

Chapter 1- Thinking Critically With Psychology

The Need for Psychological Science

- Psychology is the scientific study of how we feel, think and behave
- Our thinking and attitudes operate on 2 levels- conscious and unconscious

Limits of Intuition

- Intuition can't be used to study the natural world as it is very misleading
- We need science

Limits of Common Sense

- Common sense does not generate new knowledge
 - Is the result of experience and acquired knowledge?
- Sometimes what we call common sense makes no sense
- More easily describes what *has* happened, rather than what *will* happen
- Three factors illustrate why we can't rely solely on intuition and common sense
 - Hindsight bias
 - Overconfidence
 - Our tendency to perceive patterns in random events

Hindsight Bias

- The 'I knew it all along' phenomenon
- Once we know all the facts about something and how that something ended, we have the tendency to believe that we could have easily predicted the end
- When we don't know all the facts and conclusion, it isn't easy to predict
- Good ideas are like good inventions: once created, they seem obvious

Overconfidence

- Is the tendency to over exaggerate how accurate our beliefs, judgements and knowledge are
- We are more confident than we are accurate
- We are ignorant of our ignorance
- Think we know more than we do

Illusory Correlation

- It is our tendency to perceive a relationship between two variables when in reality, there is none or it is barely there
- This affects how we think, remember, pay attention, behave and react

Perceiving Order When There is None

- Humans are uncomfortable with randomness and uncertainty
- To deal with this, we look for patterns and order where there are none to calm our anxiety
- Curious fact of life- *random sequences often don't look random*
- In reality, random sequences occur more often than expected
- An event that happens to 1 in 1 billion people occurs 7 times a day, 2500 times a year

The Scientific Attitude

- Three main attitudes- curiosity, scepticism, and humility- make modern science possible
- To be a critical thinker, one must possess
 - **Curiosity**
 - Asks *does it work? Can the predictions be confirmed?*
 - **Open-mindedness**
 - **Scepticism**
 - Don't accept things at face value, use logic and evidence
 - Asks *what do you mean? How do you know?*
 - Sceptical testing can reveal which ideas best match the facts
 - **Awareness of....**
 - **Humility**
 - Accept that they are not the only smart ones
 - No matter how smart, we will fail
 - Science is not about power, ego or prestige
 - *"The rat is always right"*
 - **Cautiousness**
 - What we know today could change tomorrow

Critical Thinking

- Aka smart thinking
- Examines assumptions, appraises the source, discerns hidden values, evaluates evidence and assesses conclusions
- Helps clear coloured lenses of our biases
- Critical thinkers recognize multiple perspectives and expose themselves to sources that challenge their preconceived ideas

The Scientific Method

The Scientific Method

- What makes a field of research a science, is the method used to do research
- Any field that uses the scientific method (SM) is a science

- The SM is a standardized procedure that allows us to do research in a logical, rational and objective way
- **Observation**
 - Everything begins with observation
 - What starts as casual observation becomes systemic
- **Theory**
 - Helps us organize and summarize observations in a coherent way
 - It **attempts** to explain observations
 - By summarizing facts, a theory simplifies
 - By linking facts with deeper principles, a theory offers a useful summary
- **Hypothesis Testing**
 - Extract idea from theory and test it using rigorous scientific methodology
- **Operational**
 - To check biases, psychologists report their research with precise **operational definitions**
 - **Definition-** the line of scientific rules that must be followed when testifying hypothesis
 - The researcher must clearly state how he measured his variables
- **Replication**
 - We must repeat studies
 - When we repeat and obtain similar results, we become confident in the results
- **Generate or refine**
 - We use results to generate new theories and questions or refine existing theories and questions
- Then the process begins all over again

Types of Research Studies

- There are 3 main types of research studies
 - Descriptive, correlational and experimental research

Descriptive Research

- To observe and describe what we observed
- **Case study**
 - An in-depth investigation of an individual or a very small group of people
 - The researcher will gather any relevant information related to the case
 - *Advantages*
 - Most in-depth research that can be done
 - Sometimes an excellent first step for something complex and rare
 - Allows us to preserve and document information about rare cases that otherwise would be lost

- Allows us to have a glimpse into human nature
 - *Disadvantages*
 - The sample is too small- can't generalize
 - Researcher bias- could filter data through own expectations and beliefs
- **Survey**
 - Can be descriptive or correlational
 - Asks people to report their behaviours or opinions
 - The researcher will ask a large sample of people questions that are of interest to him/her
 - We can't survey every single person in a population which is why we extract a sample and survey them. The results are then generalized to the rest of the population
 - *Advantages*
 - Very easy to do
 - Cheap
 - Can reach a large number of people
 - Include people who aren't usually included
 - Sometimes the only way to find something is to ask
 - *Disadvantages*
 - People lie intentionally and unintentionally
 - Very sensitive to word choice
 - If you change the words, you change the results
 - Very sensitive to characteristics of the person doing the survey

Representative Sample

- In order for results to be scientifically viable, we must use a representative sample
- Characteristics of the sample must closely match the characteristics of the population
- How to get a representative sample
 - **Random sampling**
 - Chance and only chance will determine who will be part of the sample
 - Everyone in the population has an equal chance of being included
- Large representative samples are better than small ones, but a small representative sample of 100 is better than an unrepresented sample of 500
 - Cannot compensate for an unrepresented sample by adding more people

Naturalistic Observation

- The researcher will leave the lab and go into the real world to do research there
- Does not explain behaviour, but instead *describes* it
- **#1 rule-** researcher must **never** interfere, only observe

- Is called a *small science*- science that can be done with pen and paper rather than fancy equipment or a big budget
 - New technologies (eg social media, facebook) are allowing researchers to track volunteers and their habits without interfering
- *Advantages*
 - Doesn't get more real than this- real world, real behaviour, real-time
 - Allows us to discover things we may never discover in a lab
- *Disadvantages*
 - Researcher bias
 - Even though the researcher doesn't interfere, the mere presence could change behaviour

Correlational Research

- Allows us to observe, describe and **make predictions**
- Allows us to find out if there is a systematic and reliable relationship between two variables
- We ask three major questions when doing this type of research;
 - Do the variables covary (have a relationship)?
 - In what direction do they covary?
 - **Positive correlation**- there is a relationship between variables. When one changes, the other changes in the **same** direction.
 - **Negative correlation**- there is a relationship, but the variables change in **opposite** directions.
 - How strong or weak is the relationship?
 - In order to find out, we use a statistic called a **correlation coefficient (r)**
 - Helps us see the world more clearly by revealing to what extent two things relate
 - r gives us the answer to all three questions
 - Value of r varies from -1 to +1
 - $r = 0$ means there is no relationship
 - $r = +1$ means perfect correlation (every time one variable changes, the other changes too)
 - $r = -1$ means negative correlation
 - The closer r is to 0, the weaker the relationship
 - The closer r is to +1, the stronger the relationship
- **Scatterplots** can be very revealing when asking how strongly two variables are related
- *Advantages*
 - Excellent first step
 - Can be done before conducting an experiment to see if any relationship is present

