diseases or experiences

Changing the Brain:

- Some researchers induce lesions/ remove parts of the brain in animals
    - If behaviour changes after lesion, removed structure = important for behaviour
    - Lesions of human brains only studied in patients without brain region due to injury, stroke, etc.

        - infer brain function by measuring changes in behaviour of patients before/after lesion
- Since brain works by generating electrical signals, it is possible to change brain function with electrical stimulation
    - **Transcranial magnetic stimulation (TMS):** brief magnetic **pulse** applied to head that temporarily induces weak electrical current in brain
        - allows precise study of when events occur in brain, so has good temporal resolution
        - application is limited to surface of cortex and can't extend to deep areas of the brain
    - **Transcranial direct current stimulation (tDCS):** similar to TMS except it uses electrical current **directly**, rather than inducing it w magnetic pulses, by placing small electrodes on the skull

Neuroimaging:

- **Positron emission tomography (PET):** Records blood flow in the brain
    - detect the injected radioactive substance in specific brain regions, allowing researchers to infer that those areas were active during the task
    - detects radioactive substance that's injected into bloodstream of participant just before/while they are performing a task (ie. adding numbers)
        - Because active neuron populations require metabolites, more blood and more radioactive substance flow into those regions
- **Functional magnetic resonance imaging (fMRI)** : Relies on blood flow in the brain
    - Changes in oxygen levels in the blood and **does not require any substance to be injected into the participant**
- Both have a good spatial resolution (still not as precise as dissection studies)
    - Since it takes several seconds for blood to arrive at active areas of the brain, **PET and fMRI have a poor temporal resolution;**
        - do not tell us very precisely when the activity occurred
- **Electroencephalography (EEG)**: Measures electrical activity of the brain
    - has a much **greater temporal resolution** than PET or fMRI (ms rather than s)
    - Poor spatial resolution
        - Like tDCS, electrodes = placed on participant's head when performing a task
            - more electrodes used, and measure rather than produce activity
- **Diffuse optical imaging (DOI)**

    - **High spatial and temporal resolution**
    - One shines infrared light into the brain and measures light that comes back out
    - relies on fact that properties of light change when passes through oxygenated blood, or encounters active neurons
    - Researchers can infer from properties of collected light what regions in brain were engaged by task

Psychophysiology

- research where dependent variable = physiological measure and independent variable= behavioural or mental

Psychophysiological methods: large domain of neuroscience methods

- Many are invasive; involving lesions, injections, manipulations, etc.
- make inferences about someone's cognitive/emotional state based on self-report, physiology, or overt behaviour

Central Nervous System (CNS):

- **Structural Magnetic Resonance Imaging (sMRI) :** NON INVASIVE
    - participant is placed in magnetic field, causes small portion of their atoms to line up in same direction
    - body is pulsed w low-energy radio frequencies that are absorbed by the atoms
    - As atoms return to previous state, give off energy in form of electromagnetic radiation
        - The machine transforms into 3D picture of the tissue in the body
        - image used to compare the size of structures in different groups of people
- **Functional Magnetic Resonance Imaging (fMRI):** Used to assess changes in the activity of tissue-- good for comparing brain activation in different tasks
    - Measures neural activity in different areas of the brain
    - When neurons fire, they use energy, which must be replenished (Gluc. + O2= supplied to brain from bloodstream)
    - O2 = transported through blood using hemoglobin (contains binding sites for O2)
    - As neurons fired, O2 in surrounding blood= consumed, reducing oxygenated hemoglobin
    - body compensates and provides a ton of oxygenated hemoglobin in the blood
    - When activity in neuron declines, oxygenated hemoglobin replenishes
        - **fMRI measures the change in the concentration of oxygenated hemoglobin**
            - Known as blood-oxygen-level-dependent (BOLD) signal

        - Measures blood volume/ blood flow, which we infer neural activity from
            - **poor temporal resolution (**precision of measurement w respect to time)
            - When combined with sMRI, provides excellent spatial resolution (ability to distinguish one object from another in space)
- **Electroencephalography (EEG):** studying brain activation
    - Uses 2-256 electrodes to measure difference in voltage btw pairs of points on the head
    - electrodes = fastened to flexible cap that's placed on the participant's head
    - From scalp, electrodes measure electrical activity that's naturally occurring in brain
    - **In contrast to fMRI, EEG measures neural activity directly**
    - **Great temporal resolution (**allows to document less than a millisecond events)
    - Analyses watch change in amplitude/ frequency of recorded EEG on an ongoing basis
- **Electrocorticography (ECoG): INVASIVE**
    - Electrodes placed within skull, directly on the brain
    - allows more precise localization of neural activity (essential in medical applications)
- Magnetoencephalography (MEG)
    - the current associated w neural activity produces weak magnetic fields that can be detected by sensors placed near participant's scalp
    - The number of sensors used varies from a few to several hundred
    - Since magnetic fields of interest = small, special shielded rooms from magnetic fields in environment are needed
        - avoid contamination of the signal being measured
    - **same excellent temporal resolution as EEG**
    - Magnetic fields able to pass through hard/soft tissue relatively unchanged, thus **providing better spatial resolution than EEG**
- **Positron Emission Tomography (PET):** measure processes in the body, including the brain
    - relies on positron-emitting tracer atom that's introduced to bloodstream in biologically active molecules (ie. Glucose, water, ammonia, etc)
    - **Positron:** particle like an electron but with a positive charge
    - Over time, tracker emits positrons (detected by a sensor)

    - Spatial location of tracer in brain can be determined based on the emitted positrons
    - allows researchers to construct 3D image of areas of brain that have highest needs for the molecule
    - represent neural activity over tens of minutes (**poor temporal resolution)**
- **Transcranial Magnetic Stimulation (TMS): NONINVASIVE**
    - causes depolarization or hyperpolarization in neurons near the scalp
    - not considered psychophysiological because independent variable=physiological
        - coil of wire =placed above the participant's scalp. When electricity flows through coil, produces a magnetic field. This magnetic field travels through skull and scalp and affects neurons near surface of brain
    - When magnetic field= rapidly turned on/off, a current =induced in neurons, leading to depolarization or hyperpolarization, depending on number of magnetic field pulses
    - Depending on intensity, coil orientation, and frequency, neural activity in stimulated area may be attenuated or amplified
    - TMS is able to explore neural plasticity (ability of connections between neurons to change)

Peripheral Nervous System:

- The research focused on the peripheral nervous system involves;
    - Skin conductance, Cardiovascular responses, Muscle activity, Pupil diameter, Eye blinks, Eye movements
- **Sympathetic Nervous System (SNS)**
    - Incr. in skin conductance can be associated w changes in psychological activity
        - Studying skin conductance allows researcher to investigate whether psychopaths react to fearful pictures in a normal way
    - **Skin conductance provides relatively poor temporal resolution**, (entire response taking a few s to emerge/resolve)
- **Parasympathetic Nervous System (PNS)**
    - Input from PNS decrease Heart rate and contractile strength
        - HR = easily monitored by using 2+ electrodes and measured by counting # of heartbeats in time period
    - Electrocardiogram: measure HR/heart variability
        - allow researchers to monitor SNS/ PNS reactivity to various stimuli or situations

- **Electromyography (EMG):** Measures electrical activity produced by skeletal muscles
    - measures voltage between two points
    - used to determine when participant first initiates muscle activity to engage in a motor response to the stimulus or degree to which participant begins to engage in an incorrect response
    - **The temporal resolution of EMG is similar to that of EEG and MEG (great!)**
    - Eye blinks = assessed using EMG electrodes placed just below the eyelid
    - electrical activity associated directly with eye blinks/eye movements measured w electrodes placed on the face near the eyes (because there is the voltage across entire eyeball)
        - Another option for measurement of eye movement: camera used to record video of an eye
        - With help of calibration period where participant looks at multiple, known targets, eye position = extracted from each video frame during the main task
        - Info=compared with data from calibration phase, allowing researchers to identify sequence, direction, and duration of gaze fixations

Evolution of the Nervous System:

- basic behaviours have been conserved in the brains of many simple animal forms= foundation of more complex behaviours in animals that evolved later
- At micro-anatomical level, individual neurons differ in complexity across animal species
- Human neurons exhibit more intricate complexity than other animals
    - Dendrites in humans have many more branch points, branches, and spine
- Both macro-/micro- complexities of NS give rise to complex behaviours
- The complexity of behaviour and NS can be observed in the genus Homo
    - Comparing sophistication of material culture in homo habilis and homo sapiens
        - Evidence shows that homo habilis used crude stone tools compared with modern tools used by homo sapiens
- Darwin proposed two forces of natural and sexual selection as work engines behind changes in brain and NS
    - "psych = based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation"
        - Psychology will be based on evolution

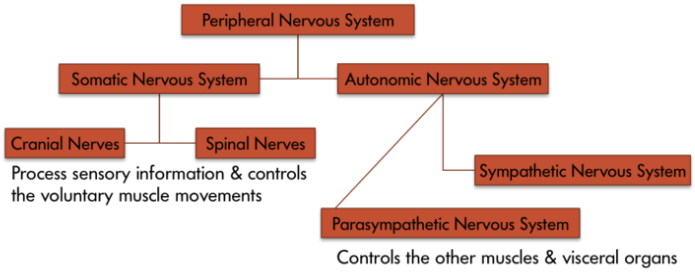
Development of the Nervous System:

- Development of NS in an individual mimics the evolutionary advancement of this structure observed across many animal species
- During development, nervous tissue emerges from ectoderm through the process of neural induction
    - Ectoderm: ⅓ layers of the mammalian embryo
    - Neural induction: causes formation of neural tube (extends in a head-to-tail plane)
        - The tube (hollow) seams itself in the head-to-tail direction
        - Spina Bifida: Abnormality when neural tube doesn't close towards the tail
            - Lumbar and sacral segments of spinal cord = disrupted
        - As gestation progresses, neural tube balloons up (cephalization) at front end
            - Forebrain, midbrain, hindbrain and spinal cord can be visually delineated (Day 40)
            - About 50 days into gestation, 6 cephalic areas can be anatomically discerned
        - The progenitor cells (neuroblasts) that form lining (neuroepithelium) of neural tube generate all neurons and glial cells of CNS
        - During early stages of this development, neuroblasts rapidly divide and specialize in many varieties of neurons/ glial cells
            - This rapid incr. of cells = NOT uniform along the neural tube
                - Why forebrain and hindbrain expand into larger cephalic tissues than midbrain
        - The neuroepithelium also generates a group of specialized cells that migrate outside the neural tube to form the neural crest
            - Neural crest gives rise to sensory and autonomic neurons in PNS

The Structure of the Nervous System:

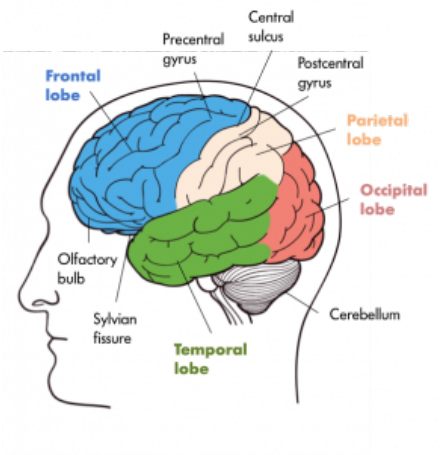
- PNS: Divided into somatic and autonomic nervous systems
    - **Somatic Nervous System**
        - Consists of cranial nerves (12 pairs) and spinal nerves (31 pairs)
        - Under the volitional control of the individual in maneuvering bodily muscles

- **Autonomic nervous system**: control over muscles and glands -- **FIGHT OR FLIGHT**
  - **Sympathetic Nervous System: Energizes fight or flight**
    - Energizes muscles (eg. heart) and glands (eg. adrenals), causing activity and release of hormones that lead to fight-or-flight response
  - **Parasympathetic Nervous System: regulates fight-or-flight responses**
    - undue energy mobilization into muscles and glands and modulates the response --"Rest and digest"



