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COGNITIVE NEUROSCIENCE, ATTENTION AND PERCEPTION

Unit Structure

1.1 COGNITIVE NEUROSCIENCE: NEURONAL STRUCTURE AND FUNCTION; INTELLIGENCE AND NEUROSCIENCE; METHODS OF COGNITIVE NEUROSCIENCE

1.1.1 Cognitive Neuroscience:

Cognitive Neuroscience scientifically studies how different structures of our brain can influence different mental processes; Various methods of investigating the brain, such as MRI, fMRI, PET, CT scans, etc. are utilized for it. Typically, a cognitive neuroscientist is a research scholar who focuses on unraveling the mystery of our brain and understanding its contribution to cognition. As a result of technological and scientific advancement, along with the progression of sophisticated computer technology, cognitive neuroscientists have not only been able to broaden our understanding of how the brain works, and what it does, but also solve the problems that were encountered by the contemporary scientific philosophy.

The term "Cognitive Neuroscience" refers to the scientific and biological study of different brain areas and their corresponding influence on our thought processes. With the help of brain-scanning techniques, cognitive

neuroscientists have been able to find the specific brain areas correlated with particular behaviours, moods, and emotions.

It is important to note that there are some crucial points of distinction between cognitive neuroscience and cognitive psychology. The subject matter of Cognitive Psychology as a discipline revolves around the scientific study of our thinking processes, whereas Cognitive Neuroscience inherently revolves around finding the relation between specific brain activity and thinking.

Neuroscience, however, studies the entire nervous system at the molecular and cellular level, of which the brain is a small yet most significant part. Cognitive Neuroscience is the scientific integration of neurobiology and cognitive functions (especially executive cognitive functions).

Historical Origins:

Cognitive neuroscience is an interdisciplinary field that has risen from the sacral conjunction of neuroscience and psychology. The successful establishment of this discipline is a result of a radical rethinking of research methodology that has been made possible by the incorporation of valuable insights from other fields. Typically, cognitive neuroscience focuses on describing the association between our mind and neural mechanisms. Historically, the initial efforts of subdividing the brain with its correlated mental function proved to be somewhat controversial and problematic. Phrenology, one of the earliest attempts towards localization of brain functions referred to the prediction of mental abilities involving the measurement of the supposed shape of the scalp and its bumps. It is not surprising to know that the phrenology movement was a failed attempt because it lacked an empirical scientific basis, thereby becoming obsolete in the long run.

The aggregate field view, which held that all regions of the brain are involved in every single one of our actions, was also eventually rejected as more precise brain-mapping techniques became available. This began primarily as a result of experiments conducted by Hitzig and Fritsch, who have graced humanity by providing experimental support for the hypothesized motor area in the cortex through his experiments on dogs, wherein they electrically stimulated specific parts of the cerebral cortex which produced movement in dogs.

Integrating ideas and methods from other fields, such as Gestalt psychology, Neuropsychology, and the Cognitive Revolution, led to the development of cognitive neuroscience. This field aims to better understand the relationships between different types of neural substrates and the behaviours they underlie.

Origins in Philosophy:

Philosophers' interest in the mind dates back centuries.It is now generally accepted that we need to investigate the full chain of causes for a phenomenon if we are to gain a thorough understanding of it, beginning

with atomic theories from the 5th century and continuing through Galileo, Descartes, and Boyle in the 17th and 18th centuries. For example, Descartes' believed that the machines built by humans could work as models of scientific explanation. Aristotle believed that our brain was our body's cooling system and our competence for intelligence came from our heart. It was in the 2nd century AD that the Roman physician, Galen, contradicted it and advocated that the source of our mental activity was our brain. He also believed that are personality and emotions were invoked by our other organs, and not the brain. One of the first people to believe that the centre of our mind and emotion is in fact our brain and the nervous system was an anatomist and physician, Andreas Vesalius. These and many such other ideas and propositions which led to the emergence of philosophical explanations about the mind also contributed to the establishment of psychology, which in turn contributed to the field of cognitive neuroscience.

Combining Neuroscience and Cognitive Science:

The interaction between cognitive science and neuroscience was not much before the 1980s. Cognitive Neuroscience took up the herculean task of integrating the then-recent theoretical foundations of cognitive psychology from the 1950s and 1960s with different methods and perspectives from experimental psychology, neuroscience, and neuropsychology. (The formal establishment of neuroscience as an integrated discipline had not happened until 1971).

EEG (1920) and MEG (1968) were the predominantly used methods in the earlier days of cognitive neuroscience. The end of the 20th century saw the evolution of new technologies such as TMS (1985) and fMRI (1991) which have paved its way into the mainframe methodology of cognitive neuroscience. Sometimes, other brain imaging methods like PET and SPECT have also been used by cognitive neuroscientists.

Near-infrared spectroscopy (NIRS) is an upcoming non-invasive technique that utilizes the absorption of infrared light to determine changes in oxygenated and deoxygenated haemoglobin in the cortical areas. A procedure called Single-unit recording uses a microelectrode to measure the electrophysiological responses of a single neuron and is also used in some animals. Apart from this, there are other methods like facial EMG, eye tracking, and microneurography which are also used. The Adaptive Resonance Theory (ART) was first developed in the 1970s by Gail Carpenter and Stephen Grossberg to describe many elements of how our brains absorb information. Pattern recognition and prediction issues have also been examined, along with a small number of neural network models employing supervised and unsupervised learning approaches.

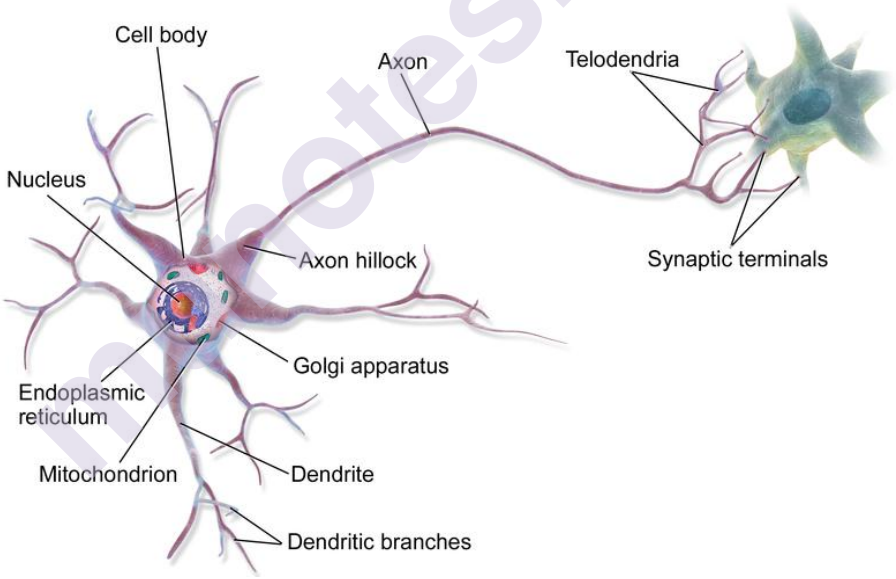
In 2014, Stanislas Dehaene, Trevor Robbins, and Giacomo Rizzolatti were awarded the Brain Prize for their ground-breaking work in understanding cognitive and behavioural disorders and the higher brain mechanisms that underpin complex human abilities like language, mathematical ability, motivation, and social cognition**.** In 2014, Brenda Milner, Marcus Raichle,

and John O'Keefe were recognised with the Kavli Prize in Neuroscience for their ground breaking research on the brain's specialised networks for memory and cognition. O'Keefe had a spectacular year in 2014; as in addition to his Pulitzer Prize, he shared the Nobel Prize in Physiology or Medicine with May-Britt Moser and Edvard Moser for their discovery of the brain cells responsible for our complex navigational system. The Brain Prize was awarded to Wolfram Schultz, Peter Dayan, and Ray Dolan in 2017 for their integrated analysis which connects reward to learning and its underlying brain mechanisms which have obvious influences on human behaviours with special reference to decision-making involving drug addiction, compulsive behaviour, schizophrenia, and gambling.