- Sometimes is the only research we can do to get information as it is sometimes unethical to do otherwise
- Describes, observes and predicts
 - Having information about only one correlated variable will allow us to predict information about the other variable
- *Disadvantages*
 - **With correlations, you absolutely cannot infer causality**
 - Can't say that variable A caused a definite change in variable B, only that there is a relationship between the two

Regression Towards the Mean

- The illusion that uncontrollable events correlate with our actions is feb by a statistical phenomenon called **regression towards the mean**
- Average results are more typical than extreme results, thus after an unusual event, things tend to return towards their normal average
 - Extraordinary things happening tend to be followed by more ordinary ones
- When fluctuating behaviour returns to normal, there is no need to invent fancy explanations as to why it does so
 - Regression towards the mean is probably at work

Experimental Research

- Observe , describe, predict and **infer causality**
- Cause and effect relationship
 - Is the only research that allows us to say that variable A is related to variable B
- Why can we infer causality?
 - The researcher is going to manipulate the variable of interest
 - Researcher will control all other variables that could affect results whether they are known or unknown
- **Independent variable (IV):** a variable that influences, effects and changes another variable
 - Is the variable the researcher will control
- **Dependant variable (DV):** the variable that is being changed by the IV
 - Is the variable that the researcher will measure
- An experiment's purpose is not to recreate the exact behaviours of everyday life, but to test *theoretical principles*

Manipulate the Independent Variable

- In the experiment, the researcher will manipulate the IV he is interested in studying
- Researcher will create at least 2 levels/groups of the IV
 - **Experimental group-** subjects are exposed to IV
 - **Controlled group-** subjects are not exposed to IV

- At the end of study, the results of both groups will be compared to see if exposure to IV changed the DV

Control All Other Independent Variables

- The researcher will control all other IV's that could affect the DV and the results
 - These are IV's that are of no interest, but could affect the study
 - Can be known or unknown
- Why must IV's be controlled?
 - Must be done or else researcher will not be sure what caused the manipulation of the DV
- If those IV's are not controlled, they become **confounding variables** that confuse the results
 - Won't know what caused what
- Must control for unknown IV's by doing **random assignment**
 - Chance and only chance will determine which participant is going to be in the experimental group and which will be in the controlled group
 - Every participant has equal chance of being in either group

Placebo Effect

- When doing research to test the effectiveness of a drug or treatment, we must control for the placebo effect
 - **Placebo-** a fake treatment that has no therapeutic value whatsoever
 - **Placebo effect-** when we give a placebo to a participant unknowing to them and they believe that they are getting the actual treatment
 - They may get better due to this belief alone
 - Is scientifically proven
- If the results of the placebo and the actual drug are identical, it means that the drug has no effect

Blind Procedures

- Is another way to control experiment
- We keep subjects in the dark as to the main reason of the study
 - This is done to control **subject bias** because if they know what you are doing, it may affect the results

Double Blind Procedures

- Keep both subject and researcher interacting with them blind
- This controls both subject and researcher bias

Summary of Important Points

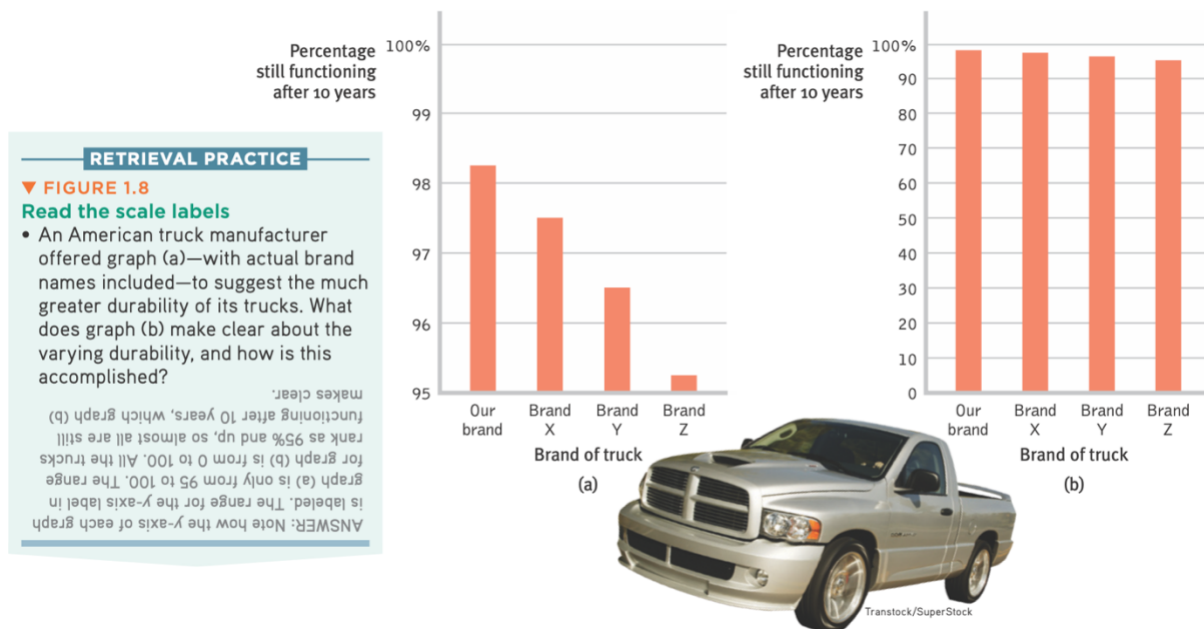
- Experiments aim to manipulate an IV, measure a DV, and control confounding variables
- An experiment has at least two different conditions (groups): an experimental group and a controlled group
- An experiment tests the effects of at least one IV on at least one DV
- Random assignment is used to control for unknown IV's

Statistical Reasoning

- Statistics are mathematical tools that help researchers describe data and make inferences from it
- Must be used in research
- There are two different types of statistics

Descriptive Statistics

- Allow researchers to organize, summarize and describe in an understandable way
- Examples: percentages, histograms, bar graphs, etc.
 - It is easy to make a graph to make the difference look big
 - The secret lies in the vertical axis (y-axis)
 - When viewing graphs, read the scale labels and note their range



Measures of Central Tendency

- Are descriptive stats that allow researcher to have an idea about the *typical* score in a distribution of scores
- Is a single score that represents a whole set of scores
- Neatly summarize data
- There are three measures of central tendency

- **The Mean**
 - Is the mathematical average
 - Takes into consideration every single score in a distribution of scores
 - *Con-* is sensitive to extreme scores in a distribution of scores
 - Such scores will artificially inflate or deflate the average, thus distorting it
 - Researchers usually remove them from data
- **The Median**
 - Aka. the 50th percentile
 - If we were to average a distribution of scores from highest to lowest or vice versa, the median would be the score that falls in the middle of the distribution
 - 50% will fall above the median and 50% will fall below it
 - *Pro-* Not affected by extreme scores
 - *Con-* is only one number is missing a lot of information
- **The Mode**
 - The most frequently occurring score in a distribution of scores
 - *Con-* most frequently occurring does not necessarily mean the most typical