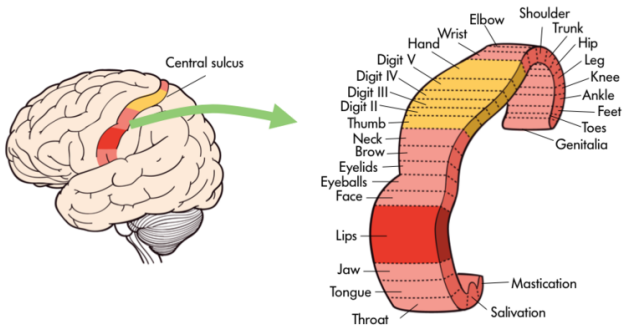
CNS:
Cerebrum

- New development in evolution of the mammalian nervous system
- When crumpled into the skull, it forms furrows called sulci
  - Bulges between sulci are called gyri
- Division of hemispheres based on two sulci;
  - **The central sulcus:** divides hemisphere into frontal and parietal-occipital lobes
  - **The lateral sulcus**: marks the temporal lobes



Primary motor cortex: Connects to muscles of body

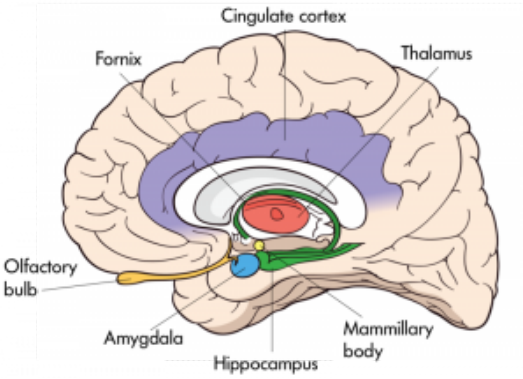
- Lies just in front of the central sulcus
- Moves them on volitional command



- Magnification Factor: disproportionate representation of body on primary motor cortex
- Broca's Area: Involved with language production
    - Lies at the lower end of the central sulcus, in left frontal lobe
    - Aphasias: Damage to Broca's area, people lose the ability to speak
- **Primary somatosensory cortex**
    - Behind the central gyrus, in parietal lobe
    - On postcentral gyrus, which represents whole body receiving inputs from the skin and muscles
    - Parallels the primary motor cortex
        - Resembles it in terms of areas devoted to the bodily representation
    - All spinal and some cranial nerves send sensory signals to the primary somatosensory cortex (TOUCH PAIN)
- **Secondary somatosensory cortex**: involved w taste experiences that originate from mouth etc
    - Close to lower end of strip, curved inside parietal lobe
- Wernicke's area: Involved with language comprehension
    - Just below the parietal lobe, under caudal end of lateral fissure (In the temporal lobe)
    - Connected to the Broca's area through **arcuate fasciculus**
        - Nerve fibres that connect Broca's area to Wernicke's area
    - Damage results in many kinds of agnosias
        - Inability to know/ understand language/speech related behaviours
- Primary Auditory cortex: Involved with audition
    - Close to Wernicke's area
- Primary olfaction cortex
    - Devoted to smell (olfaction)
- Globus Pallidus: Involved w motor movements and their coordination

Hypothalamus and Thalamus: Involved w motivations, and trafficking of sensory/motor throughputs

- Hypothalamus: key role in regulating endocrine hormones in conjunction w pituitary gland that extends from hypothalamus through a stalk



Midbrain: Process visual and auditory information

- Comes into view with superior and inferior colliculi
- Substantia nigra: Regulates arousal, sleep, and temperature
    - Involved in Parkinson's disease

Hindbrain & pons

- Processes sensory and motor information employing the cranial nerves
- Works as a bridge that connects the cerebral cortex with the medulla
- Reciprocally transfers information back and forth between the brain and the spinal cord

Medulla Oblongata

- Processes breathing, digestion, heart and blood vessel function, swallowing, and sneezing

Spinal cord

- Gray matter resides inside, white matter resides outside
- Paired nerves (ganglia) exit spinal cord, some close towards back (dorsal) and others towards front (ventral)
    - Dorsal nerves receive sensory information from skin and muscles (afferent)
    - Ventral nerves send signals to muscles and organs to respond (efferent)

Studying the Nervous System:

- Modern staining procedures (immunocytochemistry) make it possible to see selected neurons
- Early on, lesion studies in animals provided info about function of NS, by removing parts of the NS or using neurotoxins to destroy them and documenting the effects on behaviour/ mental processes
- **To study many neurons, electroencephalographic (EEG) techniques were introduced**

- **Computerized axial tomography (CAT):** resolution of this method is **inferior to MRI**
    - Uses X-rays to capture many pictures of brain and sandwiches them into 3D models
- **Magnetic resonance imaging (MRI): Resolution much better than CAT scans**
    - capture brain images using large magnets that bobble hydrogen nuclei in the brain
    - do not provide any functional information about the brain
- **Positron Emission Tomography (PET)**
    - Involves acquisition of physiologic (functional) images of brain based on detection of positrons
    - Radio-labelled isotopes of certain chemicals (i.e analog of glucose) enter active nerve cells and emits positrons (captured and mapped into scans)
        - show how brain and its modules become active (or not) when energized with entering glucose analog

Week 7: Introduction to Sensation and Perception

Sensation and Perception

Introduction:

Sensation: The physical processing of environmental stimuli by the sense organs

• During sensation, sense organs are engaging in transduction (process in which physical energy converts into *neural* energy)

Perception: The *psychological* process of interpreting sensory information

• Ex. Being able to identify a gas leak

Absolute Threshold: Each sense organ requires minimal amount of stimulation in order to detect a stimulus

• Signal detection is used to measure absolute thresholds

• Involves presenting stimuli of varying intensities to a subject to determine the level at which they can reliably detect stimulation in a given sense

• Ex. Listening to increasingly louder tones during a hearing test and determining the threshold at which they begin to hear

• *False Alarm*: Indicating that a sound was heard when one wasn't played

• *Correct Rejection:* Correctly identifying when a sound wasn't played

Differential Threshold/Just Noticeable Difference (JND): The smallest difference needed in order to differentiate two stimuli

• Weber's Law: The JND is proportional to the magnitude of the initial stimulus

• Bigger stimuli require larger differences to be noticed

- Ex. It's much harder to tell the difference between 10 and 11 lbs than it is for 1 and 2 lbs

Bottom-Up Processing: Building up to perceptual experience from individual pieces

• Ex. Processing stimuli the very first time you eat something

Top-Down Processing: Experience influences the perception of stimuli

• Ex. Stimuli we've experienced in our past will influence how we process new ones

Sensory Adaptation: Decrease in sensitivity to a stimulus after constant stimulation

• Habituation: Decreasing responsiveness to a stimulus as a result of repeated exposure, but you could draw your awareness back to it (not related to sensitivity of the receptor itself)

Vision:

How visions works:

1. Light enters eye through the *pupil*

2. Pupil regulates amount of light entering the eye by *contracting* in bright light and *dilating* in dimmer lightfc

3. Light passes through the lens, which focuses an image on the retina (cell layer in back of

the eye containing photoreceptors)

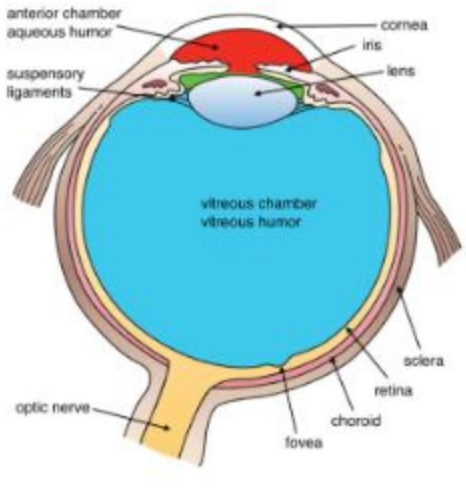
4. Electrical signal sent through layer of cells in the retina, eventually travelling down the *optic nerve*

5. After passing through the thalamus, the signal goes to primary visual cortex

6. Info is sent to a variety of different areas of the cortex for more complex processing

Binocular Disparity: Difference in images processed by the left and right eyes

- Provides us our binocular vision (perception of 3D space)



Retina: Transduces light into electrical signals through photoreceptors

- 2 main types of photoreceptors:

a. Rods: Sensitive to low levels of light and black, white, and gray colours

- 120 million rods
- Located around the fovea (dominates periphery)

b. Cones: Sensitive to colour and fine detail when light is brighter

- Located in fovea
- 5 million cones

Fusiform face area processes faces and *extrastriate body area* processes body parts

• Damage to these areas can result in specific kind of agnosia (loss of the ability to perceive stimuli)

- Ex. *Prosopagnosia*: Inability to recognize faces

Ventral Pathway: The "what" pathway

Dorsal Pathway: The "where" pathway

Dark and light adaptation:

• Dark Adaptation: Adjustment of eye to low levels of light

o Night vision ability takes around 10 minutes to turn on

o Rods become bleached in normal light conditions and require time to recover

• Light Adaptation: Adjustment of eye to high levels of light

o Large number of rods and cones are bleached at once, causing us to be blinded for a few seconds

o Light adaptation happens almost instantly compared with dark adaptation

2 main theories of colour vision

1. Trichromatic Theory: Colour vision is influenced by 3 different cones responding preferentially to red, green and blue

• Issues: Yellow does not appear to be a mix of red and green and people with colour blindness, who cannot see either green or red, can still see yellow

2. Opponent-Process Theory: Colour vision is influenced by cells responsive to pairs of Colors

• Evidence: Some neurons are excited by one colour but inhibited by another colour

• Can explain the *afterimage* effect

• Cones send info to retinal ganglion cells that respond to pairs of colors (red-green, blue-yellow, black-white)

Hearing (Audition):

Stages of a sound wave travelling through the ear:

1. Sound waves are funneled by the pinna into the auditory canal

2. Sound wave reach tympanic membrane (eardrum)

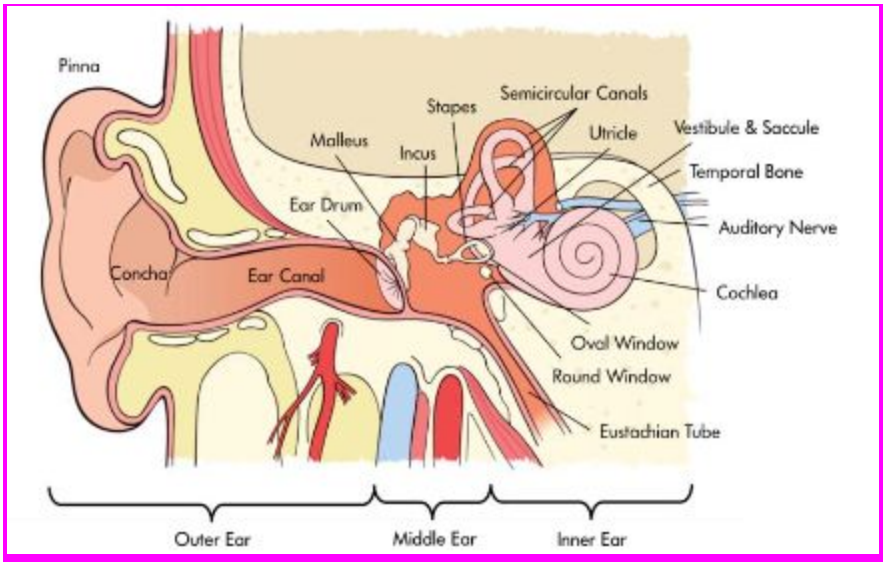
    • Vibrates against the malleus (hammer), incus (anvil), and stapes (stirrup)

    • These 3 bones collectively called ossicles

3. Tympanic membrane and ossicles amplify the sound waves before entering cochlea

4. Auditory hair cells in cochlea transduce sound into electrical potentials

5. Electrical signals are sent through the cochlear nerve to the thalamus, and then to the primary auditory cortex



Ear divided into 3 parts:

1. *Outer* Ear: Consists of the pinna, ear canal, and tympanic membrane

2. *Middle* Ear: Consists of the ossicles

3. *Inner* Ear: Consists of the cochlea, basilar membrane, organ of Corti

• Cochlea establishes frequency analysis (one of the most important principles of hearing)

o Low frequencies create maximal basilar-membrane vibrations near the apex of the cochlea

o High frequencies create maximal basilar-membrane vibrations near the base of the cochlea

o Phase Locking: Frequencies are also represented by the timing of spikes within the auditory nerve (crucial for comparing time-of-arrival differences)

• Basilar membrane vibrates in response to the pressure differences produced by vibrations of the *oval window*

• Organ of Corti has 3 rows of outer hair cells and 1 row of inner hair cells

o Outer hair cells: Mechanically amplify the sound-induced vibrations

o Inner hair cells: Transduce vibrations into action potentials

Balance and the Vestibular System:

Inner Ear: Associated with balance and detects where we are in space

• Vestibular system (parts of inner ear involved in balance) comprised of 3 semicircular canals (respond to changes in the head's orientation in space)

o Disturbances in the vestibular system can result in issues with balance,

Touch:

Somatosensation: Ability to sense touch, pain, and temperature

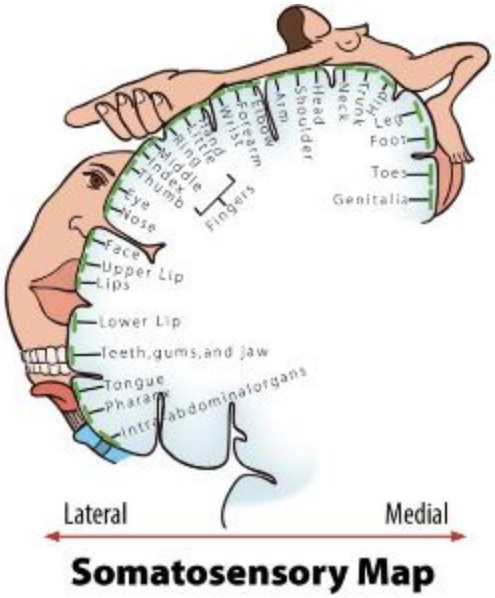
• *Tactile stimuli* (associated with *texture*) are transduced by mechanoreceptors

o Info is sent through the thalamus to the primary somatosensory cortex for further processing

• Regions of cortex are organized in a somatotopic map

o Different regions are sized based on the sensitivity of specific parts on the opposite side of the body

o Ex. Lips are more sensitive than other body parts so it'll have a larger representation on the map



Nociception: Our ability to sense pain

• Phantom Limbs: The perception that a missing limb still exists

• Can also involve phantom limb pain (pain in a limb that no longer exists)

• Damaged nerves from amputation site may be still sending info to the brain

Smell and Taste:

Olfaction (smell) and gustation (taste) require transduction of chemical stimuli into electrical Potentials

• Odorants in environment bind with olfactory receptors found in the olfactory epithelium

- o Shape Theory of Olfaction: Odorants of different size and shape correspond to different smells

- Head trauma may cause anosmia (loss of ability to smell)

Taste receptor cells found in taste buds on tongue

- Taste buds aren't the bumps on your tongue (papillae); they're small divots around the Bumps
- Receptors also respond to chemicals (tastants) from the outside environment

5 basic tastes:

1. Sweet
2. Sour
3. Salty
4. Bitter
5. Umami (savory)

- Combination of food and smell creates flavour

Putting it all Together: Multimodal Perception

Multimodal Perception: Info from more than one sensory modality is being experienced and Processed

- Superadditive Effect of Multisensory Integration: We respond more strongly to multimodal stimuli compared to the sum of each single modality together
  - o Ex. You're still able to understand what friends are saying to you at a loud concert, as long as you are able to get visual cues from watching them speak
- Principle of Inverse Effectiveness: You're less likely to benefit from additional cues from other modalities if the initial unimodal stimulus is strong enough

Hearing

Perceptual Attributes of Sound:

Categories of perceptual attributes of a sound:

1. Loudness: Amplitude (intensity) of sound wave codes for the loudness of a stimulus
    - Most direct influencer of loudness is sound intensity (sound pressure)
    - Loudness is influenced by frequency content, duration, and context
2. Pitch: Pitch is coded in the frequency of a sound wave
    - The faster a waveform repeats over time, the higher the pitch
    - Harmonic complex tones are the most common pitch-evoking tones
        - They consist of more than one frequency
        - The frequencies are all integer multiples of a common fundamental frequency (F0)
        - Ex. A harmonic complex tone with a F0 of 100 Hz would also contain energy at frequencies of 200, 300, 400 Hz, and so on
        - Pitch of the missing fundamental is a phenomenon where even if the energy at the F0 is absent, we still perceive the remaining sound to have a pitch corresponding to the F0
3. Timbre: Timbre (quality) explains the complexity of the sound wave
    - Describes words such as bright, dull, harsh, hollow
    - Spectral content
        - Sounds with more high-frequency energy tend to sound brighter, tinnier, or Harsher
        - Sounds with more low-frequency content tend to sound deeper, richer, or more dull

• Temporal envelope

o How the sound begins and ends

o Ex. A piano has a rapid onset, whereas the attack of a clarinet note can be much more gradual

Audibility, Masking, and Frequency Selectivity:

0 dB sound pressure level (SPL) corresponds to the quietest perceptible sound level

• Masking: Process by which the presence of one sound makes another sound more difficult to hear

o Upward Spread of Masking: Low-frequency sounds are more likely to mask high frequencies than the other way around

• Types of masking:

a) Swamping: The activity in the cochlea produced by a masking sound "swamps" the activity produced by the target sound

b) Suppression: The response to the masking sound reduces the neural response to the target sound

c) Informational Masking: Perceptual fusion of the masking sounds and target sounds

Spatial Hearing:

Sources of info that help our ability to located sound in space:

1. Interaural Time Difference (ITD): A sound source on the left will generate sound that will reach the left ear slightly before it reaches the right ear

• Most useful at low frequencies

2. Interaural Level Differences (ILD): At higher frequencies the head casts an acoustic "shadow," so that when a sound is presented from the left, the sound level at the left ear is somewhat higher than the sound level at the right ear

- Most useful at high frequencies

Touch and Pain

Sensation:

Cutaneous senses of the skin connect the brain to the body and the outside world

- Pain: An unpleasant sensory and emotional experience associated with actual or potential tissue damage
- Interoception: The sense of the physiological state of the body
    - Ex. Hunger, thirst, temperature, pain
- Exteroception: The sense of the external world, of all stimulation originating from outside our own bodies

Info somatosensory receptors send to the CNS is divided into 4 modalities:

1. Cutaneous Senses: Senses of the skin
2. Proprioception: Body position
3. Kinesthesis: Body movement
4. Nociception: Sense of pain

3 groups of skin receptors:

1. Mechanoreceptors: Respond to mechanical stimuli
    - Ex. Stroking, stretching, vibration of the skin
2. Thermoreceptors: Respond to cold or hot temperatures
3. Chemoreceptors: Respond to certain types of chemicals

Nociceptors: High-threshold sensory receptors that are capable of transducing and encoding noxious (harmful) stimuli

- Most are subtypes of mechanoreceptors or chemoreceptors

Action potentials in the receptor cells travel as nerve impulses with different speeds

- A-Fibers: Fast-conducting sensory nerves with myelinated axons
    - Ex. The sharp pain you primarily feel when stepping on a pin
- The unpleasant ache after stepping on the pin is a signal sent from C-pain/Aδ-fibers
    - Aβ-fibers conduct touch signals from low-threshold mechanoreceptors
    - Aδ-fibers conduct heat, noxious, and thermal signals
    - Aα-fibers are the fastest conducting fiber, which conducts proprioceptive info

Pain is divided into *sensory-discriminatory* (localize the touch stimulus and distinguish whether it's a blunt or a sharp stab) and *affective-motivational* (lets us know that stepping on the pin is bad) aspects

- A-fibers contribute to sensory–discriminatory aspects
- C-fibers contribute to affective–motivational aspects
    - C-Fibers: Slow-conducting unmyelinated thin sensory nerves
    - C-pain fibres: Convey noxious, thermal, and heat signals
    - C-tactile fibers: Convey gentle touch, light stroking
    - Social Touch Hypothesis: C-tactile fibers form a system for touch perception that supports social bonding

Modulation:

Experience of perceiving somatosensory and nociceptive signals is subjective and malleable by motivation, attention, emotion, and context

- Pain is necessary for survival, but our brain can stop it if it needs to
- Motivation-Decision Model: Brain automatically evaluates pros and cons of any situation (weighing threats and rewards)
- Descending Pain Modulatory System: A top-down system able to inhibit or facilitate pain so that more important actions can be attended to

• Analgesics: Pain relief

• Expecting pain relief from a medical treatment contributes to the placebo effect

• Rats that expected candy stood on a burning plate for longer than the rats who expected regular food

o Rewards have an analgesic effect

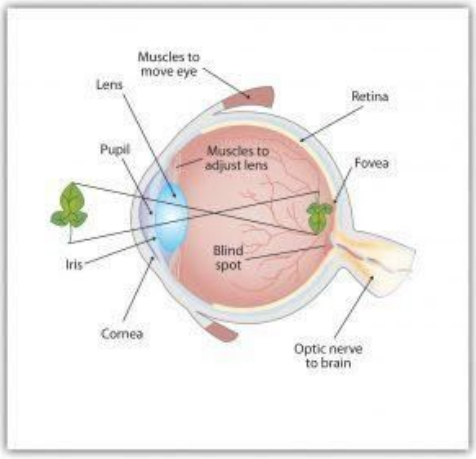
Week 8 The Visual World

Introduction:

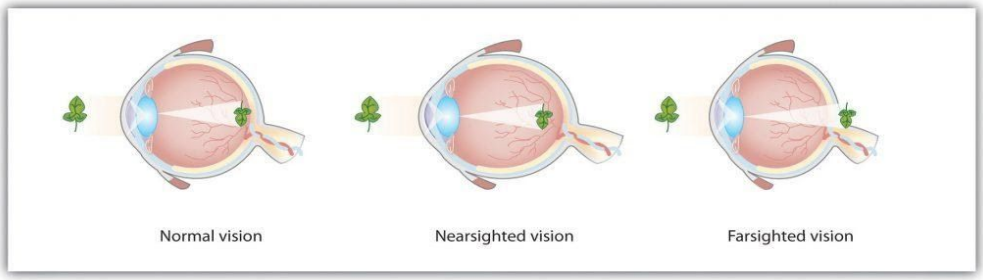
- The air is filled with a sea of electromagnetic energy (pulses of energy waves that carry info place to place)
  - Electromagnetic waves vary in wavelength
    - Humans can only detect a range from about 400-700 billionths of a meter
      - Part of the electromagnetic spectrum; visible spectrum

The Sensing Eye and the Perceiving Visual Cortex:

- Light enters eye through **cornea** (clear covering that protects eye and focus incoming light)
- The light then passes through the **pupil** (small opening in centre of eye)
  - Surrounded by the **iris**
    - Coloured part of eye that controls size of pupil
  - Behind the pupil = **lens**
    - Focuses incoming light on the **retina (l**ayer of tissue at back of eye that contains photoreceptor cells)
- Visual Accommodation
  - process of changing the curvature of lens to keep light entering eye focused on the retina
  - Occurs as eyes move from near objects to distant objects
  - Rays from top of the image strike the bottom of the retina and vice versa
  - Rays from left side of the image strike right part of the retina and vice versa, causing the image to be upside down and backwards
  - The image projected on the retina is flat (final perception of image = 3D)



Nearsighted: Focus is in front of the retina
Farsighted: Focus is behind the retina



Blind Spot

- Hole where there are no photoreceptor cells as optic nerve leaves the retina
- visual cortex fills in small hole in vision w similar patterns from surrounding areas,;never noticing the difference

Feature Detector Neurons: respond to strength, angles, shapes, edges and movements of a visual stimulus

- Specialized neurons, located in visual cortex
- Activation of these neurons is passed onto other parts of visual cortex, where other neurons compare the information supplied by the feature detectors with images stored in memory

Perceiving Form: Idea that the “whole is more than the sum of its parts”

- We create forms out of objects component sensations based on idea of the Gestalt
- 1. Figure and Sound
    - We structure input so always see a figure against a background
    - I.e vase illusion
- 2. Similarity
    - Stimuli that are similar to each other tend to be grouped together
    - (i.e XYX columns)
- 3. Proximity

    - Tend to group nearby figures together
    - Ie. sets of shoes
- 4. Continuity
    - Tend to perceive stimuli in smooth, continuous ways rather than in more discontinuous ways
    - I.e line of dots left to right instead of looking at branches of dots
- 5. Closure
    - Tend to fill in gaps in an incomplete image to create a complete, whole object
    - I.e image with blank spaces of white etc helps create image

Depth Perception: ability to perceive 3D space and accurately judge distance

- In part innate, in part learned through experience

Perceiving Depth:

- Visual Cliff: mechanism that gives perception of dangerous drop-off, where infants can be safely tested for their perception of depth
    - Infants brought close to this drop-off cried or walked away
    - improve their hand-eye coordination as they learn to better grasp objects and gain more experience in crawling
        - Therefore, depth perception is innate and learned
- Depth Cues: Results in-depth perception
    - Messages from our bodies and external environment that supply us with info about space and distance
- Binocular Depth Cues: Depth cues created by retinal image disparity
    - Require the coordination of both eyes (The space between our eyes)
    - Convergence: Requires both eyes to work!
        - Inward turning of eyes that's required to focus on objects less than about 50 feet away from us
        - The visual cortex uses size of the convergence angle to judge object's distance
    - Accommodation: Helps determine depth

Perception - Unified:

- Perception operates in context of info supplied by multiple sensory modalities at same time
    - A set of unimodal stimuli
- Multimodal Perception
    - Effects on perception when there's info from more than one sensory modality
    - At some point in perceptual processing, info from various sensory modalities=integrated

Questions About Multimodal Perception:

- We rarely combine auditory stimuli associated with one event w the visual stimuli associated with another
- **Superadditive Effect of Multisensory Integration**
  - If stimuli presented in one modality at a time and measured the response to each unimodal stimuli, adding them together would NOT equal response to multimodal stimulus
  - Indicates there are consequences resulting from integrated processing of multimodal stimuli
- **Principle of Inverse Effectiveness : f**or stimulus w multimodal components
  - If response to each component independently= weak, then opportunity for multisensory enhancement = large
  - If one component is sufficient to evoke strong response, then opportunity for multisensory enhancement = small
  - Effectiveness of multisensory enhancement (superadditive effect) = inversely related to unimodal response with the greatest effect
- If experience of world is multimodal, then at some point during perceptual processing, the unimodal info coming from separate sensory organs = combined

Multisensory Neurons and Neural Convergence:

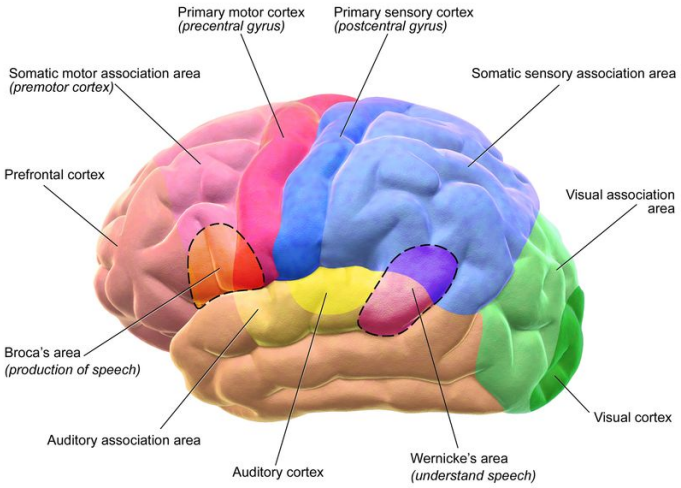
- Large # of brain regions in midbrain and cerebral cortex are related to multimodal perception
  - regions contain neurons that respond to stimuli from multisensory modalities
  - Superior Temporal Sulcus
    - Contains single neurons that respond to both visual/ auditory components of speech
  - Multisensory Convergence Zones: Neural intersection of info coming from diff. senses
    - Neurons devoted to processing one sense at a time send their info to convergence zones, where it is processed together
  - Superior Colliculus: Multisensory convergence zone
    - Receives inputs from many different areas of the brain
    - Involved in the "orienting response"
      - Behaviour associated w moving one's gaze toward location of seen/heard

Crossmodal Receptive Fields:

- **Neuron Receptive Field:** specific region of space immediately surrounding the perceiver
    - If stimulus presented in neuron's receptive field, that neuron responds by incr/decr its firing rate
    - If stimulus presented outside of neuron's receptive field = NO EFFECT on neuron's firing rate
    - Neural Convergence
        - When 2 neurons send info to third neuron, (3rd neuron's receptive field= combination of receptive fields of two input neurons)
        - For multisensory neurons, convergence arrives from different sensory modalities
        - Receptive fields of multisensory neurons= combination of receptive fields of neurons located in different sensory pathways
        - When info. from separate modalities coming from overlapping crossmodal receptive fields, is treated as coming from same location
            - Neuron responds with a superadditive response
    - **Spatial Principle of Multisensory Integration**
        - Multisensory enhancement observed when sources of stimulation are spatially related to one another
        - Enhancement effects are observed in multisensory neurons ONLY when inputs from different senses arrive within short time of one another

Multimodal Processing in Unimodal Cortex:

- Multisensory neurons have been observed outside of multisensory convergence zones
- Primary Visual Cortex: recieves info from eyes, primary auditory cortex, superior temporal sulcus
    - Therefore, processing of visual info is influenced by auditory info



- Researchers propose that these areas only prefer to process info from specific modalities, but engage in low-level multisensory processing whenever it's beneficial to perceiver.

Behavioral Effects of Multimodal Perception:

- 2 broad classes of behavioural effects associated w multimodal perception:

Multimodal phenomena: Concerns the binding of inputs from multiple sensory modalities and effects of this binding on perception

- Audiovisual Speech
  - When speaking, generate sound waves that carry meaningful info
  - If perceiver is also looking at speaker, then perceiver also has access to visual patterns that carry meaningful info
  - **McGurk Effect (GAGA VS BABA)**
    - when visual and auditory info about speech is integrated, can have profound effects on perception
    - misperceiving sounds due to audio/visual parts of speech being mismatched
    - Represents that speech has a visual and auditory aspect
- Tactile/Visual Interactions in Body Ownership
  - **Rubber Hand Illusion**
    - Sets up a correspondence between the tactile sensations and the visual sensations
    - After short time, participants report feeling as though rubber hand is theirs

Crossmodal phenomena: Concerns the influence of one sensory modality on the perception of another

- Visual Influence on Auditory Localization
  - **The Ventriloquism Effect**

        - fool listener into thinking that location of origin of speech is at puppet's mouth
        - Instead of localizing auditory signal to correct place, our perceptual system localizes it to the mouth of the puppet
        - visual location of mouth movement overrides the less well-specified location of auditory info
- Auditory Influence on Visual Perception
    - **Double Flash Illusion:** seeing two visual flashes when flash accompanied by two beeps
        - Participant asked to stare at central point on computer monitor
        - On extreme edge of participant's vision, a white circle is briefly flashed one time
        - There is also a simultaneous auditory event (either 1-2 beeps in rapid succession)
        - See one flash when accompanied with a single beep
    - **The Perception of Collisions Between Two Circles**
        - Stimuli can be perceived as either;
            - Two balls moving through each other
            - Collisions btw the 2 balls that bounce off eachother in opposite directions
        - presentation of an auditory stimulus at time of contact btw the balls strongly influenced the perception of a collision event

Crossmodal Speech:

- effects show altered perceptual processing of unimodal stimuli by virtue of prior experience with the alternate unimodal stimulus
- Familiarity w visual info led to incr. recognition of speaker’s auditory speech, to which participants had never had exposure
- Similarly, it has been shown that when perceivers see a speaking face, they can identify the (auditory-alone) voice of that speaker, and vice versa
- The visual form of a speaker engaged in act of speaking appears to contain info about what that speaker should sound like and vice versa

Week 9 Consciousness and Sleep

Conscious Experience: study of consciousness confronts challenge of producing general understanding beyond what can be known from one's individual perspective

- Consciousness: Ability of person to generate series of conscious experiences
    - Can refer to the state of individual
        - Sharp/ dull state of consciousness, drug-induced state of euphoria, diminished state due to drowsiness, sleep, neurological abnormality etc
    - Conscious experience: moment of awareness
- First-person Perspective: Dominated understanding of consciousness
    - Observations made by individual about personal conscious experiences (introspection)
- Contemplative Science: research concerned w understanding how contemplative practices (i.e meditation) can affect individuals behaviour, emotional reactivity, cognitive abilities, brain
    - Seeks insights into conscious experience that can be gained from first-person observations by individuals who gained extraordinary expertise in introspection
- Dualism: Rene Descartes position
    - Mental and physical are different substances
    - Can be contrasted w reductionist views that mental phenomena can be explained via descriptions of physical phenomena

Conscious Views of Visual Perception:

- Motion-Induced Blindness: bright discs completely vanish from awareness in full attention
    - May think if you attentively look at a bright spot, must be aware of it, (NOT the case)
- Awareness of visual feature depends on type of reciprocal exchange of info across multiple brain areas, particularly in visual cortex
    - Directly activating visual motion area (V5) w externally applied magnetic field = make you see moving dots
    - Activating visual motion area alone doesn't let you see motion
    - reverberating reciprocal exchange of info btw higher-level visual areas and primary visual cortex = essential for generating visual awareness
        - Will not see moving dots if feedback signal from V5 to primary visual cortex= disrupted
- Cortical Blindness: Brain damage limited to primary visual cortex = complete blindness
    - Other areas of visual cortex may still receive visual input through projections from brain structures i.e thalamus and superior colliculus

        - May mediate some preserved visual abilities that take place w/o awareness
    - Phenomenon of blindsight refers to blindness due to a neurological cause that preserves abilities to analyze and respond to visual stimuli that are not consciously experienced
- Neural Synchronization: play an important role because it promotes neural communication
    - Exchanges of info across brain areas= crucial for generating visual awareness
    - Communication among neural populations enhanced when oscillatory cycles of excitability are synchronized
        - Info transmitted from one population in excitable phase is received by target population when also in excitable phase
- Integration Theory of Consciousness: shared info itself constitutes consciousness
    - Organism would have minimal consciousness if structure of shared info is simple
        - would have rich conscious experiences if structure of shared info is complex
    - Complexity defined as # of intricately interrelated info units/ ideas generated by web of local and global sharing of info
    - The degree of consciousness in an organism would be;
        - High if numerous and diversely interrelated ideas arise
        - Low if few ideas arise or if numerous ideas are random and unassociated
    - If every neuron connected to every other neuron, all neurons would activate together, generating few distinctive ideas
    - W **low level of neuronal connectivity**, all neurons tend to activate independently, **generating numerous but unassociated ideas**
    - Rich level of consciousness require suitable mixture of short, med, and long-range neural connections
    - Consciousness is conceptualized in this theory as an all-or-none approach

Conscious Experience of Memory

- Episodic Recollection: Main point of conscious human memory function
    - It allows one to re experience the past, to virtually relive an earlier event
    - People who suffer from amnesia due to neurological damage to critical brain areas have poor memory for events and facts
    - Memory deficit disrupts type of memory called **declarative memory** makes it difficult to consciously remember

        - Therefore, they are typically are spared a set of memory functions that don't involve conscious remembering
            - Various habits, motor skills, cognitive skills, procedures, etc.
        - Some types of memory involve only subcortical brain regions (rather than brain operations that depend on networks of neurons in the cerebral cortex)
            - As conscious remembering does
    - Exceptions:
        - Perceptual Priming: memory that doesn't entail conscious experience of remembering and is typically preserved in amnesia
            - reflects fluency of processing produced by prior experience, even when individual can't remember the prior experience
            - Person w amnesia can demonstrate this item-specific fluency due to changes in corresponding cortical areas
                - Would still be impaired if asked to recognize words or faces they previously experienced
        - Remembering an episode = conscious experience not merely due to involvement of one portion of cerebral cortex
            - due to specific configuration of cortical activity involved in sharing or integration of info
        - Storing memories for events we experience depends on connections among multiple cortical regions and hippocampus
        - Memory storage becomes more secure due to interactions btw hippocampus and cerebral cortex that happen over long period of time
            - Conscious retrieval depends on activity of sets of networks in cortex
        - Non-conscious memory retrieval depends on restricted portions of cortex or on brain regions separate from cortex

Conscious Experience of Body Awareness: brain generates body awareness from coincident sensations

- Temporoparietal Junction: Region of cortex involving brain mechanisms that mediate construction of body awareness
    - Damage can generate distorted body awareness
    - Altered neural activity in this region through artificial stimulation can produce an out-of-body experience
    - **Virtual Reality:** Other brain mechanisms generate normal awareness of sense of self and sensation of being inside a body
        - Sensation known as "presence"

    - normal localization of self may be equally artificial (not a given aspect of life but is constructed through special brain mechanism)
- A Social Neuroscience Theory of Consciousness: important role to ability to localize own sense of self
    - Your better in social environment to extent that you can predict what people are going to do
    - Brain has developed mechanisms to construct models of people's attention/ intention
    - Localizes models in corresponding people's heads to keep track of them
    - same brain mechanism adapted to construct model of one's own attention/ intention
        - then localized in one's own head and perceived as consciousness
        - primary function of consciousness is to allow us to predict our own behavior