1.1.2 Neuronal Structure and Function:

A neuron, also known as a nerve cell, is the fundamental building block of the nervous system of animals. Neurons are electrically active cells that exchange information with neighbouring cells across junctions called synapses.

Figure: Structure of Neuron



Broadly speaking, considering their functions, neurons can be classified into three types- sensory neurons, motor neurons, and interneurons.

Sensory neurons are responsive to receiving input from external stimuli like light, touch, or sound that can impact the cells of our sensory organs. They are also tasked with sending this information to the brain or spinal cord.

Motor neurons on the other hand, receive commands from the brain and spinal cord and are responsible for sending these commands to our muscles, who carry out the ultimate movement commands.

Interneurons provide a unique purpose as well by connecting neurons to one another; a network of neurons is called a neural circuit.

Typically, a neuron consists of the following parts- Soma, Dendrites, and a Single Axon.

The Soma is its cell body which has a compact structure, whereas, the dendritesare filaments that extend from the Soma.

The axon can be seen leaving the Soma at something that looks like a swelling and is called as the axon hillock. This axon hillock can travel upto 1 metre in humans and probably more in other species. Even though it branches, it still maintains a consistent diameter.

At the longest end of the axon's branches are structures that we call axon terminals, which play a vital role in transmitting the electrical signal through the synapse to another cell. (It is important to also note that sometimes some neurons may not have axons or dendrites. Neurite is the term used to refer to small processes on neurons that are probably still developing and will eventually grow into axons or dendrites.)

Neurons primarily use their soma and dendrites to receive information from the environment, while their axons are responsible for transmitting those signals to neighbouring neurons. The synapses allow for the transmission of information and signals from the axon of one neuron to the dendrite of another.

This process is both, electrical as well as chemical in nature. As a result of the maintenance of voltage gradients across the membrane of neurons, they are electrically excitable in nature.

Neurons typically generate an all-or-nothing electrical impulse, when there are high voltage changes over a small interval. This is termed as an action potential, which rapidly travels throughout the exam and in the process also leads to the activation of synaptic connections as it reaches them. Synaptic signals also can be of two types by nature- excitatory or inhibitory which causean increase or decrease in the net voltage respectively.

Neurogenesis is the process through which new neurons are generated in our brain. It is formed by the neural stem cells majorly during prenatal brain development and childhood, after which neurogenesis typically stops.

Neurons can differ in size and shape and can be categorized on the basis of their structure and function. One of the first categorizations of grouping neurons was done by an anatomist called Camillo Golgi and he classified them into two types. Type I neurons typically had long axons and were used to communicate long distance signals and Type II neurons had short axons. The elemental morphology (structure) of type I neurons includes soma and a long axon which is peculiarly covered by a white fatty substance called the myelin sheath that provides insulation and prevents

electrical interference from surrounding neurons. The cell body is wrapped around by the dendritic tree, and as mentioned earlier is responsible for receiving incoming signals from the other neurons. The axon terminals are branched off at the end of an axon and release neurotransmitters in the synaptic cleft. The synaptic cleft is the gap between the terminals and the other neuron's dendrites.

Structural Classification:

Apart from Golgi I and II neurons, based on their anatomy, most neurons can be classified as:

- The unipolar neurons have a single extension from their cell body
- The bipolar neurons have one axon along with one dendrite
- The multipolar neurons have 1 axon along with 2 or more dendrites
- The anaxonic neurons are those neurons where we cannot distinguish between its axon and dendrite/s.
- The pseudounipolar neurons consists of an axon which is interestingly split into two branches, out of which one goes to the peripheral nervous system and the other to the central nervous system.

Functional Classification:

Direction:

Neurons are classified into three groups based on their function:

- **Sensory neurons,** also known as afferent neurons, are in charge of relaying information from sensory organs and tissues to the central nervous system;
- **Motor neurons,** also known as efferent neurons, are in charge of relaying motor commands from the central nervous system to various parts of the body;
- **Interneurons,** given their unusual name, are in charge of connecting neurons within the central nervous system.

Action on Other Neurons:

To distinguish the neuron that sends the signal from the neuron that receives it, the terms "presynaptic" and "postsynaptic" are often used. The postsynaptic neuron receives information from the presynaptic neuron through neurotransmitters released by the former.

Metaphorically speaking, imagine a neurotransmitter to be the **key** and a receptor to be a **lock**! A neurotransmitter has the potential to activate multiple types of receptors at the same time. These **receptors** can typically be categorised as **excitatory** (which cause an increase in the firing rate), **inhibitory** (which cause a decrease in the firing rate), or **modulatory**

(which cause effects that last long but are not directly related to the firing rate). The effect on the postsynaptic neuron is influenced by the type of receptor which gets activated.

At this point, it is imperative to note that the difference between inhibitory and excitatory neurotransmitters is not absolute. The kind of chemical receptors present on the postsynaptic neuron usually determines whether the resultant effect is excitatory, inhibitory, or modulatory. A single neurotransmitter released by a single neuron could possibly have an excitatory or inhibitory or modulatory effect respectively on different targets. Many common neurotransmitters have displayed consistent actions, therefore, neuroscientists commonly categorise neurotransmitters based on their effects. For example, **GABA** (gamma-aminobutyric acid) typically has an inhibitory effect causing a decrease in neuronal excitability (Benzodiazepines are medicines that enhance the transmission of GABA and are used in managing anxiety), and glutamate which is majorly involved in learning and memory, is excitatory in nature.

Discharge Patterns:

Neurons can also be classified in terms of their electrophysiological characteristics-

- **Tonic neurons** are those that are tonically (constantly) active and fire at a constant frequency
- **Phasic neurons** are those that fire in bursts
- **Fast-spiking neurons** are those that are known for their high firing rates.

1.1.3 Intelligence and Neuroscience:

Researchers have always been intrigued by identifying the neural basis of human intelligence. The earliest attempts made to study the neuroscience of intelligence included studying correlations between external head parameters and intelligence or measuring the weight and brain volume postmortem. However, modern technological and scientific advancements have graced our fraternity with methodologies like MRI, fMRI, EEG, PET, etc. that allow us to study the living brain and decipher different correlates of our higher-order mental functions.

Researchers have found empirical evidence for human intelligence correlates, which include the overall brain volume, volumes of white matter and grey matter, along with cortical thickness, and neural efficiency to name a few. Even though our understanding of the marvelous brain has greatly increased in the last three decades, more research is warranted to understand its entirety.

Brain volume:

The development of MRI and fMRI have bestowed upon us a non-invasive and very accurate measure of the living brain's structure and

function respectively. Generally, it has been found that brain size and volume are positively correlated with overall cognitive functioning and intelligence. It is interesting to note that the strongest correlations between intelligence and brain volume have been found in the frontal, temporal, and parietal lobes of the brain.

Many studies have found the correlation of intelligence in healthy adults and total brain volume to be approximately 0.4 when using tests of high psychometric standards. Another study that utilized the UK Biobank and was conducted on a large scale (n = 29k) reported a correlation of .275. Such studies have been questioned by critics with respect to the variation in scales since not much is known about them.

McDaniel conducted a meta-analytic review and found two interesting conclusions- the correlation between in vivo brain size and intelligence was higher for females (0.40) than for males (0.25) and this correlation typically increased with age, meaning the smaller the child, the lesser the correlation between brain size and intelligence.

It is important to note that the volume of one's brain alone doesn't constitute the most accurate account of one's intelligence, and neither does it mean that it doesn't account for anything. On an average, brain volume explains about 12% to 36% of the variance in intelligence.

The amount of variance explained by brain volume hugely relies on the type of intelligence being measured too. For example, studies have shown that when measuring verbal intelligence, 36% of variance can be attributed to brain volume, however, when measuring visuospatial intelligence, only 10% of variance can be. Brain size and intelligence have been shown to correlate positively, however this relationship has been exaggerated in the literature, according to the work of psychologist Jakob Pietschnig. We demonstrate that it is not justifiable to interpret size as an isomorphic proxy of human intelligence differences, despite his statement that it is tempting to interpret this connection in the context of human cognitive evolution and species variations in brain size and cognitive capacity.