Measures of Variability

- Scores in a distribution of scores will differ
- Measures of variability allow researchers to have an idea about the typical difference between the scores
- **The Range**
 - Take the highest and lowest score and subtract them from each other
 - *Con-* takes into consideration only 2 scores and misses a lot of information and could distort the typical difference
- **The Standard Deviation**
 - Much better measure of variability of the range
 - Takes into account every single score in a distribution of scores
 - Looks at difference between every score and mean and gives the average difference between the score and mean
 - Scores clustered around mean- standard deviation is smaller
 - Scores widespread around mean- standard deviation is larger
- **Normal Curve**
 - Large numbers of data often form a symmetrical, bell-shaped distribution
 - Most cases fall near the mean and fewer cases fall near the extreme
 - This bell shaped curve is so typical that it is called the normal curve

B- Inferential Statistics

- Allow researchers to make inferences from data
- Allow researchers to *generalize from sample to population*
- Allow researchers to determine if the results are statistically significant or not
 - Means that they are not likely to be due to chance, rather they are likely to reflect real relationships/differences between variables
 - Results are considered to be statistically significant when the probability that they are due to chance is very small
- **P-Value (On Exam)**
 - Is a statistic that will inform about the probability of results being due to chance
 - Ranges between 0 and 1
 - P value = 0.05 or less means that the results are statistically significant
 - Otherwise they are statistically insignificant

When Is An Observed Difference Reliable?

- When deciding when to generalize from a sample, three principles should be considered:
 - Representative samples are better than biased samples
 - Less-variable observations are more reliable than those that are more variable
 - More cases are better than fewer
- Generalization based on few unrepresentative cases are unreliable

Statistical Significance Summary

- When sample averages are reliable and when the difference between them is relatively large, we say that the difference has statistical significance
 - This means that the observed difference is probably not due to chance variation between the samples
- Statistical significance indicates the likelihood that a result will happen by chance
 - However, this does not say anything about the importance of the result

Psychology's Research Ethics

Studying and Protecting Animals

- Psychologists study animals to understand how different species function and also to learn about humans
- Animals and humans are very genetically similar and so animal experiments have led to treatments for many human diseases
- There are two issues that emerge regarding the use of animals for experimentation:
 - Is it right to place the well being of humans above that of animals?
 - If we give human life first priority, what safeguards should protect the wellbeing of animals?

- Many ethics committees have guidelines to be followed when using animals for experimentation
 - British Psychological Society (BPS)
 - Animals must be housed in reasonably natural living conditions, with companions for social animals
 - American Psychological Association (APA)
 - Researchers must ensure the comfort, health and humane treatment of animals and minimize infection, illness and pain
- Animals themselves have benefitted from animal research

Studying and Protecting Humans

- Occasionally, researchers stress or deceive people, but only when it is believed essential to a justifiable end
- Some experiments won't work if participants know everything beforehand
- The ethics codes of the APA and BPS dictate researchers to:
 - Obtain a participant's **informed consent** before the experiment
 - Protect them from harm and discomfort
 - Fully **debrief** people (explain the research afterwards)

Values in Research

- Psychology is not value free
- Researchers' values influence their choice of topics
- Knowledge, like all power, can be used for good or evil
- Although psychology does have the power to deceive, its purpose is to enlighten

Chapter 2-The Biology of The Mind

Function and Structure of The Nervous System

- The nervous system (NS) consists of two divisions:
 - **Central Nervous System**- brain + spinal cord
 - **Peripheral Nervous System**- all the nerves in the body that are outside the CNS
- Our NS is a communication network
 - **Receives** information from environment
 - **Organizes** and integrates the information
 - **Uses** the information in order to send out messages
- Is responsible for the **conscious** experience
 - Awareness of self and environment

Neurons

- Are the basic units of communication in the NS
- Main job is to receive and transmit information
- Cluster into work groups called **neural networks**
 - Each layer's cells connect with cells in the neural network's next layer
- Three major types of neurons:
 - **Sensory neurons**
 - Receive information from the environment and transmit to the CNS
 - Are *afferent*
 - Send information to interneurons
 - **Interneurons**
 - Only found in CNS
 - Communicate with other neurons
 - Organize and integrate information
 - Issue orders to other neurons
 - **Motor neurons**
 - Receive information from CNS and transmit it to muscles
 - Are *efferent*

Basic Structure of Neurons

- **Soma (cell body)**
 - Find DNA here
 - Manufactures everything the neuron needs to function
- **Dendrites**
 - Receive information from other neurons and conduct it towards the cell body
- **Axon**
 - Thin, tube-like structures
 - When a neuron decides to communicate with another neuron, it fires, produces electrical impulse also known as action potential
 - Carries action potential away from cell body all the way to the **terminal buttons** (axon terminal)
 - Terminal buttons release chemicals called **neurotransmitters**
- **Terminal buttons**
 - Found at the end of axon branches
- **Myelin Sheath**
 - Some axons are covered with myelin sheath
 - Is a white, fatty substance
 - **Insulates** axon and **speeds up** transmission
 - Healthy myelin is essential for healthy functioning
 - Synthesized until the age of 25

- **Synapse**
 - Place where neurons communicate
- **Synaptic Cleft/Gap**
 - Tiny space between two neurons at the synapse
- **Presynaptic Neuron**
 - Is the neuron that sends **out** messages
- **Post-synaptic Neuron**
 - Is the neuron that **receives** the message

Glial Cells or Glia

- Are present in the cerebral cortex
- Outnumber neurons
- Researchers thought that glial cells were the **nannies** of neurons
 - Provide neurons with nutrients, structural support, clean up after neuron and disposes of neuron after it dies
 - Also produce myelin sheath
- Today, researchers believe that they are more than just nannies
 - Involved in information processing, learning, memory, creativity and intelligence
- Play a vital role in the brain
- In complex animal brains, the proportion of neurons to glia increases

Communication of Neurons

- When a neuron decides to communicate, it fires
 - Produces an electrical impulse/action potential
- Action potential travels all the way down the axon and then releases neurotransmitters
 - Neurotransmitters relay messages to post-synaptic neurons
- Is an **electrochemical** process

Within a Neuron

- Our brains are 80% water
 - Contains dissolved chemicals such as:
 - Na⁺ ions
 - Cl⁻ ions
 - K⁺ ions
- These ions are found both inside and outside a neural cell in different concentrations
 - Concentration will change depending on what is happening with the neuron
- **Neuron at rest:**
 - More negative ions inside the neurons (negatively charged)
 - More positive ions outside the neuron (positively charged)
 - When at rest, the electrochemical charge is **-70 mV** inside the neuron