Consciousness: indicate awareness

- Includes awareness of the self, of bodily sensations, of thoughts and of the environment
- Even while we are awake, many things lay outside the realm of our conscious awareness

Unconsciousness:

- Senselessness or a barrier to awareness

Subconscious:

- Some of our memories and even our basic motivations are not always accessible to our conscious minds

Level of Awareness:

- We have the "low awareness" of subtle, even subliminal influences
- We also have conscious thinking, feeling which includes all that you are aware of
    - Low Awareness:
        - Cues: Significant sensory information
            - Automatically elicit responses even though we never consciously perceive it
        - Priming: Readily activating concepts and associations from one's memory
            - All influences occur beneath one's conscious awareness
        - Implicit Associations Test (IAT): uses computers to assess reaction times to various stimuli
            - difficult test to fake since records automatic reactions that occur in milliseconds

            - Delays associated w more mental effort needed to process information
            - When info is processed quickly, can be contrasted w slower processing
            - The difference in processing speed is reflective of bias
    - High Awareness: Includes effortful attention and careful decision making
        - Just because we may be influenced by invisible factors, it doesn't mean we are helplessly controlled by them
        - Mindfulness: state of higher consciousness
            - effortful consideration of thoughts = expansion of conscious awareness
            - Humans alternate btw low/high thinking states (neural networks for both)
            - The less we're paying attention, more likely we're to be influenced by non-conscious stimuli
            - Although subtle influences may affect us, we can use higher conscious awareness to protect against external influences
            - Flexible Correction Model
                - People who are aware that thoughts/ behavior are influenced by outside source, can correct their attitude against the bias

	Costs	Benefits
Low Awareness	*Influenced by subtle factors*	*Saves mental effort*
High Awareness	*Uses mental effort*	*Can overcome some biases*

Hypnosis: mental state of reduced peripheral awareness and incr focus on singular stimulus

- Results in an enhanced susceptibility to suggestion
- Hypnotist will induce hypnosis by getting person to pay attention to only the hypnotist's voice
    - As individual focuses, begin to forget the context of setting and responds to hypnotist's suggestions as if they were their own
    - You cannot be hypnotized against your will
- Once hypnotized, won't do anything you wouldn't do in more natural state of consciousness
- Hypnotized participants = highly suggestible, seemingly under the hypnotist's control
- Mesmerize: To entrance or transfix a person's attention

Dissociation: separation of one's awareness from everything besides what one is centrally focused on

- Consequence: person is less effortful/self-conscious of their own thoughts and behaviors

Hypnotherapy

- Combination of relaxation, suggestion, motivation and expectancies to create desired mental/ behavioral state

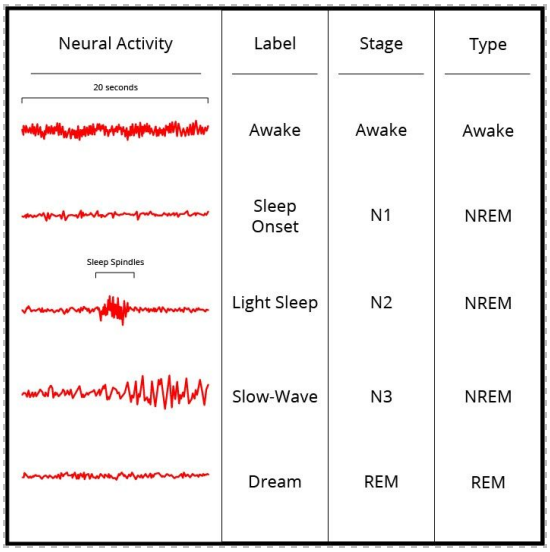
Trance States: Involve dissociation of the self

- People said to have less voluntary control over their behaviors and actions
- Hypnotic and trance states are simply shifts from the standard conscious experience

Sleep: Lacks full awareness but the brain is still active

- **Melatonin:** Hormone that incr. at night and is associated with becoming sleepy
- **Circadian Rhythm:** Your natural daily rhythm
    - influenced by the amount of exposure to daylight and work and activity schedule
    - **Jet Lag:** Changing location can disrupt natural sleep rhythms
        - can overcome jet lag by synchronizing yourself to the local schedule
            - Exposure to daylight and forcing awakeness
    - When you fall asleep, your shift in consciousness is reflected in your brain's electrical activity
    - **Betawaves:** Marks brain activity while you are awake and alert
        - Characterized by being high in frequency but low in intensity
        - The most inconsistent brain wave
    - Reflects wide variation in sensory input that a person processes through the day
    - **Alphawaves:**Marks brain activity that's less frequent, more consistent and more intense
        - As you slip into actual sleep you transition through many stages;
            - REM: Those the include rapid eye movement
            - NREM: Those that are non-rapid eye movement
        - Each stage is typically characterized by its own unique pattern of brain activity;
        - Stage 1 (NREM/N1): The "falling asleep" stage and is marked by theta waves
        - Stage 2 (NREM 2/N2): Considered light sleep, Makes up 55% of sleep
            - Occasional "sleep spindles" or very high intensity brain waves

        - associated with the processing of memories
    - Stage 3 (NREM 3/N3): Makes up 20-25% of sleep
        - marked by greater muscle relaxation and delta waves
    - Stage 4 (REM): 20 % of sleep and is associated with dreaming -- VIVID
        - Marked by the rapid eye movement, brain activity similar to wakefulness
        - brain waves occur less intensely than other stages



People who do not receive adequate sleep;

- more irritable, slower reaction time, more difficulty sustaining attention, make poorer decisions

Psychoactive Drugs

- **Hallucinogens:** alter person's perceptions; creating visions or hallucinations that are not real
    - **Marijuana**, LSD, MDMA, etc.
        - Dried flowers of the hemp plant, smoked to produce euphoria
        - THC produce distortions in perception of time, create sense of rambling, unrelated thoughts, can cause hunger or excessive laughter
- Depressants: Substances that slow down the body's physiology and mental processes
    - Alcohol: The most widely used depressant
        - Reduction of inhibition, incr neurotransmitter GABA, loss of balance/coordination, interferes w coordination of visual/motor systems of brain, toxic

                - When person's blood alcohol content (BAC) reaches .3-.4%, serious risk of death
            - Lack of judgment/ physical control w alcohol = risk taking behavior/ dangerous behavior
            - Addictive; heavy drinkers experience significant interference w ability to work effectively
        - Opiates (narcotics): Stimulate endorphin production in the brain
            - Often used as pain killers by medical professionals, Highly addictive
- Stimulants: Substances that speed up the body's physiological and mental processes
    - People feel more alert when under the influence of these drugs
    - Excessive consumption can result in anxiety, headaches, and insomnia
        - Caffeine: in coffee and tea
        - Nicotine: active drug in cigarettes and other tobacco products
    - Cocaine & methamphetamine: blocks "re-uptake" of dopamine in the brain --ADDICTIVE
        - The brain doesn't naturally clear out dopamine, builds up in synapse, creating euphoria and alertness

Week 10 Attention and Memory

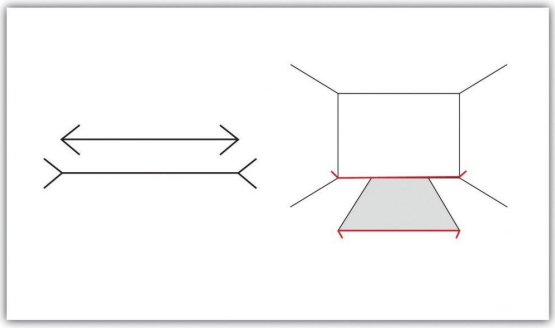
Accuracy and Inaccuracy in Perception

- We do not experience sensation, we experience the outcome of perception
    - Total package the brain puts together from pieces it receives through senses
- Sensory Interaction: working together of different senses to create experience
    - Involved w combination of taste, smell, and texture = flavor we experience in food
    - Involved when enjoying a movie due to way images and music work together
- Nausea: sensory info received from eyes and body doesn't match info from vestibular system
- Synesthesia: experience where one sensation creates experiences in another
    - Experiencing colour when tasting food or hearing sounds when certain objects are seen
- Selective Attention: ability to focus on some sensory inputs while tuning out others
    - Allows focus on single talker at party while ignoring other conversations

    - At the same time, we monitor what's happening in the channels we are not focusing on
- Sensory Adaptation: decreased sensitivity after prolonged and constant exposure
    - ability to adapt to things that don't change around us is essential to our survival
    - leaves sensory receptors free to detect the important/ informative changes in environment/ respond accordingly
    - sensory receptors= alert to novelty, fatigued after constant exposure to same stimulus
    - When staring at object, image doesn't fade because eyes are constantly adjusting to diff light angles (making thousands of tiny movements called saccades every minute)
        - This guarantees that image we are viewing always falls on fresh receptor cells
- Perceptual Constancy: ability to perceive a stimulus as constant despite changes in sensation
    - A door that has opened is still perceived as a door instead of a line
    - The visual system also corrects for colour constancy
        - Green leaf on cloudy day may reflect same wavelength of light as brown tree branch does on sunny day, but we still perceive leaf as green and branch as brown

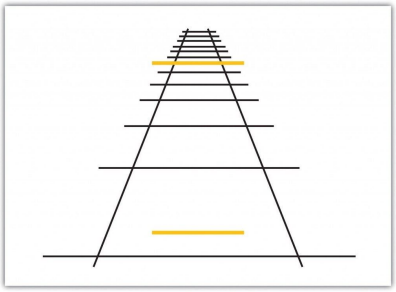
Illusions: occur when perceptual processes (normally help perceive the world)= fooled so we see something that DNE or is inaccurate

- Mueller-Lyer Illusion
    - line segment in bottom arrow looks longer than on top, though they are same length
    - Monocular Depth Cues
        - bottom line looks like edge that is normally farther away from us, whereas the top one looks like an edge that is normally closer



- The Moon Illusion: Refers that moon is perceived to be 50 % larger when near horizon than when seen overhead

    - The monocular depth cues of position and aerial perspective create the illusion that things that are lower and more hazy are farther away
- The Ponzo Illusion
    - Top yellow bar seems longer than bottom one, but in reality they are the same size
    - Monocular depth cue of linear perspective leads to believe that, given two similar objects, distant one can cast only same size retinal image as closer object if it is larger



- Humans become closely in touch w environment that physical body and environment we sense/ perceive becomes **embodied**
    - Built into/ linked w our cognition, such that world becomes part of our brain

The Important Role of Expectation in Perception:

- emotions, mindset, expectations, and contexts in which sensations occur have profound influences on perception
    - People who are warned that they are about to taste something bad, rate what they taste more negatively
    - People perceive child/adult pair as looking more alike when told that they parent/child
- perceptions influenced by desires and motivations
- When hungry, food-related words tend to grab our attention more than non-food-related words
- We perceive objects that we can reach as bigger than those that we cannot reach

Key Takeaways:

- Sensory interaction occurs when diff senses work together ie. when taste, smell, and touch together produce the flavor of food
- Selective attention allows us to focus on some sensory experiences while tuning out others
- Sensory adaptation occurs when becoming less sensitive to aspects of environment, freeing us to focus on more important changes
- Perceptual constancy allows us to perceive an object as the same, despite changes in sensation

- Cognitive illusions are examples of how our expectations can influence our perceptions
- Our emotions, motivations, desires, and even our culture can influence our perceptions

<u>Attention</u>

What is Attention?