Grey matter:

Grey matter volume, like total brain volume, has been shown to correlate favourably with IQ. More specifically, persons with a higher IQ have a greater concentration of cortical grey matter in the prefrontal and posterior temporal regions of the brain. Both verbal and nonverbal IQ have been discovered to have a positive correlation with cerebral grey matter, which is rather intriguing.

Extensive research has also found gender differences in the correlation of grey matter and intelligence. Men typically have stronger IQ and grey matter correlations in the frontal and parietal lobes while women show the strongest IQ and grey matter correlations in their frontal lobes and Broca's area. It is fascinating to note that the overall intelligence in both genders is not affected despite these differences. Thus, we can also conclude that

humans can achieve the same level of cognitive ability through different ways or brain areas.

A particularly interesting methodology that is utilized in studying the correlates of cortical grey matter with intelligence is called voxel-based morphometry (VBM). VBM has blessed researchers to study these correlates with higher spatial resolution, and have identified that in healthy adults the strongest positive correlations of grey matter and intelligence are found in frontal, temporal, parietal, and occipital lobes, whereas in children between 5 to 18 years of age, such correlations have been identified in the anterior cingulate region.

Reis and colleagues were able to discover that the grey matter in the prefrontal cortex of children between 5 and 17 strongly contributes to variance in intelligence compared to subcortical grey matter. Frangou and coworkers also examined the links between grey matter and IQ in children and young adults (aged 12-21) and found some fascinating findings. Their first set of findings were pretty much in line with earlier studies and found positive correlations between grey matter in the orbitofrontal cortex, cingulate gyrus, cerebellum, and thalamus and intelligence. Contradictorily, they also found negative correlations between grey matter in the caudate nucleus and intelligence. Also, as far as children under the age of 11 are concerned, researchers haven't been able to find significant positive correlations between grey matter volume and intelligence since intelligence develops with time.

White Matter:

White matter typically consists of myelinated axons and takes care of transmitting signals between neurons and also provides electrical insulation. The white matter also takes care of connecting together different regions of the grey matter in the cerebral cortex. The biggest white matter structure in the brain is the corpus callosum, and many studies have found statistically significant positive correlations between areas of the corpus callosum and cognitive performance. It has also been noted that even though the size of the corpus callosum positively correlates with both verbal as well as nonverbal intelligence, the association was found to be stronger for nonverbal measures compared to that of verbal ones.

The integrity of white matter tracts is an essential contributor toinformation processing speed and their decreased integrity is directly linked with lesser intelligence. Such discoveries imply that our brain is structurally interconnected and relies heavily on axonal fibers which are crucial for the efficient and fast processing of information, therefore, affecting our general intelligence.

Unfortunately, VBM studies were unsuccessful in finding an association between intelligence and corpus callosum in healthy adults. From this contradictory finding, we can conclude that the relationship between grey matter and intelligence is way too stronger compared to white matter volume.

Cortical Thickness:

The thickness of cortical areas has also been found to be positively correlated with human intelligence. As expected, the association between cortical thickness and IQ follows a pattern of negative correlation in early childhood and by late childhood, the pattern shifts to a positive correlation. It has been found that children who are more intelligent develop cortical thickness more steadily and over larger time durations than those who are not so intelligent. It would be a little unfair to base intelligence on cortical thickness alone becausesocioeconomic circumstances and educational opportunities also play a very important role in determining the growth and development of intelligence.

Cortical Convolution:

If one keenly observes the surface of our brain, one may realize how it has many convolutions (meaning folds); these folds and creases in the cerebral cortex of the human brain permit a large surface area of our marvelous brain to be fit within our skulls. The cortical convolution has increased significantly over the period of human evolution. It is hypothesized that the higher the degree of such cortical convolutions in the human brain, the higher their distinct cognitive abilities.

Neural Efficiency:

Multiple brain imaging studies involving the use of PET scans have discovered that people who are more intelligent typically show less activation in their brain during a cognitive task, as measured by glucose metabolism, wherein it was found that the more intelligent people are, the better their brains are at processing information and therefore require less energy to accomplish the task. This hypothesis is formally termed as the neural efficiency hypothesis.

Many studies involving fMRI and EEG have shown that the difficulty level of a task also is a crucial factor that affects neural efficiency. It has also been observed that the more able an individual is, the more they invest their cortical resources in difficult tasks. This has been profoundly true in the case of the prefrontal cortex because people with greater intelligence show greater levels of activation in the prefrontal cortex when working on difficult tasks compared to those with lower intelligence. Many scientists have also proposed that individuals blessed with higher intelligence have a better capacity to block interference out compared to those individuals with low intelligence.

Parieto-frontal Integration Theory (P-FIT):

The Parieto-frontal integration theory advocates for a biological model of intelligence. They believe that the human intelligence stems from a sophisticated, integrated, and widely distributed neural network, majorly involving the frontal and parietal lobes. Barbey and colleagues recently conducted a lesion mapping study and have gathered evidence which supports the Parieto-frontal theory of intelligence.

1.1.4 Methods of Cognitive Neuroscience:

Psychophysics:

Psychophysics can be defined as the scientific study of the association between stimulus and sensations. It focuses on deciphering or analyzing the process of perception by trying to understand the effect that different properties of a stimulus have or can have on a subject's experience or behaviour. In a nutshell, it tries to explain the association between the sensations and perceptions that physical stimuli can produce. Psychophysics has been very widely used in varied forms in experimental psychology and has important practical applications.

Eye tracking:

Eye tracking typically refers to the process of measuring one's point of gaze and the device that is used for tracking eye movements is what we call an eye tracker. These eye trackers are utilizedfor research in various domains- psycholinguistics, marketing, psychology, product design, etc. They are also being considered for their prospective utilization in rehabilitation purposes or robotic applications that provide assistance. There are different methods that can be used for measuring eye movements. For example, using video images that enable us to extract eye position, using different search coils, or using an electrooculogram.

Functional MRI:

fMRI is a method of investigating brain activity which detects changes in our blood flow. Whenever any part of our brain is being used, it gets activated and the blood flow to that area also increases. the fMRI test is based on this idea that are cerebral blood flow is directly proportional to neuronal activation.

In 1990, Seiji Ogawa pioneered functional magnetic resonance imaging (fMRI) by using a technique known as blood-oxygen level dependent (BOLD) contrast. It's a specialist scan that can pick up on neural activity in the brain or spinal cord by measuring a hemodynamic response that tracks with the brain's cellular energy expenditure. Since the 1990s, functional magnetic resonance imaging (fMRI) has dominated the field of brain mapping research due to the fact that it does not need any invasive procedures or radiation.

It is also well-known to be contaminated by noise from a variety of sources, therefore statistical approaches are required to recover the original signal. The end result is colour coded by the strength of activation across the brain regions studied and is graphically represented. This technique enables us to localize brain activity up to millimetres but the standard procedure gives us a window of only a few seconds.

FMRI is majorly used in research compared to clinical diagnosis. It compliments other methods of investigating the brain like Near Infrared Spectroscopy (NIRS) and electroencephalography (EEG).

There are many scientists and researchers who are working towards developing newer and better methods that not only provide higher spatial and time resolution but also use biomarkers instead of the BOLD signal. In fact, there are a few companies that have also developed lie detectors based on fMRI techniques but more research is required before they can be used for commercial purposes.

Electroencephalography:

Electroencephalography (EEG) is a non-invasive method that involves the use of multiple electrodes placed on the scalp which allow us to record the spontaneous electrical activity of our brain over a period of time. It allows us to measure the voltage fluctuations that occur as a result of ionic currents within the neurons of our brain.

There is another technique called as electrocorticography (ECoG) which involves invasive electrodes unlike the ones used in EEG, and hence are also sometimes referred to as intracranial EEG.