- In this case, the membrane is **polarized**
 - Even at rest, the neuron receives messages
 - Two types of messages:
 - **Inhibitory**
 - Instruct neuron not to fire
 - These messages cause the inside to become more negative (**hyperpolarized**)
 - **Excitatory**
 - Messages that instruct neurons to fire
 - Gates in the axon open and Na⁺ ions flood in
 - Cause inside to become less negative and the membrane is therefore **depolarized**
- A neuron fires when the inside is about **-50/-55 mv**
 - This is known as the **threshold of excitation**
 - If excitatory signals exceed the threshold, an action potential fires
- **Refractory period:** a resting pause after an AP where the neuron pumps the Na⁺ ions back outside

Action Potential

- Is an **all or nothing** phenomenon
 - No such thing as partial action potentials
- Everytime a neuron fires, it is the same strength from beginning to end
- Action potential travels down the axon in a domino like effect
 - Doesn't travel like an arrow

Between Neurons

- Presynaptic neuron fires, action potential travels down to the terminal buttons
- In terminal buttons, there are **synaptic vesicles** (little bags containing neurotransmitters)
- Synaptic vesicles attach to membrane, then burst open releasing neurotransmitters into synaptic gap
 - Cross gap and attach to receptor site in postsynaptic neuron
 - The neurotransmitter unlocks the channels on the postsynaptic neuron and charged ions flow in, either exciting or inhibiting the neuron

Deactivating Neurotransmitters

- After delivering its message, neurotransmitter must be deactivated
- Two ways this can occur
 - **Reuptake**
 - Reabsorbed into neuron and recycled
 - **Degradation**

- Enzyme will break down neurotransmitter
- Neurotransmitter must be deactivated or else it will deliver message over and over again
 - This will either overexcite or overinhibit the NS

Neurotransmitters

- Are chemicals that neurons use to deliver messages
- Health levels of neurotransmitters are essential for health mental and physical health
- Problem is there is an imbalance
- **Dopamine**
 - Major neurotransmitter
 - Influences movement, learning, attention and emotion
 - Imbalanced
 - Schizophrenia (high levels), (low levels) depression, low motivation, parkinsons, no pleasure
- **Acetylcholine (ACh)**
 - Enables muscle action, learning and memory
 - Is the messenger at every junction between **motor** neurons and skeletal **muscles**
 - When ACh is released into muscle receptor cells, the muscle contracts
 - If it is blocked, paralysis occurs
 - Alzheimer's disease- ACh producing neurons deteriorate
- **Serotonin**
 - Affects mood, hunger, sleep and arousal
 - Undersupply = depression
- **Norepinephrine**
 - Controls alertness and arousal
 - Undersupply can depress mood
- **GABA**
 - Gamma-aminobutyric acid
 - Major inhibitory neurotransmitter
 - Undersupply is linked to seizures, tremors and insomnia
- **Glutamate**
 - Major excitatory neurotransmitter
 - Involved in memory
 - Oversupply can overstimulate brain producing migraines or seizures

- Enhances, facilitates and increases the activity of NT
- **Antagonists**
 - Will weaken, diminish and block the activity of NT

The Brain

- Is 2% of body weight
- Consumes 20-25% of glucose in the body
- Brain is the fattest part of the body- 60% fat
- (above will not be on the test)

Tools of Discovery

- **Clinical Observation**
 - The oldest method and at one time, the only method
 - Still used today
 - Systematically observe people who have brain problems and will systematically describe and document what is observed
- **Brain Manipulation**
 - Researcher will intentionally interfere with the functioning of the brain
 - Will then systematically observe, document and describe the results of this manipulation
 - Ways to manipulate the brain:
 - Surgically
 - Chemically
 - Electrically
 - Magnetic field
 - Optogenetics
 - Sonogenetics
- **EEG**
 - Allows us to see the brain in action
 - Not invasive, safe
 - Put electrodes on scalp which will then pick up electrical activity of neurons
 - Will pick up brain waves

Neuroimaging Techniques

Name	Description
CT or CAT Scans	<ul style="list-style-type: none"> ● Uses x-ray technology to take multiple images of the brain at different angles ● Does not allow the viewing of brain function ● Can see anatomy and structure

MRI	<ul style="list-style-type: none"> ● Doesn't allow viewing of brain function ● Can see anatomy and structure ● Exposed to powerful magnetic field which causes tissue to release electromagnetic signals ● Machine uses these signals to create detailed images of the brain
PET Scan	<ul style="list-style-type: none"> ● The brain consumes glucose for energy <ul style="list-style-type: none"> ○ The more active an area of the brain is, the more glucose it will consume ● Injected with radioactive glucose and the machine tracks it ● The more active areas will show up in red and less active areas in blue ● Allow us to see brain function
fMRI	<ul style="list-style-type: none"> ● Shows brain function ● Non invasive, believed to be safe ● Exposed to powerful magnetic field and machine tracks blood flow to the brain ● More active areas will have more blood flow ● Produces colourful images

Lower Brain Structures

- **The Brainstem**
 - Oldest and innermost region
 - Starts where the spinal cord ends
 - Is a **relay** station
 - All information coming to or from the brain must go through it
 - Is believed that the analysis of information begins here
 - Is a **crossover** point
 - Information coming from the right side of the body crosses to the left side of the brain when it reaches the brain stem (and vice versa)
 - Considered to be the life center of the brain
 - Contains structures that control vital functions of the body
 - **Medulla**
 - Controls heartbeat, breathing, swallowing, vomiting, etc.
 - Will die if it is damaged
 - **Pons**
 - Sits right above the medulla
 - Helps coordinate movement and regulate sleep
 - **Reticular Formation (RF)**

- Located between ears
 - Associated with arousal, wakefulness, sleep
 - Filters incoming stimuli
 - Some cases of coma can be caused by damage to the RF
- **Thalamus**
 - Sits on top of the brain stem
 - Is the brain's sensory control centre
 - Is also a **relay** station
 - All information collected by senses (except smell) goes to the thalamus which conveys it to different brain areas
 - All information from higher brain areas goes to the thalamus which relays it to lower brain areas
 - Filters information, highlighting what is important
 - Regulates motivation, arousal and attention
- **Cerebellum**
 - Known as the little brain
 - Controls muscle tone, posture, balance, voluntary movements
 - Associated with learning and motor skills that become automatic (eg: writing)
 - Is **1/10th** of brain volume
 - Over half of the brain's neurons are located here
 - These neurons have 20x more connections than neurons in other parts of the brain
 - Researchers believe that it is involved in higher cognitive function
 - Evidence indicated that it could be linked to learning, creativity, certain aspects of language and memory
 - When we get drunk, the cerebellum also gets drunk

Limbic System

- Consists of multiple structures and is linked to multiple functions
 - Learning, memory, emotion, motivation, etc.
 - Contains the *amygdala*, *hippocampus* and the *hypothalamus*
- **Hippocampus**
 - Processes conscious **memories**
- **Amygdala**
 - Linked with **aggression** and **emotions**
 - Experience (particularly fear), perception, formation of emotional memories and the fight or flight (stress) response
 - Can detect threatening stimuli in environment before they are consciously perceived
- **Hypothalamus**