- William James;
  - "It's the taking possession by mind, in clear form, of one out of what seem several simultaneously possible objects/trains of thought. Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others."
- Limited Capacity: idea that we have limited capacity for information processing
  - can only be consciously aware of a small amount of information at any given time
  - When watching for rare event, it is easy to allow concentration to lag
- Sustained Attention (Vigilance): Attention in the context of a type of search task
- Divided Attention
  - Allows to determine how well individuals can attend to many sources of info at once
- Spatial Attention: how focus on 1 part of environment/ how we move attention to other locations in environment
- Selective Attention: Some info is attended to while other information is intentionally blocked out
  - ability to select certain stimuli in environment to process, while ignoring distracting info
- The Cocktail Party
  - We simultaneously do a lot of unconscious monitoring of the world around us
  - Once engaged in convo w someone, become aware that can't also listen to other convo at the same time
  - However, if someone behind you mentions your name; typically notice it immediately and may start attending to that conversation

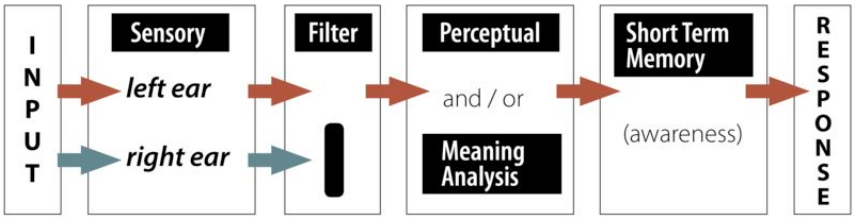
Dichotic Listening Studies:

- Dichotic listening: 2 messages presented simultaneously to individual, with 1 message per ear
  - individual asked to repeat back (shadow) one of the messages as they hear it
  - able to describe if ignored message was man/ woman's voice, but wouldn't be able to describe what message was about

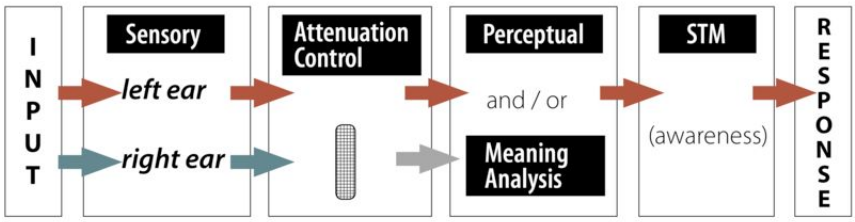
    - people weren't able to tell that language of message changed or same word was repeated 35+ times
- limited capacity for processing info for meaning, making selection process more important

Models of Selective Attention:

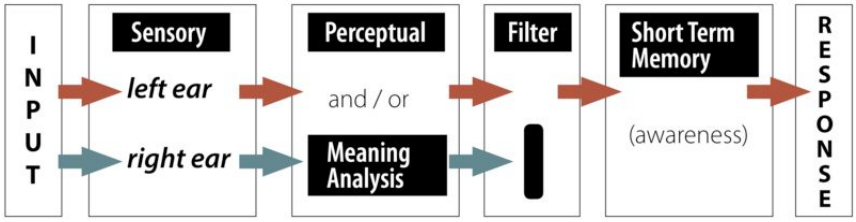
- Broadbent's Filter Model: Based on dichotic listening tasks and other experiments
    - Found that people select info on basis of physical features
        - The sensory channel (ear) that a message was coming in, the pitch of the voice, the colour or font of a visual message
    - People seemed vaguely aware of physical features of unattended info, but had no knowledge of meaning
- Result: selection occurs very early, with no additional processing for the unselected information



- Treisman's Attenuation Model
    - Carried out dichotic listening experiments where 2 diff stories presented to two ears
    - People asked to shadow the message in one ear, as stories progressed, were switched to opposite ears
    - Individuals followed the story, or the content of message, when shift occurred, then realized were shadowing wrong ear and switched back
        - suggests that we monitor unattended info to some degree
    - suggested that selection starts at the physical or perceptual level
    - unattended info is not blocked completely, is just weakened/ attenuated
    - meaningful info in unattended ear will get through further processing at level of meaning
    - If preliminary analysis shows that non-selected info= especially meaningful, then Attenuation Control will strengthen more meaningful info



- Late Selection Models: Suggests that info in unattended ear processed on basis of meaning-- CONSISTENT W IDEAS OF SUBLIMINAL PERCEPTION
    - only info that's relevant for task response gets into conscious awareness
    - don't have to be aware of or attending a message for it to be fully processed for meaning
    - Assumes that analysis of meaning occurs before selection occurs, but only the selected information becomes conscious



- Multimode Model: Addresses inconsistency between models
    - Suggests that stage at which selection occurs can change depending on the task
    - can select what to attend to at very early stage and don't process content of unattended message at all
    - The benefit: have flexibility to change how we deploy attention depending upon what we are trying to accomplish-- One of the greatest strengths of our cognitive system
- Inattentional Blindness
    - Neisser investigated same questions w visual materials by superimposing two semi-transparent video clips and asking viewers to attend to just one series of actions
    - viewers often were unaware of what went on in the other clearly visible video
- Subliminal Perception: idea that stimuli presented below the threshold for awareness can influence thoughts, feelings, or actions
    - Difficult studying this: because difficulty of establishing what threshold for consciousness is/ determining what type of threshold is important

Divided Attention and Multitasking:

- Divided attention tasks (each task is evaluated separately)

    - two participants trained to take dictation for spoken words while reading unrelated material for comprehension
    - To determine baseline performance when individual can allocate as many cognitive resources as necessary to complete one task at a time
    - performance= evaluated when two tasks are performed simultaneously
        - decrease in performance = even if attention can be divided/ switched btw tasks, cognitive demands are too great to avoid disruption of performance
    - changing the tasks,(i.e reading aloud vs silently), impaired performance initially, so multitasking ability may be specific to these well-learned tasks

Distracted Driving:

- Problem: cognitive-demands on limited capacity systems can impair driving performance
    - effect of cell phone convo on performance is just as significant when individual is having convo w hands-free device as with a handheld phone
- Studies using eye-tracking devices show: drivers less likely to recognize objects they looked at when using cell phone while driving
- Cognitive distractions (i.e cell phone convo) produce inattentional blindness/ lack of awareness

Failure of Awareness:

- able to process one stream of info at a time, effectively filtering other info from awareness
- To large extent, only perceive that which receives focus of cognitive efforts**: our attention**
- Dichotic Listening: deaf to substance of ignored speech, NOT due to limits of auditory senses
    - form of cognitive deafness, due to nature of focused, selective attention
    - selective listening task highlights power of attention to filter extraneous info from awareness while letting in only those elements of environment we wish to hear
- Inattentional Blindness :**W/o attention to unexpected event, unlikely to become aware of it**
    - Subjects view video of two distinct, but transparent/ overlapping events
        - Because events were transparent/ overlapping, both produced sensory signals on the retina regardless of which event received the participant's attention
    - When participants asked to monitor one of the events by counting the number of times actors performed an action, often **failed to notice unexpected events in the ignored video stream**

    - surprising failure to notice unexpected object/ event when attention focused elsewhere
    - more likely to notice unexpected objects that share features w attended items in display
        - However, even unique items can go unnoticed
    - crucial influence on noticing: effort you put into the attention-demanding task
        - can miss unexpected visual objects when devoting limited cognitive resources to memory task
- Inattentional Deafness
    - When listening to set of spatially localized convo via headphones, people fail to notice a specific voice
    - Under conditions of focused attention, see/ hear far less of unattended info than we expect
    - greater the demands on attention, less likely people to notice objects falling outside their attention
    - Under condition of distraction, we effectively develop tunnel vision
- 90% of people believe they would spot a chest-thumping gorilla in a video
    - ability to focus attention intently may be more evolutionarily useful than ability to notice unexpected events
    - **Steps to limit the impact of inattentional blindness;**
        - Max attention available by avoiding distractions, pay attention to what others might not notice, understand limits of attention in order to avoid them

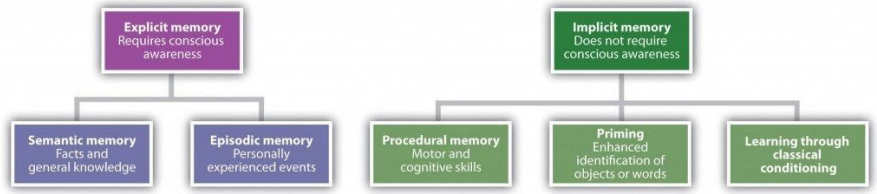
Memory

As types	Explicit memory
	mplicit memory
As stages	Sensory memory
	Short-term memory
	Long-term memory
As processes	Encoding
	Storage
	Retrieval

Explicit Memory: refers to knowledge or experiences that can be consciously remembered

- **Episodic Memory:** The firsthand experiences that we have had

    - assessed using measures where individual being tested must consciously attempt to remember the info
- **Semantic Memory:** knowledge of facts and concepts about the world



Recall Memory Test: measure of explicit memory, involves bringing from memory information that has previously been remembered

- rely on recall memory when take a test (test requires us to generate remembered info)
- Recall involves two steps; generating answer, determining whether its correct

Recognition Memory Test:measure of explicit memory, involves determining whether info learned before

- Rely on multiple choice test
- Recognition only involves one step, Determining which item from a list seems most correct
- Recall/recognition memory measures tend to be correlated
    - People who do good on one tend to do good on the other

Relearning:

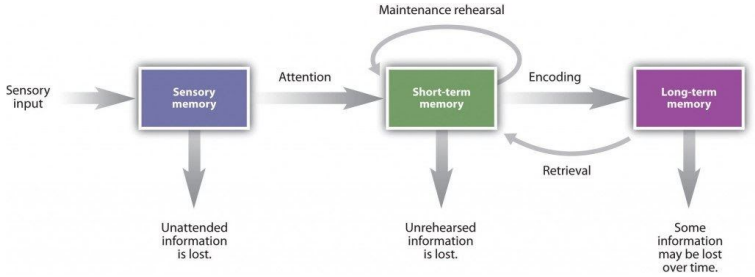
- Assess how much more quickly info is processed/learned when studied again after already been learned but then forgotten
- more sensitive measure of memory than recall or recognition because allows assessing memory in terms of "how much" or "how fast" rather than "correct" versus "incorrect"

Implicit Memory: refers to knowledge that we cannot consciously access, direct effect on our behavior

- Refers to influence of experience on behavior, even if the individual is unaware
- Procedural Memory: often unexplainable knowledge of how to do things
    - Allows to perform complex tasks, though we may not be able to explain to others how we do them (i.e ability to crawl, walk, and talk are procedures)
- Classical Conditioning Effects
    - We learn, often w/o effort/ awareness, to associate neural stimuli w another stimulus, which creates a naturally occurring response
- Priming
    - Changes in behavior as result of experiences that have happened frequently/ recently

- Refers to activation of knowledge and influence of that activation on behavior
- Word Fragment Test: One measure of the influence of priming
    - person asked to fill in missing letters to make words, sentence is read, then person asked to fill in the letters again. The new words are more related to sentence read.
    - difference in implicit memory probably occurred because as the sentence was read, specific words were primed even though they were never directly mentioned explicitly
    - Once the concept is primed, it influences our behaviors; Eg. On fragment tests

Stages of Memory:



- Sensory Memory: brief storage of sensory information
    - memory buffer lasts briefly and forgotten unless attended to/passed for more processing
    - purpose: give brain time to process incoming sensations, allow visualizations as unbroken stream of events
    - Iconic Memory: Visual sensory memory
        - have access to everything in iconic memory, and if task short enough (250 milliseconds), able to report on what they are asked to see
    - Auditory Sensory Memory (echoic memory): Can last as long as four seconds
    - Eidetic Imagery: can "see" image long after presented, can report accurately on image
        - These people often suffer from disorders such as autism
        - There is also same evidence is eidetic memories in hearing
            - Some people report that their echoic memories persist for unusually long periods of time

Short Term Memory (STM):

- place where small amounts of info temporarily kept for few seconds+ but less than a minute
- Most info that gets into sensory memory is forgotten, but info that we turn attention to w goal of remembering, may pass into STM

- Info in short-term memory is not stored permanently, becomes available for us to process
- Working Memory:processes we use to make sense of, modify, interpret and store info in STM
    - Not a store of memory like STM, but a set of memory procedures/operations
    - Central Executive: part of working memory that directs attention and processing
        - Will make use of whatever strategies seem to be best for the given task
- STM limited in length and amount of information it can hold
- way to prevent decay of info from STM is to use working memory to rehearse it
- Maintenance Rehearsal: process of repeating info mentally/ out loud
    - We engage in maintenance rehearsal to potentially transfer it to long-term memory
    - If continue to rehearse info, will stay in STM until stop rehearsing it
- Digit Span Test: Test of working memory
    - Reading rows of # at rate of 1 #/ s, and writing down after each row w/o looking
    - "seven plus or minus two" pieces of info can be held at once in short-term memory
- Chunking: memory technique that allows to expand ability to remember things in STM
    - process of organizing info into smaller groupings (chunks), thereby incr # of items that can be held in STM

Key Takeaways:

- Memory refers to ability to store/ retrieve information over time
- Explicit memory refers to experiences that can be intentionally and consciously remembered, and it is measured using recall, recognition, and relearning. Explicit memory includes episodic and semantic memories
- Measures of relearning (also known as “savings”) assess how much more quickly information is learned when it is studied again after it has already been learned but then forgotten
- Implicit memory refers to the influence of experience on behavior, even if the individual is not aware of those influences. The three types of implicit memory are procedural memory, classical conditioning, and priming
- Information processing begins in sensory memory, moves to short-term memory, and eventually moves to long-term memory

- Maintenance rehearsal and chunking are used to keep information in short-term memory
- The capacity of long-term memory is large, and there is no known limit to what we can remember

Week 11 Memory

MEMORY (ENCODING, STORAGE, RETRIEVAL)

- Memory reflects a number of different abilities
    - Holding information while working with it (working memory)
    - Remembering episodes of one's life (episodic memory)
    - General knowledge of facts of the world (semantic memory)
- Remembering episodes involves three processes:
    - Encoding information (learning, perceiving it)
    - Storing it
    - Retrieving it
    - Failures occurring at any stage leads to forgetting or to having false memories
- The key to improving memory is to improve processes of encoding and to use techniques that guarantee effective retrieval
    - Good techniques:
        - Relating new information to what one already knows
        - Forming mental images
        - Creating associations among information that needs to be remembered

VARIETIES OF MEMORY

- Short term memory / **working memory** – the ability to hold information in our minds for a brief time and work with it
- **Episodic memory** – the ability to remember the episodes of our lives
- **Semantic memory** – more or less permanent knowledge
- **Autobiographical memory** – memory for the events of one's life

THREE STAGES OF THE LEARNING/MEMORY PROCESS

- There are three necessary stages in learning and memory process:
    - **Encoding** – the initial learning of information
    - **Storage** – the maintaining of information over time
    - **Retrieval** – the ability to access information when you need it
- Any successful act of remembering requires that all three stages be intact

- Two types of **errors** that can occur
    - Forgetting
    - Misremembering
- Forgetting or misremembering can occur when the three stages are not as discrete as our description implies

ENCODING

- "real life" encoding is much more challenging
- Outside, you encounter countless sights and sounds
    - The physical and mental environments are much too rich for one to encode all the happenings around them or the internal thoughts they have in response to them
- An important principle of encoding is that **it is selective**: we attend to some events in our environment and we ignore others
- Second principle is that **it is prolific**: we are always encoding the events of our lives
- **Distinctiveness** – having an event stand out as quite different from a background of similar events – as a key to remembering events
- When memories are tinged with strong emotional content, they often seem to leave a permanent mark on us
- **Flashbulb memory** – describes a sort of vivid memory of finding out an important piece of news – highly detailed and vivid memory of an emotionally significant event
- The process of encoding is selective, and in complex situations, relatively few of many possible details are noticed and encoded
- Encoding always involves **recording** – taking the information from the form it is delivered to us and then converting it in a way that we can make sense of it
- Recoding strategies that can be used during study to improve retention
    - As we study, we should think of the meaning of the vents, and we should try to relate new events to information we already know
        - Helps us form associations we can use to retrieve information later
    - Imaging events also makes them more memorable
        - Creating vivid images out of information can greatly improve later recall
- Recoding can add information that was not even seen or heard during the initial encoding phase
    - Several of the recoding processes, like forming associations between memories, can happen without our awareness

        - One reason people can sometimes remember events that did not actually happen – during recording, details got added; false memories
- Sometimes humans make false memories from inferences
- **Pragmatic inferences** – there is usually one particular inference you're likely to make
- **Logical inference**
- Encoding is essential in the learning and memory process
    - Unless an event is encoded in some fashion, it will not be successfully remembered later

STORAGE

- We encode each of our experiences within the structures of the nervous system, making new impressions in the process – and each of those impressions involves changes in the brain
- Experiences leave **memory traces (engrams)**– indicates the change in the nervous system representing an event
    - Memories have to be stored somewhere in the brain, in order to do so, the brain biochemically alters itself and its neural tissue
- Basic idea that events create engrams through a process of **consolidation** – the neural changes that occur after learning to create the memory trace of an experience
- We shouldn't take engrams too literally; they aren't perfect packets of information that lie dormant, waiting to be called
    - Rather, when we remember past events, we reconstruct them with the aid of our memory traces – but also with our current belief of what happened
- The time between learning and testing is called the **retention interval**
    - Memories can consolidate during this time, aiding retention
- **Retroactive interference** – the phenomenon whereby events that occur after some particular event of interest will usually cause forgetting of the original event
    - Refers to new activities during the retention interval that interfere with retrieving the specific, older memory
    - One of the main causes of forgetting
- The **misinformation effect** – when erroneous information occurring after an event is remembered as having been part of the original event
- Interference may arise between the occurrence of an event and the attempt to recall it, the *effect itself is always expressed when we retrieve memories*

RETRIEVAL

- The key process in memory is retrieval
- If information were encoded and stored but could not be retrieved, it would be useless
- *Available* information is the information that is stored in memory – but how much and what types stored cannot be known
- All we can know is what information we can retrieve – *accessible* information
    - Accessible information represents only a tiny slice of the information available in our brains
- General principle underlying the effectiveness of retrieval cues is the **encoding specificity principle** – when people encode information, they do so in specific ways
    - Principle states that, to the extent a retrieval cue matches or overlaps the memory trace of an experience, it will be effective in evoking the memory
- For cues to work, they can't match too many other experiences
- **Cue overload principle** – states that the more memories that are associated to a particular retrieval cue, the less effective the cue will be in prompting retrieval of any one memory
    - for a retrieval cue to be effective, a match must exist between the cue and the desired target memory; to produce the best retrieval, the cue-target relationship should be distinctive
- the **recognition failure of recallable words** – highlights the point that a cue will be most effective depending on how the information has been encoded
    - cues that work best to evoke retrieval are those that recreate the event or name to be remembered
- Whenever we think about the past, we engage in retrieval
- Retrieval of distant memories is reconstructive
    - We weave the bits and pieces of events in with assumptions and preferences to form a coherent story

PUTTING IT ALL TOGETHER: IMPROVING YOUR MEMORY

- To improve learning and memory, we need to encode information in conjunction with excellent cues that will bring back the remembered events when we need them
- To maximize retrieval, we should construct *meaningful* cues that remind us of the original experience, and those cues should be *distinctive* and *not associated with other memories*
    - These two conditions are critical in maximizing cue effectiveness

- **Mnemonic devices** – strategy for remembering large amounts of information, usually involving imaging events occurring on a journey or with some other set of memorized cues
- **Peg word method** – set of peg words on which you could "hang" memories

FORGETTING AND AMNESIA

CAUSES OF FORGETTING

1. Encoding failures
2. Decay
3. Inadequate retrieval cues
4. Interference
5. Trying not to remember

- One very common reason as to why you cannot remember information is because you may not have learnt it in the first place
- It you fail to encode information; you will not remember it later on
    - Encoding fails if we are distracted or not paying attention to specific detail
- Another reason is that memories fade, or decay, over time
    - As time passes, memories get harder to recall
        - Critics to this idea argue that forgetting must be due to processes other than simply the passage of time, since disuse of memory does not always guarantee forgetting
- Some memory theorists have recently proposed that recent memory traces may be graded or disrupted by new experiences
- Memory traces need to be **consolidated** (process which a memory trace is stabilized and transformed into a more durable form) in order for them to last
    - When this process is interrupted by the encoding of other experiences, the memory trace does not get fully developed and is forgotten
- Encoding failures and decay account or more permanent forms of forgetting
    - Forgetting may also occur when a memory exists yet we temporarily cannot access it
        - This type of forgetting may occur when we lack the appropriate **retrieval** cues for bringing the memory back to mind
- Retrieval failures can also occur because other memories are blocking the way of recalling the desired memory
    - This is called **interference**
        - Interference can be either **proactive**, which old memories block the learning of new memories, or **retroactive**, which new memories block the retrieval of old related memories
    - For both types, competition between memories is key

- Some memories may be forgotten because <u>we deliberately keep them out of mind</u>

ADAPTIVE FORGETTING

- The five causes of forgetting account for the day-to-day episodes of forgetting
- Adaptive forgetting can be argued, allowing us to be efficient and hold onto only the most relevant memories

AMNESIA

- Profound form of forgetting
- Most widely studied amnesic patient was known by his initials “H.M”
- H.M suffered from severe epilepsy as a kid, undergoing surgery to have both his medial temporal lobes removed to relieve his epileptic seizures
    - Medial temporal lobes encompass the hippocampus and surrounding cortical tissue
- This surgery was successful in reducing his seizures and preserving general intelligence, but it left him with a profound and permanent memory deficit
    - He was unable to learn new information until his death, an impairment called **anterograde amnesia**
        - Even not being able to remember the death of his father
    - He could keep information in working memory, but when his attention turned to something else, that information was lost for good
- His memory was restricted to **declarative memory**, conscious memory for facts and events
- He also suffered from **temporally graded retrograde amnesia**, referring to an inability to retrieve old memories that occurred before the onset of amnesia
- **Dissociative amnesia** – loss of autobiographical memories from a period in the past in the absence of brain injury or disease
    - Memory loss associated with dissociative amnesia is much less likely to be permanent than it is in organic amnesia
    - It is controversial

<u>EYEWITNESS TESTIMONY AND MEMORY BIASES (33)</u>

- Eyewitness’ memories are susceptible to a variety of errors and biases, making errors in remembering specific details and can even remember whole events that did not happen

WHY IS EYEWITNESS TESTIMONY AN IMPORTANT AREA OF PSYCHOLOGICAL RESEARCH?

- There is evidence suggesting that eyewitness testimony is probably the most persuasive form of evidence presented in court, but its accuracy is dubious
- Can send innocent people to jail, even death

MISINFORMATION

- **Misinformation effect** – when erroneous information occurring after an event is remembered as having been part of the original event
    - The misinformation that subjects were exposed to after the event contaminates subjects' memories of what they witnessed
- Memory can be contaminated by erroneous information that people are exposed to after they witness an event
- Studies shown that young adults are often susceptible to misinformation, but that children and older adults can be even more susceptible
- Misinformation effects can occur easily, without intention to deceive
- Other studies show that misinformation can corrupt memory even more easily when it is encountered in social situations

IDENTIFYING PERPETRATORS

- Mock witnesses can make errors in two different ways
    - They can fail to pick the perpetrator out of a target present lineup
    - They can pick a foil in a target absent lineup
- Some factors shown to make eyewitness identification errors particularly likely
    - Poor vision
    - Stress
    - Too little time to view the perpetrator
    - Too much delay between witnessing and identification

KINDS OF MEMORY BIASES

- Memory is susceptible to a wide variety of biases and errors
- People can forget events that happened to them and people they knew, mix up details across time and place etc.
- Some memories are commonplace, not doubt experienced many of them
    - Losing keys
- Other sorts of memory biases are more complicated, lasting longer

FALSE MEMORY

- Some memory errors are so 'large' that they almost belong to their own class – **false memories**
    - Memory for an event that never actually occurred, implanted by experimental manipulation or other means
- Recent false memory studies have used a variety of different manipulations to produce false memories in substantial minorities and occasional majorities of manipulated subjects
- Using false feedback manipulation, we have been able to persuade subjects to falsely remember having a variety of childhood experiences etc.
- Once these false memories are implanted – it is extremely difficult to tell them apart from true memories

Week 12 -Language and language use

- Language *use* is a central topic of scientific investigation in psychology because it is ubiquitous (everywhere)

HOW DO WE USE LANGUAGE?

- In order for people to carry out a conversation, they must keep track of **common ground** – a set of knowledge that the speaker and listener share and they think, assume, or otherwise take for granted what they share
- Inferences are used when conversing
- New information that appears in conversation is added to the initial common ground
- Common grounds change as we talk, gathering new information that we agree on and have evidence that we share
    - Evolves as people take turns assuming the role of speaker and listening, engaging in the exchange of meaning
- Common ground helps people coordinate their language use
    - When a speaker says something to a listener, they take into account their common ground, that is, what the speaker thinks the listener knows
    - Called **audience design** – speakers construct utterances to suit the audience's knowledge
- Number of people engaging in conversation is rarely more than four
    - Coordinating conversation among four is not as difficult as with ten
- Pickering and Garrod (2004) argue that we achieve our conversational coordination by virtue of our ability to interactively align each other's actions at different levels of language use:
    - **Lexicon** (Words and expressions

    - **Syntax** (grammatical rules for arranging words and expression together)
    - Speech rate & accent
        - When a person uses a certain expression to refer to an object, others tend to use the same expression
        - When we hear people use a certain syntax structure, we are more likely to use it as well
        - People in conversation tend to exhibit similar accents and rates of speech, associated with their own social identity
- Interpersonal alignments at different levels of language use can activate similar **situation models** (a mental representation about the topic of a conversation) in the minds of those who are engaged in conversation
    - Pickering and Garrod's theory is that you describe this situations using language, other in the conversation begin to use similar words and grammar
        - **Priming** – the activation of certain thoughts or feeling that make them easier to think of and act upon
- Similar situation models begin to be built in everyone's mind through priming

WHAT DO WE TALK ABOUT?