EEG is widely used for the diagnosis of epilepsy. In some cases, it is also used to diagnose the depth of one's anesthesia, the presence of sleep disorders, and encephalopathy, and since it allows us to see brain wave activity, easy is also used to determine if somebody is brain dead. In the event that someone has a stroke or any other brain disorder, EEG typically is the first-line method used for diagnosis. However, since the development of more sophisticated techniques like MRI and CT scans which provide better resolutions, the use of EEGs have reduced. Despite these limitations, it is still extensively used for research and diagnosis.

One crucial derivative of the EEG is called as Evoked Potentials (EP) which includes averaging the activity detected on the easy in correspondence to the presentation of some kind of visual, somatosensory, or auditory stimulus.

Magnetoencephalography:

Magnetoencephalography is a method that makes use of very sensitive magnetometers to map the activity in our brain. The process of MEG typically records the magnetic fields that arise due to electrical currents caused as a result of brain activity. The most commonly used Magnetometers today are arrays of SQUIDs (superconducting quantum interference devices) and the SERF (spin exchange relaxation-free) Magnetometer is currently being researched for their utilization in machines. As of today, MEG is used in multiple researches on cognition and perception. It is also used in neurofeedback or locating regions of the brain that are afflicted by some pathology before it is surgically removed.

Transcranial Magnetic Stimulation:

Transcranial magnetic stimulation is a non-invasive technique which uses electromagnetic induction to cause electrical currents in specific brain areas that in turn leads to changes in our brain's magnetic field. The

Stimulator which generates an electric pulse is connected to the magnetic coil which is connected to the scalp. TMS has shown tremendous potential as a diagnostic tool and is currently in the process of being evolved for its therapeutic benefits while dealing with different disease states in the domain of mental health and neurology.

1.2 VISUAL PERCEPTION: VISUAL OBJECT RECOGNITION, FACE PERCEPTION

Visual perception refers to our capacity to make sense of things within our visible spectrum that we see around using light. There are different terms for vision as per the variability of light. Vision during the day is called photopic vision, vision during the night is called scotopic vision, and the vision during twilight is called mesopic vision.

Many people often get confused between visual perception and visual acuity. Please note that both of them are different concepts! While visual perception refers to our ability to interpret our surroundings, visual acuity refers to the extent to which a person can see clearly. An individual could have a "20 out of 20 vision" and still goof up while involved in the process of visual perception.

There are multiple physiological components involved in the process of vision and are collectively termed as the visual system. Our visual system has been the center of attention for a lot of research in psychology, cognitive science, molecular biology, neuroscience, etc.

The Visual System:

In most mammals, including humans, the process of vision starts with light entering our eyes through the cornea.

Once light passes through the cornea, it is focused on to ourretina by the lens in our eyes. A retina is situated at the back of our eye and is a membrane that's extremely sensitive to light. The retina is a transducer which is responsible for converting light into neuronal signals.

This kind of transduction is possible because of the existence of extremely specialized cells in the retina called rods and cones. These rods and cones are photoreceptive, which means that they have the capacity to detect photons of light followed by the production of neural impulses.

These neural impulses are then transmitted from the retina to the central ganglia in the brain through the optic nerves. After this, the lateral geniculate nucleus is responsible for transmitting the signals to the visual cortex. However, this is not the only route which carries signals of sensory information, sometimes, signals from the retina directly travel to the superior colliculi.

The primary visual cortex is also called the striate cortex and receives signals from the lateral geniculate nucleus. There is a specialized part in the visual system of our brain called the Extrastriate Cortex a.k.a. the

Visual Association Cortex. It consists of a set of cortical structures and not only receive information from each other but also from the primary visual cortex. Current descriptions have proposed that the extrastriate cortex is further divided into two functional pathways namely a dorsal and a ventral pathway. At present, this is a conjecture and is known as the Two Streams Hypothesis.

It is typically believed that humans can visibly see in the range of 370 and 730 nanometres of the electromagnetic spectrum. Some researchers also believe that the younger population can see light down to 340 nanometers.

1.2.1 Visual Object Recognition:

Visual object recognition can be defined as our ability to recognize the objects that we see around us. A peculiar and essential feature involved the in process is called as object invariance. **Object invariance** enables us to identify various things that we see as well as the changes in them with respect to various aspects such as illumination, position, and background to name a few.

Basic Stages of Object Recognition:

Many researches in the neuropsychological domain have found evidence which indicates that there are four stages involved in the process of recognizing objects.

Let's have a look at them:

- **Processing basic aspects** of the object like form, colour, and depth.
- **Grouping the basic components based on their similarity** creating a visual form, and gathering information on distinct edges enabling the figure-ground segregation.
- The visual representation is then **searched** for **in our memory and matched with existing structural descriptions**.
- This leads to **semantic attributions** of our visual representation and provides us with the required meaning that ultimately leads to the **successful recognition** of an object.

It is also important to note that apart from this generic bottom-up hierarchy, many researchers have also proposedintegrative hierarchies of the top-down bottom-up processing, in addition to parallel processing.

1.2.2 Face Perception:

Face perception refers to our ability to identify and interpret a face. Our consciousness is a crucial factor in this kind of perception, therefore it excludes facial recognition systems that are automated.

The fact that our understanding and perception of the face is one of the most essential aspects required for social cognition. We gather a lot of

information like their identity, their current thoughts or feelings, and even somewhat predict their immediate actions by looking at their face.

Being able to recognize faces is not just important for perceiving someone's identity, mood, gender, and ethnicity, but it is also necessary for having healthy interactions with each other and understanding are immediate surroundings.

The fact that facial perception occurs as a result of visual intake is common sense, however, there have been a few studies which have found that even people who are born blind could learn to perceive faces without vision.

Early Development:

There have been multiple studies to identify the average age when human beings typically develop face perception abilities, but unfortunately there is no time-frame that is widely accepted on this matter.

Ability to Distinguish Faces From Other Objects:

Many studies done on infants have shown that they typically exhibit more preferential attention to faces compared to other objects in their environment, indicating their ability to distinguish between faces and objects.

Newborns typically show a lot of interest in faces when they are around the age of 3 months, but this preference tends to gradually disappear until it emerges again during the end of their first year, and then again gradually declines through the next 2 years of their life.

Many psychologists believe that the increasing motor abilities of infants can be one of the primary reasons why their interest in faces re-emerges around the age of 3 months.

Even though newborn children tend to show a preference for faces as they grow up, especially between the age of 1 to 4 months, this preference seems to be particularly inconsistent.

The fact that infants peculiarly turn their heads towards faces indicate a preferential attention for faces. This can be concluded as the presence of some form of rudimentary facial processing ability.

Ability to Detect Emotion In The Face:

Even though the extent of an infant's development of their ability to recognize emotions is unclear, it has been found that by the time they are seven months old, infants can distinguish faces by emotions. They are able to recognize the facial expressions of anger and fear, primarily due to deeply ingrained evolutionary mechanisms.

A study involving two event-related potentials in the posterior part of the brain showed different activations caused by different kinds of negative expressions, namely anger and fear. These findings hint towards the fact

that infants can at least partially distinguish between threat and anger, especially when it is directed towards them. Another interesting finding was that there was activation not just in the posterior parts of the brain but also in the occipital areas.

A point of distinction noted in infants is that 5-month-olds exhibited similar ERPs for happy as well as fearful faces, however, 7-month-olds focused more on the fearful ones. The fact that fear typically tends to create heightened cognitive focus towards fear, peculiarly indicates that the nature of emotion is threat salient. This also has deeply ingrained evolutionary explanations that aid our survival.

By now it is established that infants by 7 months of age have the ability to understand facial expressions to some extent at least. They typically use facial cues to gauge the motives of other people, especially when the situation is unclear or ambiguous. One study involved the experimenter taking away a toy from a child with different expressions and found a significant difference in the infants' reactions. In the condition where the experimenters took away the infants' toys and maintained neutral facial expressions, the infants typically watched their faces longer (trying to make sense of the experimenter's face) compared to when the experimenters maintained happy facial expressions.

As Psychology students, we all understand that emotions are an extremely important part of the social interactions that we have. The kind of facial expressions a person exhibits will go a long way in determining how we perceive them. Many studies in social psychology have found that faces that are perceived as displaying positive emotions are evaluated as more favourable as compared to those displaying negative emotions.