- Sits under the thalamus
- Is known as the brain within the brain because it is so powerful
- Regulates **homeostasis** and **pleasure**
- It controls:
 - Drives (hunger, thirst, etc)
 - Maintains homeostasis
 - Pleasure centers
 - Endocrine system
 - Autonomic system
- **Reward Deficiency Syndrome**
 - Is a theory that tells us the following:
 - Some people have sluggish/underperforming pleasure pathways due to low dopamine
 - According to theory, some people will seek drugs, shopping, gambling, food, etc. to pump up pleasure pathways

Cerebral Cortex

- Is the **youngest** part of the brain
- Most **complex** part of the brain
 - Humans have the most complex cerebral cortex
- Responsible for higher mental functioning
- Is the outer layer of the brain
- Contains billions of neurons and other cells (glia)
- Contain glial cells
- 1/3 of the cortex is visible only
 - The rest is hidden in grooves and folds
 - This allows it to fit into the size of the human skull

The Two Hemispheres

- Connected via the **corpus callosum**
 - Is a bundle of nerve fibers that the 2 hemispheres use to exchange information and communicate
- **The left hemisphere**
 - Receives information from the **right** side of the body
 - Controls the right side of the body
 - Responsible for **language**
 - Makes quick and literal interpretations of language
- **The right hemisphere**
 - Receives information from the **left** side of the body
 - Controls the left side of the body
 - Excels in making inferences

- Helps modulate speech
- Helps orchestrate self awareness
- Each hemisphere consists of 4 lobes:
 - Frontal, parietal, temporal and occipital
 - Each lobe consists of 2 areas: **Primary** and **association**
 - **SEE Fig 2.23 in textbook**

Primary Areas

- Primary areas are found in each lobe
- Are linked and associated with the processing of either motor or sensory information
- The primary areas are:
 - **Visual Cortex**
 - Located in the occipital lobes
 - Processes visual information
 - **SEE Fig. 2.27 and 2.28.**
 - **Auditory Cortex**
 - Located in temporal lobes
 - Processes auditory information
 - **SEE Fig. 2.28**
 - **Somatosensory Cortex**
 - Aka. sensory cortex
 - Located in parietal lobes
 - It receives information from the skin, muscles and joints
 - Processes information pertaining to touch, pain, temperature, etc.
 - The right part of the parietal cortex receives info from the left side of the body and the left part receives information from the right side
 - The more sensitive a body part is, the larger the somatosensory cortex area it has
 - **SEE Fig. 2.24**
 - **Motor Cortex**
 - Located in frontal lobes
 - Controls voluntary movements
 - The right part of the motor cortex services the left side of the body and the left part services the right part of the body
 - **SEE Fig. 2.24**
- Each body part is represented in the parietal cortex
 - Body parts adjacent to each other (ex, hand and arm) are serviced by areas in the brain that are adjacent to each other
- The size of a body part has nothing to do with the size of the area the brain devotes to this part

- The brain devotes more tissue to sensitive areas and areas that require precise control
 - Eg: fingers have greater representation in brain than upper arm

Association Areas

-
- Found in each lobe and they are linked and associated with higher and more complex mental functioning
 - Are also involved in the processing of complex motor or sensory information
- These areas interpret, integrate and act on sensory information and link it with stored memories
- Some functions that have been linked to the association areas of the cerebral cortex are listed below;
 - **Frontal Lobes**
 - Attention, planning, abstract thinking, some aspects of memory, personality and language, impulse control, decision making and emotions
 - *Prefrontal cortex* enables judgement, planning and processing of new memories
 - Damage can alter personality and remove inhibition
 - **Temporal Lobes**
 - Some aspects of language, recognizing faces, music, some aspects of memory, god spot
 - **Parietal Lobes**
 - Nonverbal thinking, sense of space
 - **Occipital Lobes**
 - Processing of complex visual information
- Keep in mind however that the brain's lobes work in tandem (together) to produce complex human behaviours & mental processes
- Our mental experiences arise from coordinated brain activity

▼ FIGURE 2.30

A blast from the past (a) Phineas Gage's skull was kept as a medical record. Using measurements and modern neuroimaging techniques, researchers have reconstructed the probable path of the rod through Gage's brain (Van Horn et al., 2012). (b) This photo shows Gage after his accident. (The image has been reversed to show the features correctly. Early photos, including this one, were actually mirror images.)



(a)



(b)

Collection of Jack and Beverly Wilgus

Brain Reorganization

- Researchers believe that once the human brain has matured, it remains the same/unchangeable until it has a disease, injury or it ages
 - They were very wrong

Brain Plasticity

- Researchers have discovered that the human brain is plastic
 - Brain changes with experience, even the old brain
- Plasticity means an area of the brain could increase or decrease in function based on experience
 - Is the brain's ability to modify itself after damage
 - A healthy area could take over an unhealthy area
 - An area of the brain could become bigger (more synapses) or get smaller as a result of experience
- **Neurogenesis:** the ability of the brain to produce new neurons, even in old age
- Brain damage effects can be traced to two main facts:
 - Severed brain and spinal cord neurons do not regenerate
 - Some brain functions seem pre assigned to specific areas
- **Constraint induced therapy-** aims to rewire brains and improve dexterity in a brain damage victim

Functional Asymmetry

- There is functional asymmetry in the cortex
 - While the 2 hemispheres carry out similar functions, it seems that each has its own expertise
 - This does NOT mean that we have a left brain or right brain
- 2 hemispheres are working together as a team to produce complex functions, emotions, etc.
- We learn about functional asymmetry through observation, neuroimaging techniques and from split brain functions

Split Brain Functions

- Are individuals who suffered from epilepsy
- To relieve their seizures, doctors cut out their corpus callosum

Keep In Mind....

- We have a right and left visual field
 - Doesn't mean left/right eye
 - Refer to tb for further explanation

- Information that is flashed to the right visual field will go to the left hemisphere and vice versa
- In a **normal brain**, the information that is flashed to one hemisphere will be relayed to the other hemisphere
- In a **split brain** patient, information that is flashed to one hemisphere will NOT be relayed to the other hemisphere (it will not know about it)
- The **left** hemisphere controls **language** and the **right** side of the body
- The **right** hemisphere controls the **left** side of the body

The Spinal Cord (CNS)

- Is a highway for information
- All information that the body sends to the brain and back must go through the spinal cord
- Is linked and associated with **rhythmic movements**
 - Eg: walking, swimming, flying
- There are **pattern generators** in the spinal cord
 - Specialized cells controlled by the brain
 - When activated, they produce rhythmic movements
- **Spinal reflexes**
 - Reflexes are innate, unlearned behaviours
 - Controlled by spinal cord
 - A **spinal reflex pathway** consists of:
 - Single sensory neuron
 - Single motor neuron
 - Communicate through interneurons

Peripheral Nervous System (PNS)

- Connects body to CNS
- Main job is to convey information between the body and the CNS
- Consists of ALL the nerves in the body that are outside the CNS
- Has 2 main divisions:
 - **Somatic** and **automatic**