- 60%-70% of conversation is gossip
- Gossip may sound trivial and belittle our ability for language
- Dunbar (1996) conjectured that gossiping is the human equivalent of grooming, that it is an act of socializing, signaling the importance of one's partner; by gossiping, humans can communicate and share their representations about their social world
- In doing so, they can regulate their social world – making more friends and enlarging one's own group (**ingroup** – the group to which one belongs) against other groups (**outgroups** – that are more likely to be one's 'enemies')
    - Dunbar argues that it is these social effects that have given humans an evolutionary advantage and larger brain, helping humans to think more complex and abstract to maintain larger ingroups
- Dunbar's **social brain hypothesis** – that the human brain has evolved, so that humans can maintain larger ingroups
    - Some species that have larger brains tend to live in larger groups
- Dunbar's hypothesis is controversial, regardless of its validity, our everyday language use often ends up maintaining the existing structure of intergroup relationships
- Language use can have implications for how we construe our social world
- According to Semin and Fiedler (1988) someone's actions can be described by:
    - an action verb that describes a concrete action (e.g., he runs)

    - a state verb that describes psychological state (e.g., he likes running)
    - an adjective that describes personality (e.g., he is atheletic)
    - a noun that describes the role (e.g., he is an athlete)
- Depending on if a verb or adjective (or noun) is used, speakers can convey the permanency and stability of an actor's tendency to act in a certain way
    - Verbs convey particularity
    - Adjectives convey permanency
        - People tend to describe positive actions of their ingroup members with adjectives rather than verbs, and negative actions of outgroup members using adjectives, rather than verbs
            - Called the **linguistic intergroup bias**, which can produce and reproduce the representation of intergroup relationships; painting a picture favouring the ingroup
    - Ingroup members are typically good, if they do anything bad, that's more an exception; out group members are typically bad, if they do anything good, that's more an exception
- When people exchange gossip, it can spread through broader **social networks** – networks of social relationships among individuals through which information can travel

PSYCHOLOGICAL CONSEQUENCES OF LANGUAGE USE

- Constructing a linguistic representation of another person's emotion apparently biased the speaker's memory of that person's emotion
- Linguistically labeling one's own emotional experiences appears to alter the speaker's neural processes
    - When people label negative images, the amygdala – a brain structure involved in processing of negative emotions (fear) – was activated less than when they were not given a chance to label them
- Talking or writing about negative past life events improved people's psychological well-being, jus thinking about them worsened it
- If a certain type of language use (linguistic practice) is repeated by a large number of people in a community, it can have a significant effect on their thoughts and action
    - Called the **Sapir-Whorf hypothesis** – that the language people use determines their thoughts
- Language does not completely determine our thoughts – as they are far too flexible for that – but habitual uses of language can influence our habit of thought and action

<u>THEORY OF MIND</u>

- Theory of mind consists of an array of psychological processes that play essential roles in human social life

THE ROLE OF THEORY OF MIND IN SOCIAL LIFE

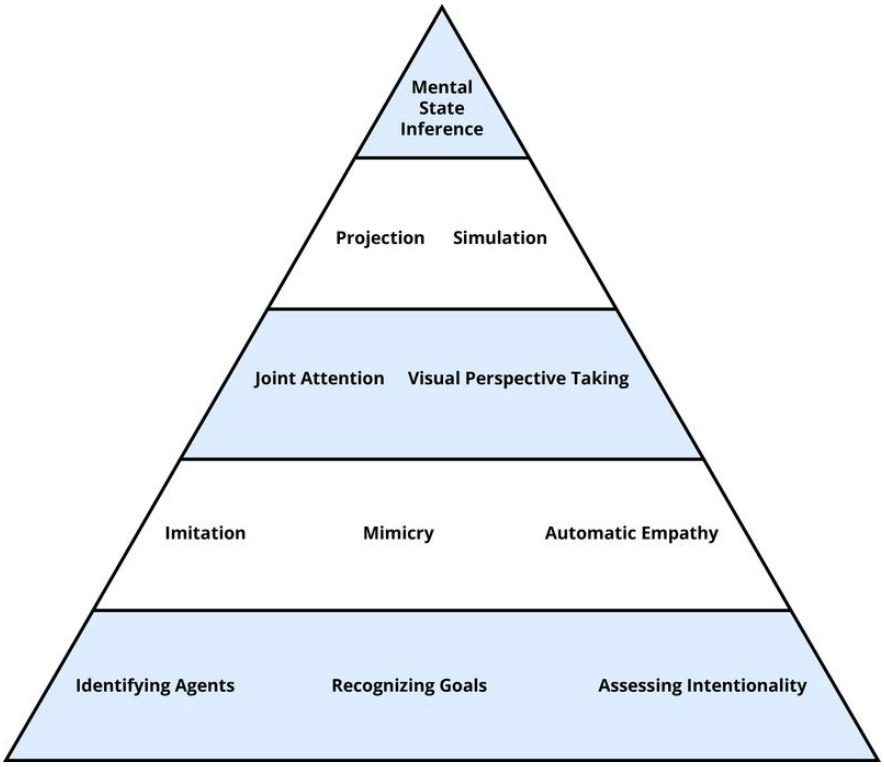
- We can interpret certain physical movements in terms of mental states
    - Without a theory of mind, you would neither understand what this (figure to the right) movement stream meant nor be able to predict either person's likely responses
- They can interpret the actions as instances of offering and trading
- Without the theory of mind, there would probably be no such things as cashiers, credit cards, and payment
    - Humans need to understand minds in order to engage in the kinds of complex interactions that social communities require

AUTISM AND THEORY OF MIND

- Another way of appreciating impact that the theory has on social interactions is to study what happens when the capacity is severely limited, as in the case of autism
- Some people with autism report that they perceive others "in a more analytical way"
- This analytical mode of processing, is very tiresome and slow "Given time I may be able to analyze someone in various ways, but may not pick up on certain aspects of an interaction"

THE MENTAL PROCESSES UNDERLYING THEORY OF MIND

- The theory of mind <u>is not a single thing</u>
    - It's a whole host of components – a toolbox, for many different but related tasks in the social world



- This figure shows some of the most important tools, organized in a way that reflects the complexity of involved processes: from simple and automatic on the bottom to complex and deliberate on the top
    - This organization reflects development, from tools that infants master within 6-12 months to tools they need to acquire over 3-5 years
- The organization also reflects evolution

Agents, Goals, and Intentionality

- The *agent* category allows humans to identify moving objects in the world that can act on their own
    - Being self-propelled, having eyes, reacting systematically to interaction
- The process of *recognizing goals* builds on the agent category, as agents are characteristically directed toward goal objects, meaning they seek out said objects
    - What it means to recognize goals, is to see the systematic and predictable relationship between an agent pursuing a particular object across various circumstances
- **Intentionality** – the quality of an agent's performing a behaviour intentionally
- Concept of *intentionality* is more sophisticated than he *goal* concept
    - Human perceivers recognize that some behaviours can be unintentional even if they were goal-directed

    - To act intentionally, you need, aside from a goal, the right kinds of beliefs about how to achieve the goal; the adult concept of intentionality requires that an agent have the *skill* to perform the intentional action in question

Imitation, Synchrony, and Empathy

- Imitation and empathy are two other basic capacities that aid the understanding of mind from childhood
- *Imitation* is the human tendency to carefully observe others' behaviours and do as they do
- a subtle form of imitation is called **mimicry** – copying others' behaviour, usually without awareness
    - When people mutually mimic one another, they can reach a state of **synchrony** – two people displaying the same behaviours or having the same internal states (because of mutual mimicry)
- People who enjoy and interaction synchronize their behaviours more, and increased synchrony makes people enjoy their interaction more
- Some research findings suggest that synchronizing is made possible by brain mechanisms that tightly link perceptual information with motor information
    - **Mirror neurons** – neurons in monkey brains that fire both when the monkey performs a certain action and when it perceives another agent performing that action
        - In humans it's more complex, people perceive uncountable behaviours and don't copy all of them
    - Human imitation is selective
- **Automatic empathy** – a social perceiver unwittingly taking on the internal state of another person, usually because of mimicking the person's expressive behaviour and thereby feeling the expressed emotion
    - It builds on imitation and synchrony in a clever way

Joint Attention, Visual Perspective Taking

- **Join attention** – two people attending to the same object and being aware that they both are attending to it
    - Such a shared engagement is critical for children to learn the meaning of objects – their value, and the words that refer to them
- **Visual perspective taking** – can refer to perceiving something from another person's spatial vantage point, or more generally to effortful mental state influence (trying to infer the other person's thoughts, desires, etc.)

    - When we overcome our egocentric perspective, we imaginatively adopt the other person's spatial viewpoint and determine how the world looks from their perspective

Projection, Simulation (and the Specter of Egocentrism)

- When imaging what it might be like to be in another person's *psychological* position, humans have to go beyond mental rotation
- One tool to understand another's thoughts or feelings is **simulation** – using one's own mental states as a mode for others'
- A simpler form of modeling is the assumption that the other thinks, feels, wants what we do – called the **"like-me" assumption** or in inclination toward ***social projection***
    - In a sense, this is an absence of perspective taking, because we assume that others' perspective equals our own, though it can be an effective strategy if we share with the other person the same environment, background, knowledge, and goals, but gets us into trouble when this presumed common ground is in reality, lacking
- It is harder to recognize our egocentrism and actively take other people's perspective – that is, grasp their actual mental states, even if they are different from our own

Explicit Mental State Inference

- The ability to truly take another person's perspective requires that we separate what we want, from what the other person is likely to want, feel etc.
- To do so, humans make use of a variety of information
    - They rely on stored knowledge – both general knowledge ("Everybody would be nervous when threatened with a gun") and agent-specific knowledge ("Joe was fearless because he was trained in karate")
    - They rely on perceived facts of the concrete situation – what is happening to the agent, the agent's facial expressions and behaviours, what the person saw or didn't see
- This capacity of integrating multiple lines of information into a mental-state inference develops steadily within the first few years of life, this process leads to a substantial body of research
    - Research began with testing whether children can pass a **false-belief test** – experimental procedure that assesses whether a perceiver recognizes that another person has a false belief – one that contradicts reality
        - The child is shown a picture story of Sally, who puts her ball in a basket and leaves the room, when Sally leaves the room, Anne

comes and takes the ball from the basket and puts it inside a box; the children are asked *where* Sally thinks the ball is located

- The right answer is that she will look in the basket, but we have to infer this *false belief* against our own better knowledge that the ball is in the box – this is difficult for kids before the age of 4
- People are good at automatically relating to other people, using their own minds as a fitting model for others', <u>but people need to recognize when to step out of their own perspective and truly represent the other person's perspective</u>

TOOLS IN SUMMARY

- People process information as motion, faces, and categorize it into concepts as agent, intentional action, or fear; rely on relatively automatic psychological processes, such as imitation, joint attention, and projection; rely on more effortful processes, such as simulation and mental-state inference
- These processes link behaviour that humans observe to mental states that humans infer – theory of mind *and* behaviour

FOLK EXPLANATIONS OF BEHAVIOUR

- People have a strong need to answer such "why" questions, from trivial to significant; justifying people's explanations of behaviour
- We have an insatiable desire to *understand,* to find *meaning* in people's behaviour
- Older theories of how people explain and understand behaviour suggest that people merely identify causes of the behaviour – which is true for most unintentional behaviours
    - But to explain *intentional* behaviours, people use a more sophisticated framework of interpretation, which follows directly from their concept of intentionality and the associated mental states they infer
- For an agent to perform a behaviour intentionally, they must:
    - Have a desire for an outcome
    - Beliefs about how a particular action leads to the outcome
    - An intention to perform that action
- To explain *why* the agent performed the action, humans try to make the inverse inference of *what desires* and *beliefs* the agent had that led her to so act
- By relying on a theory of mind, explanations of behaviour make meaningful what would otherwise be inexplicable motion