The fact that 7-month-olds tend to focus more on fearful faces is well established, but in another study when infants were exposed to faces with happy expressions, it aroused more enhanced sympathetic reactions in them; What is more interesting to know is that this reaction was similar when the facial expressions were presented subliminally as well as in ways that warranted the infants' conscious awareness. This interesting finding enables us to conclude that conscious awareness of stimuli is not a prerequisite to getting an infant's reaction.

Many developmental psychologists and researchers have proven innumerable times that exposure to different kinds of stimuli in the first five years of a child's life and early perceptual experiences are undoubtedly vital for the development of a person's perceptual abilities as an adult. The same is applicable to the development of visual perception as well.

The amygdala and the fusiform gyrus have shown heightened activation when one is involved in the process of face perception.

Ability to Mimic Faces:

At what age we learn to mimic facial expressions is a very controversial and disputed topic.

A few researchers are of the opinion that infants as young as 2 days have the capacity to mimic an adult, but many developmental psychologists advocate that the faces of babies exhibit smiles or rounds because they are not in full control of their facial muscles yet.

Susan Jones also disputed the idea that children younger than two years of age could mimic facial expressions. She advocated that infants are typically not aware of the emotional content underlining facial expressions and therefore, cannot imitate them until they are 2 years old. She also reported that the ability to mimic could emerge at different ages in children.

1.3 ATTENTION AND CONSCIOUSNESS: ATTENTION PROCESSES, THEORIES OF ATTENTION, CONSCIOUSNESS OF MENTAL PROCESSES; PRECONSCIOUS PROCESSING

Our ability to selectively focus or concentrate on a particular aspect of information while blocking out other bits of information can be termed as Attention.

William James defined attention as the act of directing one's mental energies toward a certain target. It suggests stepping away from some activities so as to concentrate on others more productively. It's the mental act of seizing control of one item or line of thought among numerous that are present at once.

The fact that our cognitive resources for the processing of information are limited is well documented in many studies. Our attention is not just afflicted by a limited amount of cognitive processing resources but also by an attentional bottleneck. An attentional bottleneck refers to the actual amount of information that our brain can process per second. Many researchers believe that an attentional bottleneck could be a primary cause of inattentional blindness. Inattentional blindness refers to our failure to notice something when we are focusing elsewhere.

Attention is a research area which intrigues multiple domains right from psychology and neuroscience to education and marketing. The current researches on attention are aimed at trying to find the source and effects of all the sensory cues and signals that grab our attention, and understanding the correlation between attention and other executive functions like working memory.

Consciousness:

Even though the terms- attention and consciousness are sometimes used interchangeably by a few people, they are different constructs. While

attention refers to our ability to focus on something, consciousness refers to our awareness of things happening internally and/or externally.

Consciousness typically includes any form of thought, experience, or feeling that we may be aware of. Many things about consciousness are still highly disputed- to name a few- questions like whether there are different types of consciousness or different levels of consciousness, are humans and animals alike in the possession of consciousness.

1.3.1 Processes of Attention:

According to cognitive psychologists, there isn't any aspect of our life where attention does not play an important role. Our ability to pay attention to something is often taken for granted by most of us. Right now, while you are reading these lines, you are exercising your ability to pay attention.

Broadly speaking there are four different forms of attention. Let's have a look at them:

Selective attention:

In a world where we are constantly bombarded with a lot of information/stimuli from our environment, the phenomenon where our brain consciously blocks out other stimuli and focuses on something in particular, is termed as selective attention.

Divided attention:

Our ability to focus on two or more things at the same time is termed as divided attention. One of the best examples of divided attention could be when we are chatting with someone on WhatsApp while talking to someone in person. One thing to keep in mind over here is that we will be able to engage in two things at the same time only if one of them is highly practiced and habituated.

Executive attention:

This is a form of attention that enables us to block irrelevant bits of information from the environment and helps us to attend to those bits of information that are important or relevant to us.

Sustained attention:

This is a form of attention that helps us to concentrate on a particular task and maintain that focus for a prolonged period of time.

1.3.2 Theories of Attention:

A famous researcher named Chun and his colleagues differentiated attention on the basis of the type of information that we pay attention to. According to them, catering to sensory information picked up from the environment and its subsequent perception refers to external attention, while other cognitive functions somewhat within our control like working

memory, long-term memory, or response selection are referred to as internal attention.

We possess a specialized mechanism that cognitively controls which bits of information we encode and hold on to in our working memory while blocking out distractions.

Advocates of early selection theory of attention believe that the locus of selection while processing any kind of information is at the early/initial stages, therefore the stimuli that were not paid attention to in the beginning are not processed fully.

When involved in a primarily difficult task, all of our attention is directed toward the target. This indicates early selection patterns.

Contradicting early selection theory of attention, advocates of late selection theory have argued that our attention typically operates after we have fully processed the stimuli.

When involved in a task that is relatively easy, objects or events that are unattended can be processed too. This indicates late selection patterns.

The debate about whether the early selection theory of attention is more accurate or late selection has been ongoing for a very long time and there is enough evidence supporting both sides leaving us with little resolution on this matter.

As of now, the best possible intermediate solution has been brought on by the perceptual load theory which advocates that task requirements will determine the locus of our selective attention. Therefore, when the task is difficult, meaning the cognitive load is higher, the locus of selection is early, and when the cognitive load is lower, the locus of selection is late. It is imperative to note that initially the perceptual load theory was widely accepted, however in recent times it has been challenged on the merits of its theoretical foundations and methodology.

Kerr and colleagues have proposed a neural framework which tries to account for how body-focused attention can have an "upward" influence all the regulation of our cognition and emotion.

The range of 7 to 14 hertz is also known as the Alpha rhythm and is believed to play an important part not only in modulating the sensory inputs received by our neocortex but also by enhancing its signal-to-noise properties throughout the neocortex.

This notion of top-down modulation of the attentional alpha rhythm can be generalized to our thalamocortical circuits and is also believed to accentuate our capacity for filtering and prioritizing the input of information received by our brain.

Somatic attentional modulation has also shown enhancement in our capacity for selective special attention in both modalities involving vision

and hearing. Many recent researches have also concluded that increased Alpha power enhances our working memory capacity.

Many people including ancient philosophers as well as modern researchers have advocated and proven how mindfulness of our mind and body can lead to greater attentional flexibility and allows us to be present in the here and now and with time learn to be non-reactive towards internal and external experiences, especially those invoking negative thoughts and emotions.

Tsuchiya and colleagues conducted a research to study the relation between consciousness and attention. The idea that consciousness in different senses, originating from the Prefrontal Parietal Network (PPN) interrelates with a type of attention- has always been a common belief. The PPN is also known to have an association with not just working memory, and executive control, but also chunking. Hence, many researchers believe that the core psychological components of consciousness are complemented by attention.

On the contrary, there are many others who believe that both, attention and consciousness typically follow an independent path while engaged in a decision-making process, however, they also agree that attention has intermodal effects on consciousness. For instance, conscious perception of auditory, olfactory, or visual stimuli, or conscious retrieval of memories- are influenced by attention.

Unfortunately, empirical research into the impact of top-down attention on conscious perception of an isolated stimulus that was either dominant (visual input in the current moment) or non-dominant (olfactory input and past memory/future planning) have failed. This has led many researchers to conclude that any kind of unexpected strong olfactory stimuli or peripheral vision, or any kind of sensed familiarity- has the capacity to create interference in our top-down attention and its interdependence with conscious experience.

1.3.3 Consciousness of Mental Processes:

Consciousness can be simply defined as our awareness of internal and external existence. Philosophers and scientists alike, have always been intrigued by trying to understand the experience of consciousness in totality. Studying consciousness can be controversial because it not only feels most familiar (since we are always aware of it) but also the most mysterious aspect of our life (since we don't know how or where it comes from). As mentioned earlier in the chapter, one thing that everyone agrees about is that consciousness exists, but there is still a lot of debate on how to go about studying it.