Somatic Nervous System

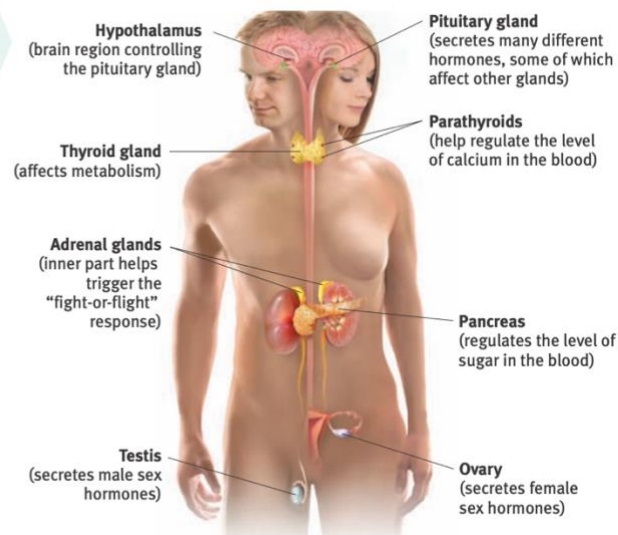
- Two main functions
 - **Sensory function**
 - Information collected by senses will be sent to the CNS via sensory neurons
 - **Motor function**
 - Motor information sent from CNS to skeletal muscles (muscles attached to bones) via motor neurons

Autonomic Nervous System

- Controls glands, organs and visceral muscles (muscles not attached to bones)
- There are 2 divisions
 - **Sympathetic nervous system**
 - Mobilizes the body's resources, energizes and arouses the body, prepares the body for fight or flight
 - Linked to the stress response
 - **Parasympathetic Nervous System**
 - Conserves the energy of the body
 - Calms, relaxes, and helps the body repair itself

The Endocrine System

▼ FIGURE 2.11
The endocrine system



- Is a major communication network
- Consists of all the glands in the body
 - These glands release hormones into the bloodstream
- Hormones are chemical messengers that carry messages to the body, including the brain
- 3 major types of hormones:
 - One type is responsible for **homeostasis**
 - **Reproductive** hormones
 - **Stress** hormones
 - Short term stress hormones are good for us

NS and Endocrine System

- Both are communication networks
- Both produce molecules that act on receptors elsewhere
- The nervous system controls the endocrine system

- However, the nervous system including the brain is still influenced by the hormones produced by the endocrine system
 - There is constant interplay between them
- Some hormones are chemically identical to neurotransmitters
- Endocrine messages take much longer than neural messages to travel through the body
 - However, endocrine messages last longer than neural messages

Pituitary Gland

- Known as the *master gland* because it controls ALL other glands in the endocrine system
 - Is controlled by the **hypothalamus**
- Releases **growth hormone** that stimulates physical development
- Also releases **oxytocin** which enables contractions, breast milk flow and orgasms
 - Also promotes pair bonding, group cohesion and social trust
- Pituitary secretions also direct other endocrine glands to release hormones

Adrenal Gland

- A pair of endocrine glands located above the kidneys
- Secrete hormones **epinephrine** and **norepinephrine**
 - Increase heart rate, blood pressure, blood sugar and provide surge of energy
 - Also responsible for fight or flight response

Other Glands

- **Parathyroid**- regulate calcium levels in the blood
- **Thyroid gland**- affects metabolism
- **Testis and ovaries**- secrete sex hormones
- **Pancreas**- regulates blood sugar levels

Affect Behaviours

- Hormones influence and affect behaviour
- Learn different hormones from main text in tb (ON EXAM)
- Split brain patient practice questions on exam too

Chapter 6- Sensation and Perception

The Musts of Sensation

- In order for us to sense, 3 things must happen:
 - Must be able to **detect** physical energy
 - No detection = no sensation
 - Humans are limited to what we can detect
 - Physical energy that has been detected must be **transduced**

- Means that it must be translated into a message that the brain can understand
 - Must be translated into an electrochemical message
- This information must be **transmitted** to the brain for further processing

Transduction

- All senses:
 - *Receive* sensory stimulation
 - *Transform* stimulation into neural impulses
 - *Deliver* the neural information to our brain
- The process of converting one form of energy into another that our brain can use is called **transduction**

Sensory Receptors

- Highly specialized receptors found in sensory organs
- They detect, transduce and transmit information
- Sensation is a **bottom up process**
 - Starts with the basic elements and then builds up

Psychophysics

- Is the scientific study of the interaction between the physical characteristics of the world and our psychological experience of them

Absolute Threshold

- It is not enough for us to be able to detect physical energy
 - The energy must be strong enough to be detected
- The absolute threshold is the **minimum** amount of energy/stimulation that must be present in order for us to detect it **50%** of the time

Difference Threshold (JND)

- It is very important to detect changes in stimulation
 - Essential for survival
- **JND**- the minimum **difference** in stimuli in order for it to be detected 50% of the time
 - The difference threshold increases with the size of the stimulus

Webster's Law (ON MIDTERM)

- This law states that for an average person to perceive a difference, two stimuli must differ by a constant minimum *percentage* (not a constant amount)
 - The exact percentage is different for every stimulus

- Thresholds vary from one person to the next and in the same person from one situation to the next

Signal Detection Theory

- Predicts when we will detect weak signals
- According to this theory, our ability to detect physical energy doesn't depend only on its strength
- There are other factors that could affect our ability to do so
 - Eg: knowledge, emotion, motivation, past experiences, being tired or not, etc.

Subliminal Persuasion (ON EXAM)

- Stimuli that cannot be detected 50% of the time are **subliminal**- below the absolute threshold
- An unnoticed image/word can reach the visual cortex and briefly **prime** your response to a later question
- **Subliminal persuasion** attempts to mask messages that we cannot consciously hear in order to unconsciously persuade us to do something
- This phenomenon is based on two assumptions:
 - We can unconsciously detect subliminal stimuli
 - Without our awareness, these stimuli have extraordinary suggestive powers
- Although subliminally presented stimuli *can* influence people, research discounts attempts at subliminal advertising and self improvement

Sensory Adaptation

- With repeated exposure to a stimulus that is unchanged and harmless, our senses reduce their response to it or ignore it completely because our nerve cells begin to fire less frequently
- Allows us to focus on changing stimuli
 - It can even influence how we perceive emotions
- Why does this happen?
 - We are bombarded with stimuli on a daily basis
 - If it is not dangerous, it is important to tune it out, otherwise our nervous system will be hyperstimulated and could crash
- Our attentional resources are very limited so we must ignore the insignificant things and focus on the more important stimuli
 - Is important for survival

Circumventing Sensory Information

- Refer to figure about eyes in textbook
- Body doesn't allow sensory adaptation to occur when experiencing intense pain

- If we tune it out or adapt, we could be in serious trouble
- The body doesn't allow the eyes to sensory adapt
 - Eyes are constantly making tiny movements that we are not aware of, otherwise stationary objects would disappear
 - This way, the stimulation on the eyes' receptors continually changes