In the initial days of psychology, people believed consciousness to be our "inner life" that could only be accessed through introspection of private thought. Today, our understanding and explanations of consciousness have evolved with time, and include any kind of conscious experience, feeling, thought, or perception.

Consciousness can be looked at as anything that we are aware of, it can also be viewed as awareness of awareness. It includes a range of descriptions beginning from simple wakefulness to an individual's sense of selfhood.

The disparity in speculations of research done on consciousness arises many doubts- whether we are asking the right questions in our quest for understanding consciousness- being the biggest one.

Mental Processes:

Mental processes can include everything that our mind does naturally. Information processing, memory, emotion, attention, perception, imagination, thinking, decision-making, language use, logical reasoning, etc. are some of the most common mental processes that our brain is capable of.

There isn't a single aspect where we can say that our mind is not active- even when we are sleeping, there is some amount of activity going on! That is why, cognitive psychologists focus so much on studying mental processes because they are not just a "constant" in our life but also affect every conscious as well as unconscious aspect of it.

1.3.4 Preconscious Processing:

Preconscious processing is a term that we use for information that is available to us for cognitive processing but typically exists beyond our conscious awareness.

Many researchers have been intrigued by how priming can influence a particular response. Priming refers to a technique where we are exposed to a particular kind of stimulus without conscious intent and still it has the power to stimulate a particular type of response. For example, when buying furniture, the word "chair" is recognized more quickly following "table" rather than an apple!

The tip-of-the-tongue phenomenon refers to a condition where we know we know something, we can even describe it, but cannot retrieve the name/word. Most of us have experienced the tip-of-the-tongue phenomenon at least at some point in life. Many experiments have found that such instances are proof of preconscious information because that piece of information is not fully accessible but still available for cognitive processing.

Hypnosis:

Since, hypnosis and creativity, both involve some aspect of preconscious processing, many people believe that there could be a connection between the two. Krippner (1965) believed that since creative inspiration has its origin in the preverbal realm, hypnosis could help us to gain access to it.

The preverbal realm is majorly preconscious in nature. Many researchers like Rothenberg (1990), Smith and Amner (1997) believe that there is a

strong association between creative people and creative processes because both of them draw from our preconscious mind. McCrae (1987) further added that our openness to experience could also be an essential factor because our openness may enable us to explore ideas from our preconscious mind. It is also important to know that, even though some creative accomplishments may be drawn from our preconscious, that doesn't mean all creative acts stem from it; there could be some creative accomplishments that are intentional and tactical. This is indicative of the existence of differences in preconscious and conscious sources of inspiration for creative people.

In an interesting study by Bowers in 1979, it was found that creativity shares a moderately significant correlation with absorption and effortless experience. By effortless experience, she meant something similar to Langer's (1989) concept of mindfulness and Csikszentmihalyi's (1999) concept of flow.

1.4 NEUROPSYCHOLOGICAL BASIS OF ATTENTION AND VISUAL PERCEPTION

Attention As Arousal, Alertness, Or Vigilance:

While attention can be defined as overall alertness about our surroundings, it can also be interlinked with or influenced by our arousal and sleep-wake cycle. Vigilance, on the other hand, can be defined as the ability to focus sustained attention on something. Therefore, even though all these terms- attention, arousal, alertness, and vigilance have a similar meaning they are used more specifically in different contexts. For example, attention would be more specifically suited when someone is studying, alertness when one is attending an important lecture, and vigilance when one is working as a lifeguard on a beach or a swimming pool.

In an interesting study by Makeig and colleagues done in 2000, participants were made to study subjects in different phases of sleep, under conditions deprived of sleep, and on sedatives. The participants were subjected to repetitive tasks such as maintaining a ball within a certain region on the screen, which warranted sustained attention levels. As initially predicted, the researchers found that those participants who were sleep deprived had a more consistent poor performance which also correlated with their corresponding EEG signals.

On the other hand, sleep deprivation isn't always associated with poor performance. Tasks may be made more interesting in order to increase motivation and productivity even when we are drowsy. For example, adding some novelty, adding an element of stress, and my personal favourite- adding a reward for performing the task.

It is also interesting to note that more arousal is not always helpful for task performance. The Yerkes-Dodson curve is proof of that. The Yerkes-Dodson curve is an inverted-U that depicts performance based on level of task challenge and our alertness. When a task is not challenging enough,

our levels of alertness are low, and when the task is two challenging, our stress levels are too high. Both of these conditions can lead to poor performance. It is only those tasks which are moderately challenging (neither too difficult, nor too easy) for an individual that lead to optimal performance. Please note what one considered as challenging can be highly subjective. This subjectivity is also found in the effects of psychostimulants like caffeine and adderall, since it works by increasing focus only in some people and not in others.

Attention and visual perception:

Small and fast eye movements that we make several times per second are termed as saccades. The highest visual resolution on the retina is offered by the fovea. Choosing where to direct the fovea is a crucial choice about allocating our limited computational resources. This is how our eye movements depict the location of our attentional processes.

Researchers have been able to identify many patterns in a visual stimulus that automatically captures our attention by using technology to track the eye movements of participants as they are exposed to different images. It has been found that these patterns are defined by edges, frequency, intensity, a contrast of colours, and motion.

The features of an image that attract our attention are considered "salient" and typically occur in a "bottom-up" fashion, meaning they don't need much effortful processing and are most likely to be the result of feature detectors that are ingrained in our visual system. According to Tatler and colleagues, different participants generally tend to agree on which aspects of the image are considered as salient.

One of the best ways to study the salient regions in our visual perception is by employing "free-viewing" situations, even when the participants are not given specifications about how and what to view in the image. This is when the interplay between top-down and bottom-up approaches to attention could become clear. In a 2005 study by van Zoest and Donk, it has been found that participants may incorrectly saccade on salient distractors instead of specific visual targets out of an array of visual stimuli.

When people are viewing a complex natural image and are given high-level tasks, like assessing their age or evaluating their social economic status, task instructions have a considerable amount of effect on the generated pattern of saccades.

Researchers Itti and Koch discovered in 2001 that people's reaction times were slower and they were less likely to return to locations they had just attended if they were obliged to make multiple saccades in a row. The term "inhibition of return" describes this behaviour. Our eyes are forced to look further afield than just at the most obvious parts of an image. All of these may suggest that the mechanism responsible for creating our saccades also has a memory.

It is true that eye movements are effective methods of controlling visual attention, but they are not the only ones. "Covert" spatial attention processes different spatial locations without overtly shifting the fovea. In general, subjects must fixate on a central point during a covert spatial attention study. To perform their visual task, they are encouraged to covertly attend to the location in their peripheral vision where task-relevant stimuli are most likely to appear. For example, in an orientation discrimination task, an oriented grating will flash at the stimulus location after a spatial cue is provided, and the subject should report the orientation of the grating after it has flashed. Anton-Erxleben and Carrasco (2013) found that subjects performed worse on valid-cue trials (in which the stimulus appeared in a nonrelevant location) than on invalid-cue trials. A limited resource, covert spatial attention, contributes to the processing of visual information and can be used flexibly. There are certain areas selected for further processing at the expense of others when covert spatial attention is engaged. This has historically been called the "spotlight" of attention. A fundamental difference between covert and overt attention is that the input to the visual system is identical, but the processing is flexible.

Bottom-up saliency could also influence subliminal spatial focus. An increase in performance may occur if external spatial attention is directed from an irrelevant but salient item that suddenly illuminates at the position of a task-relevant input. It is counterproductive to direct your flashing lights in an unrelated direction (Berger et al., 2005).

Some theories of attention suggest that covert spatial attention is a valuable tool for guiding overt attention. According to the premotor theory of attention, the same neural circuit controls both covert spatial attention and saccades (Rizzolatti et al., 1987). There is evidence that the frontal eye field (FEF) plays a role in the control of eye movements. A study showed that stimulating neurons in the FEF at levels too low to elicit eye movements could produce effects similar to covert attention (Moore et al., 2003). Consequently, covert attention can be used to determine where overt attention should be directed.

Furthermore, our ability to covertly participate may be useful in social settings because eye movements convey information about knowledge and intentions that can be crucial. (Klein et al., 2009).

Researchers looking into the neurological correlates of covert spatial attention are specifically interested in discovering what parts of the brain's activity vary in response to changes in the attentional signals themselves (rather than differences in bottom-up stimulus properties). Many variations in brain activity have been seen in investigations where the receptive field of the recorded cell has been the primary focus (Noudoost et al., 2010; Maunsell, 2015). Typically, people will notice a 20-30% increase in their firing rate (Mitchell et al., 2007). The exact extent of the shift, however, varies from cortical area to cortical region, with bigger modifications observed in later regions (Luck et al., 1997; Noudoost et al., 2010). It is well established that attention affects the degree of variation in

neuronal activity. In particular, it decreases noise correlations between pairs of neurons and decreases trial-to-trial variability, as assessed by the Fano factor. Furthermore, it has been discovered that paying attention alters the electrical characteristics of neurons, lowering the likelihood of their firing and the height of individual action potentials (Anderson et al., 2013).

Aside from investigating how attention impacts neurons in the visual pathway, studies have also explored the origin of top-down attention (Noudoost et al., 2010; Miller and Buschman, 2014).

A saliency map is produced as a result of the bottom-up attention processing in the lateral intraparietal area (LIP)

In this area, cells respond to salient stimuli, including task-irrelevant and salient distractions, when they are located in their receptive fields. The prefrontal areas, on the other hand, are thought to contain the signals that enable the top-down control of spatial attention and are less susceptible to distractions.

Despite the fact that most of the research on the neural correlates of sensory attention has focused on the cortex, subcortical areas also appear to play an important role in the control and performance benefits of attention. Particularly, the superior colliculus plays a key role in both covert and overt spatial attention, and its inactivation may impair attention (Krauzlis et al., 2013).

1.5 QUESTIONS

1. Write a detail note on Cognitive Neuroscience
2. Discuss Visual Perception in detail
3. Write Short note

   a) Attention Processes

   b) Theories of Attention

   c) Consciousness of Mental Processes

   d) Preconscious Processing

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2

MEMORY AND LANGUAGE

Unit Structure

2.1 MEMORY

Memory is the ability of the mind through which data or information can be encoded, stored, and retrieved when required. Information is retained over time so that it could be used for the purpose of influencing future actions. If we lose our ability to remember, it will become extremely impossible for us to develop any personal identity or remember relationship experiences. Loss of memories is typically termed as amnesia or forgetfulness.

Memory is often viewed as an information processing instrument, comprised of a sensory processor, a short-term (or working) memory, and a long-term memory, each of which performs both explicit and implicit functions. This is commonly associated with how neurons function. All the world's data, in the form of chemical and physical impulses, is received by the sensory processor, where it is paid to with varying degrees of focus and purpose.

Working memory functions as a processor of encoding and retrieval. Various forms of stimuli can be encoded in adherence to the explicit or implicit functions that are undertaken by our working memory processor. The working memory is responsible for retrieving information from material that was previously stored. Finally, long-term memory performs a crucial function- it enables us to store data through various categorical models or systems.

Declarative aka explicit memory can be defined as a deliberate conscious storage and recollection of information. It can be further divided into semantic and episodic memory. Semantic memory can be defined as a type of memory that is typically encoded with specific meaning, and episodic memory can be defined as information of events and things we have experienced and is encoded with reference to its spatial and temporal plane.

Non-declarative aka implicit memory can be defined the automatic, unconscious storage and retrieval of information. It can be further divided into procedural memory, and priming. Priming can be defined as the process of specific responses being subliminally aroused from memory without us being fully aware of its conscious activation. Procedural memory on the other hand is the slow and steady inculcation or learning of skills that typically happens without us paying conscious attention to learning it

Memory is not an extremely perfect processing system and is influenced by many factors. The way in which any piece of information was initially encoded, stored, and retrievedis fallible.

The degree of attention received by new stimuli can reduce the amount of information that we encode for storage. Furthermore, perfect encoding doesn't guarantee perfect retrieval, and any kind of physiological damage to the hippocampus (part of the brain mainly associated with the storage of memory) can severely hamper our memory. Last but not the least, it is imperative to know that when any piece of information is not used for a long time by our brain, it could become prone to disruptions because of decay within our LTM. All these things have the potential to hamper the accuracy of our memory and its capacity.

2.1.1 Models and Research Methods:

To Assess Infants:

Infants do not yet possess the linguistic ability to report their memories and so verbal tests can't possibly be used to test the memory of young children. Over the last few years, many researchers have worked towards developing a number of psychometric measures to test recognition and recall in infants. Techniques used for testing recognition memory in infants are based on operant conditioning and habituation, whereas those used to measure recall were based on deferred and elicited imitation techniques

Let's take a detailed look at the techniques used to assess an infants' recognition memory:

Comparison procedure based on visual pairing:

The principle of habituation is usually applied throughout this process. Pairs of visual stimuli, such as two black-and-white photographs of human faces, are the first to be presented to infants. They will see this for a set

period of time. After the youngsters have seen both pictures, they are shown a fresh one and the one they already "know." The babies' exposure times to each image were also recorded. As expected, the infants looked at the new photo for a longer time compared to the familiar one, this hints at the fact that they remembered it. Other studies that used a similar procedure found that infants who are about 6 months old can remember information for a maximum of 14 days.

Operant conditioning technique:

In this technique, infants were carefully placed in a crib. There also was a ribbon which was connected to a mobile over the infants' heads. This ribbon was then tied to one of their feet.

Soon the infants began to notice that when they kick their foot, the mobile moves. The rate at which the infants kick also increased drastically within minutes. Studies based on this technique have found that the memory capacity of an infant, greatly improves over the first 18 months.

Age of the Infants	Duration of Operation Response being Retained
2- to 3-month-olds	a week.
6-month-olds	two weeks.
18-month-olds	as long as 13 weeks.

Let's take a detailed look at the techniques used to assess an infants' recall memory:

Deferred imitation technique:

In this technique, the infants are shown a unique sequence of actions like pushing the button on a box using a stick. After some passage of time, the experimenter then asks the infant to replicate the actions. These studies have found that the 14-month-old infants can remember the sequence of actions for a maximum duration of four months.

Elicited imitation technique:

This method is identical to the last one, with the exception that newborns are not prevented from imitating the behaviours during the wait. Using this approach, researchers discovered that 20-month-olds can remember action sequences even after a year. Such is the power of practice.

Let's take a detailed look at the techniques used to assess the memory in older children and adults:

Paired associate learning:

This technique follows a typical pattern of stimulus and response, wherein we learn to associate one specific word with another. For instance, when

shown a word like "lake", one must learn to say another specific word, like "boat".

Free recall:

This is a task where a subject is given a list of words to study. After that, they are typically told to recall words from the list or write them down in any order.

This task is prone to a lot of interference. When items that are previously learned in the list interfere with the recall of the later ones, we call it the Proactive Interference. On the contrary, when the words learned later in the list interfere with the recall of previous ones, we call it Retroactive Interference.

Cued recall:

In this task, participants are given strong cues to assist them in retrieving information that was already encoded into the person's memory. This is frequently done using a term related to the information that needs to be recalled. This is similar to "Match the Columns" that we used to have in school and junior college.

Recognition:

In this task, the participants are first given a list of words to study. After that, they are given a random list of words which consists of the words from the original list and some new words that were not in the list they learned. The Participants are told to identify the words that were previously presented to them in the list they studied. This is similar to the "MCQ" tests we usually have during internal examinations.

Savings method:

This is an interesting technique that typically compares the time taken to originally learn something with the time taken to learn it for the second time (after some interval). Studies based on these techniques have always found that re-learning something takes lesser duration than we took when we were doing it for the first time.

Implicit-memory tasks:

Cognitive psychologists have always been intrigued about how certain bits of information can be drawn from our memory without us being consciously aware of it. Therefore, while assessing the memory of older children and adults, a lot of tests are based on implicit memory.