The Basics of Perception

- Sensory information will be sent to the brain which will process, analyze, organize, integrate and interpret the information in a meaningful way
- Perception is a **top down process**
 - This means that the brain will use past experiences, existing knowledge, beliefs, values, etc in order to analyze and interpret the information
- It is possible to have sensation, but not perception
 - **Prosopagnosia**
 - Eyes can see faces, but brain can't recognize the face
 - Sensation, but no perception
- It is also possible to have perception but no sensation
 - Hallucinations: seeing fire when there is none

Perceptual Set

- Is a mental predisposition to perceive life and its events in a specific way
 - It comes from all of our experiences, culture, parenting, peers, rejection, love, etc.
 - Through experience, we come to expect certain results
 - Those expectations may give us a perceptual set, a set of mental tendencies and assumptions that affects (**top-down**) what we perceive
- This is why some people will laugh at a joke and others will find it offensive

Context Effects

- The context we are in is very important
 - It influences how we perceive life and events
- Same thing, different way of perceiving out

States of Being

- Will influence how we perceive life and its events
- If we are tired, full of energy, sick, happy or sad, motivated or not
- Emotions and motivation colour our perceptions, including social perception

II-Vision

The Stimulus

- There must be light in order for us to see
- Light is a form of **electromagnetic radiation** and it travels in the form of a wave
- Is part of the electromagnetic spectrum
 - Called visible light because we can detect it
- We can only detect light waves ranging between **400-700 nm**
- Two physical characteristics of light waves that are of interest:
 - **Wavelength**
 - Is the **distance** between the 2 peaks of a wave
 - Is a physical characteristic that will be translated into the psychological experience of colour or **hue**
 - Colour is a psychological experience created by our brains
 - **Long wave** - Red
 - **Medium wave**- Green
 - **Short wave**- Blue
 - All are 10^3 nanometers in wavelength
 - **Amplitude**
 - Is the **height** of the wave
 - Translates into psychological experience of brightness or **intensity**

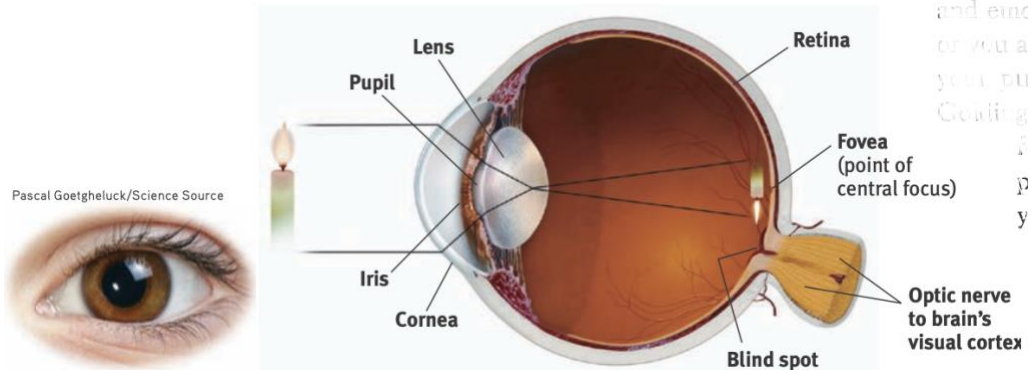
Focusing Light

- Light must enter the eye through the **cornea** which bends light to provide focus
- The light then passes through the **pupil**
- Surrounding the pupil and controlling its size is the **iris** which is a coloured muscle that dilates or constricts in response to light intensity
 - Iris also responds to cognitive and emotional states
- Behind the pupil is a **lens** that focuses incoming light rays into an image on the **retina** which is a multi-layered tissue on the eyeball's inner surface
 - The lens focuses rays by changing its curvature and thickness in a process called **accommodation**
- The retina does not see a whole image, rather its receptor cells convert light particles into neural impulses and forward them to the brain where the information is perceived

Retina- Structure

- Starting from the innermost layer:
 - **Rods** and **cones** are connected to **bipolar cells** which are connected to **ganglion cells**
 - The axons of ganglion cells will branch up to form the **optic nerve** which will carry information to the thalamus and then to the visual cortex (in occipital lobe)
- **Blind spot**
 - Is the part of the eye where the optic nerve **exits** to get to the brain

- No sensory receptors there, so when light hits this spot, nothing can be seen
- **Fovea**
 - Located at the **center** of the retina
 - Responsible for highest visual acuity



Rods and Cones

- Will detect light, transduce it and transmit information to the brain
- Known as **photoreceptors**
- Differ in many ways:
 - **Shape**
 - **Number**
 - Rods outnumber cones
 - **Function**
 - Rods are super sensitive to light (need little light to activate)
 - Used in the dark or at night
 - Allow us to see black, white and grey
 - Involved in **peripheral** vision (highly concentrated in periphery)
 - No rods in fovea
 - Cones need a lot of light to activate
 - Used during the daytime
 - Allow us to see colour and fine detail
 - Differ in location
 - Are highly concentrated in the **fovea**, less in periphery
 - **Connections to bipolar cells**
 - Cones have 1-1 connection with them
 - Rods have a several- 1 connection with them

	Rods	Cones
Number	120 million	6 million

Location in retina	Periphery	Center
Sensitivity in dim light	High	Low
Colour sensitivity	Low	High
Detail sensitivity	Low	High

Visual Information Processing

- In order of increasing complexity (least to most):
- **Retina**
 - Processing of visual information begins here
 - Ganglion cells start the processing of information
- **Visual Cortex**
 - Information reaches here after the retina
 - Has **feature detectors**
 - Highly specialized cells that respond only to very specific stimuli
 - They receive information from individual ganglion cells in the retina and pass specific information to other areas where teams of cells called *supercell clusters*, respond to more complex patterns
 - Eg: some only respond to a vertical lines, angles, etc.
- **Parietal and Temporal Lobes**
 - There **‘where’** pathways
 - Are located in the parietal lobes
 - Allows us to locate an object in space and to track its movements
 - The **‘what’** pathway
 - Located in the temporal lobes
 - Allows us to identify what is being looked at

Parallel and Spatial Processing

- We have a dual mind
 - A conscious and unconscious mind that processes information differently
- **Serial processing**
 - Done by the conscious mind
 - Information is processed one **single** step at a time
 - Step 1 must be finished before step 2 can start
- **Parallel Processing**
 - Much faster
 - Done by the unconscious mind
 - Brain will do **multiple** steps at one time

- The brain will take a job and break it down into tasks
 - Each task will be handled by a different, separate group of neurons
 - Separately, but simultaneously
 - When finished, they share the information, the brain integrates it and we perceive something coherent and meaningful
- To analyze a visual scene, the brain divides it into subdimensions (motion, depth, form, colour) and works on each aspect simultaneously

Colour Vision

- **Young-Helmholtz Theory**
 - Aka Trichromatic theory
 - People already knew that we have primary light colors
 - By combining the three colours, we can create millions of other colours
 - Red, green, blue
 - Based on this understanding, this theory proposes the following
 - There must be 3 different types of cones in the retina (Red, Blue, Green)
 - While each cone can respond to all colours, it is maximally responsive to one colour
 - Eg: red cone is maximally responsive to the colour red
 - The brain is monitoring the 3 cones to see what types are being activated, in what combination and to what degree
 - Based on this, the brain will determine colour
 - All colours fully activated= white
 - All colours minimally activated= black
- **Opponent Process Theory**
 - Developed by Hering
 - He accepted the Trichromatic theory but believed that it was not sufficient by itself
 - One of the things that it couldn't explain was complementary afterimage
 - **Afterimage**- when we continue to see an object even though we are no longer looking at it
 - **Complementary afterimage**
 - If we stare at green and then look at a white sheet of paper, we will end up seeing red
 - According to this theory, we have 4 primary light colours; red, blue, green and yellow
 - Also according to this theory, in the visual system, we have 3 antagonist visual systems
 - Red-Green, Blue-Yellow and Black-White

The following are all Gestalt rules:

Figure and Ground

- When looking at a visual scene, the brain will organize information into figure and ground
- Figure is the object that is being looked at and ground is the background
 - Figure and ground can constantly reverse
- Due to figure and ground, the same stimulus can be perceived in different ways
- Figure and ground is not a characteristic of the physical world
 - Is a psychological experience of the brain

Grouping

- **Proximity**
 - Elements in a scene that are physically close to each other will be perceived as a single unit
- **Similarity**
 - Elements that are similar to each other will be perceived as a single unit
- **Continuity**
 - Elements in a scene that seem to follow in the same direction or that continue in a pattern will be perceived as a single unit
- **Connectedness**
 - Elements in a scene that are connected to each other will be perceived as a single unit
- **Closure**
 - If an element is missing in a scene, the brain will fill in the blanks

Depth Perception

- How close or how far an object is to us
- Allows us to see the world in 3D
- Is it innate or due to experience?
 - **Visual cliff experiment** (babies 6-14 months old)
 - Depth perception is partially innate
- Experience is an absolute must for proper development of depth perception
- The brain relies on 2 major clues to determine depth
 - Binocular depth cues
 - Monocular cues

Binocular Depth Cues

- The brain will use information from both eyes to determine depth
- 2 types of binocular cues:
 - **Convergence**

- The degree to which our eyes turn inward when we look at something
- The more inward they turn, the closer an object is perceived to be
- **Retinal Disparity**
 - There is distance between our eyes
 - Because of this distance, even if we look at the same object, each eye will have a different view of it
 - The larger the retinal disparity, the closer an object is perceived to be

Monocular Cues

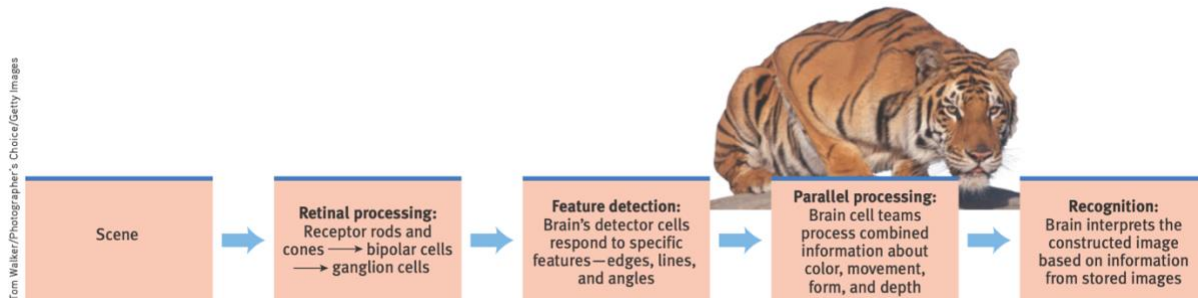
- We need information from only one eye to determine depth
- **Relative size**
 - If objects in a scene are known to be roughly the same size, then the one that appears to be larger will be perceived as closer
- **Relative Clarity**
 - The clearer and crisper an object is, the closer it is going to be perceived
- **Texture gradient**
 - The rougher a surface seems, the closer it will be perceived
- **Relative Height**
 - Objects higher in our visual field will appear to be further away than those lower in our field
- **Relative Motion (motion parallax)**
 - Perceiving depth while moving
 - When we are moving, objects that are close to us will appear to move fast and in opposite direction to us
 - Objects far away will appear to move slowly and in the same direction as us
- **Linear Perspective**
 - Two parallel lines that appear to intersect in the distance
 - They convey depth
 - Objects near the intersection will be perceived as further away
- **Light and Shadow**
 - Well lit objects will appear to be closer
 - When an object casts a shadow on another object, it will appear to be further away

Motion Perception

- When we look at an object, it will cast an image on our retina
- Researchers believe that the brain makes assumptions
 - If an image is getting larger, the brain assumes that it is moving closer to us
 - If an image on the retina is getting smaller, then the brain thinks the object is moving further away
- **Stroboscopic Movement**

- The motion we see when we watch a movie
- Nothing is actually moving on the screen
 - Movements are caused by still photographs that are being flashed really fast and the brain perceives movement
- **Phi phenomenon**
 - Adjacent lights that are turned on and off at a rapid succession which create the impression of a moving object
 - Brain creates movement due to this
 - Eg: moving christmas lights

Perceptual Constancy



- Allows us to have a coherent and stable perception of the world
- Is a **top-down** process
- It is our tendency to perceive that shape, colour and size of an object as remaining the same in spite of changes in physical stimulation, retinal images, lighting conditions, etc
- **Colour and Brightness Constancy**
 - Our experience of colour depends on the object's context
 - *Brightness constancy* also depends on context
 - The perception of constancy depends on *relative luminance*- the amount of light an object reflects relative to its surroundings
- We perceive objects, not in isolation, but in their environmental context

Relative Luminance

- Explains colour constancy and lightness constancy
- Means that when the brain is assessing how much light an object is reflecting, it does not do it in a vacuum
 - The brain will also consider how much light is reflected off other objects in the surroundings
- **Size- Distance Relation**
 - Size and distance are interconnected

- When the brain is assessing size, it takes distance into consideration and vice versa

Perceptual Adaptation in Vision

- The ability of the brain to adapt, adjust and function properly in a world that has been artificially turned upside down or artificially shifted from left to right
 - Does so without and conscious effort
 - Eg: when you get a new pair of glasses, you have to wait a few days to adjust

Sensory Deprivation and Restored Vision

- If we were blind until adulthood, would we be able to perceive if we regained vision?
- Without experience, figure and ground, perception of colour will be okay
 - Motion perception will be somewhat okay
 - There will be serious problems with shape, depth and perception of faces without experience

Critical Period

- We have critical periods in our development
 - There are certain periods during our development where we must be exposed to certain experiences otherwise we won't properly develop
- Today, it is believed that the critical period for vision is 0-6 years