2.1.2 Metacognition:

Metacognition is formally defined as us thinking about our own thinking. Metacognition of memory is therefore called metamemory. The term metamemory is used to refer to the idea that we monitor and control our own memory while engaged in the process of acquiring information.

Compared to others, this is a considerably new topic and hasn't been studied by psychologists for more than forty years. Before this, researchers believed learners to be passive, blank slates on which new ideas were engraved as a result of repetition.

It was only much later that cognitive researchers realized and started viewing the learner as an active controller of what he or she learns, regardless of whether involved in acquiring new information or retrieving something old.

Researchers now understand that individuals may track their progress while learning and retrieving information. Consider a student preparing for a French test tomorrow and studying French to English terminology such as "chateau/castle" and "rouge/red." Remember that the student has the ability to actively monitor and manage what he or she is learning as well as his or her efforts to recover answers when writing the exam the following day.

A sound theoretical framework that integrates all of these processes into one overall system was proposed by Nelson and Narens in 1990. They distinguished between different types of monitoring processes. They used the term "prospective monitoring" to refer to the learning/retrieval sequence pertaining to an individual's future performance, and the term "retrospective monitoring" while referring to an individual's past performance.

2.2 MEMORY PROCESSES; MENTAL IMAGES, MAPS, AND PROPOSITIONS

2.2.1 Memory Processes:

Memory is a crucial component of our everyday life and most of us cannot even imagine our life without memories. Remembering who we are, what good and bad others did to us, all the skills we've inculcated with time, our memory of safe and lethal things, etc. all play a very important part that aids in our survival.

We use our memory all the time, sometimes with a conscious effort and unconsciously at other times. At this moment, while you are reading this textbook, you are using your memory of words and their meanings that you had learnt when you were in school. Your brain is consciously focused on trying to comprehend what you are reading, but you are not trying to consciously recall "how" to read. Ain't that, right?

So, let us explore this fascinating topic further.

David Myers (2013) defined memory as the persistence of learning over time through the storage of information and its retrieval.

Robert Baron defined memory as the ability of one's brain to retain and later retrieve information.

According to Ciccarelli & Meyer (2008), our memory is an active system that first receives information from our senses, then organizes and alters that information as it stores the information away, and retrieves it later as required.

Psychologists typically use three ways to investigate whether learning has taken using three obvious ways- Recall, Recognition, and Relearning. We've discussed these concepts earlier in the chapter.

Psychologists have been conducting many important studies to understand memory better. For example, they have been curious to find out how memory gets affected by biological and environmental occurrences such as stroke, accidents, traumas, etc. Along similar lines, Myers (2013) noticed that people who have suffered from a stroke, may continue to have a warm personality as before and may be able to successfully complete their routine work, they may even remember past events exceptionally well, but they may not remember any new information after the surgery/stroke! Such a patient may not be able to remember what he had for lunch or if they even had one. A vice-versa situation is possible too.

Another noteworthy finding from empirical study is that, although most of us have to put in significant effort to learn a chapter, there are few individuals who can recall it by just hearing or seeing it once (photographic memory). Furthermore, some individuals can remember taught information both forward and backward, but many others cannot.

However, while studying people with a regular/ordinary memory, Konkle et.al. (2010) found that people who were exposed to 2800 images for just 3 seconds each, could spot the repeats with 82% accuracy.

In another experiment, Mitchell (2006) found that people who had seen a picture, 17 years ago, could still recognize that picture correctly even when they were shown that picture in fragmented form.

Every day, we are surrounded with sights, voices, sounds, tastes, scents, textures, locations, people, and so on. The concept of how our brain selects information from a wide expanse of knowledge and stores it for later use is interesting. How can we recall something we haven't thought about in years with such precision?

That leads us to a very important question- How exactly memories are formed and stored?

Let us try to understand this further:

Computer functioning and human memory:

This information processing model is based on the metaphorical applications of a computer's operations on human memory. Like the computer, the human mind also takes in information, performs cognitive operations on it to change its form and content, stores the information, and retrieves it as and when required. This entire operation is done in three-step processes:

1. **Encoding:** The information enters our brain in a way that it can be stored.
2. **Storage:** The information is held on to so that it can be retrieved later.
3. **Retrieval:** This refers to recalling the information at a later stage.

There is a significant difference between the way or computer functions and the way human memory works:

A computer stores information that is very literal in nature and is impervious to distortions, whereas human memories typically tend to be prone to errors, can get fragile with time, and are obviously less literal in nature. A computer saves the information as it is without assigning any additional meaning to it or linking it with previously learned information, unlike humans.

The processing of information in computers happens in a highly sequential manner, even while alternating between two softwares, applications, or tasks. The human brain on the contrary is blessed with the ability to simultaneously process a lot of information from different sources together. It is formally termed as parallel processing.

As discussed in the first point, human memories tend to be fragile in nature, and the information stored in our memory systems are constantly reconstructed and/or distorted as a result of conscious and unconscious cognitive processes. No matter how vulnerable, the potential of our memory capacity is still relatively unlimited. However, that is not the case in a computer. The biggest advantage of storing information in the computer would be that whatever is stored will remain in the same condition and will not change (unless the file is corrupted or your computer crashes and data cannot be retrieved), and it comes with a hard, physical limit of how much information can be stored in the computer.

Encoding and Effortful Processing:

Automatic processing typically takes place without much effort and it is nearly impossible to shut it off. Let's take a simple example, suppose there is one person who has been habituated to waking up at 5:00 a.m. in the morning to go to work, the probability of him waking up around 5 o'clock in the morning even if he forgets to set the alarm is very high. One of the reasons for this is that these things happen at a subconscious level and does not typically require our attention.

Effortful processing, on the contrary, does require our conscious awareness and a lot of effort, so that it can be encoded and stored properly. This type of processing is utilized when we are trying to inculcate a new or complex task that we are not familiar with, and requires our undivided attention. After the task has been successfully learned and becomes habituated, it then comes under the category of automatic processing. For example, when one is newly learning to drive a car, all of their undivided attention is focused entirely on the road ahead, they also tend to hold the

steering wheel very tightly, and simultaneously also in the process of mentally rehearsing different gears, placement of the brake and the accelerator. A similar pattern can be noticed when someone is learning to speak a new language, play a new instrument or sport.

Strategies for Effortful Processing:

Getting new information to be etched into our memory system typically tends to require strenuous efforts. Research by cognitive psychologists, however, has shown that we can always employ many strategies that can enhance our ability to form new memories. We'll know the extent of its success on how well we are able to recall the new information from our LTM. When used efficiently and effectively, strategies can be extremely beneficial and lead to better memories.

Let's take a look at few of the most common strategies:

1. Chunking:

The process of chunking is a fabulous strategy that works by clubbing or grouping familiar items into smaller chunks.

We all know that our short-term memory has a limited capacity of 7 plus or minus 2 items at a point of time. So even though we cannot technically increase our STM capacity, the process of chunking would allow us to shorten larger individual bits of information into smaller and meaningful chunks, enabling us to hold more units of information in our short-term memory.

This phenomenon was first identified by George Miller but people have been chunking information from long before. It's just that it happens so naturally that we don't even realise when we've used it. The process of chunking works best when the information is divided on the basis of personally meaningful chunks.

Chunking can be based either on language patterns or personally relevant numerical patterns. For example, BRAINISAMARVELOUSORGAN, can be chunked as "brain is a marvelous organ"- imagine trying to remember so many letters at once! The latter is easier to process and remember than the former. Let's take another example, now imagine trying to learn a mobile number- 8820987225, we don't tend to remember 10 digits individually, rather, we would usually club them as- 88 209 87 225.

2. Mnemonics:

Mnemonics are another amazing set of memory AIDS that makes the use of images or maps or peg words to enable a good encoding of information. It is a well-known fact that scholars and orators in ancient Greece used them to encode their lengthy speeches.

A lot of research in cognitive psychology has found that humans are very good at remembering pictures even if they are mental in nature. Mnemonics are based on the use of such vibrant imagery.

Acronyms or rhymes are some of the most commonly used mnemonics.

An acronym can be defined as a word that is formed using the first letter in a phrase. For example, UNICEF is the acronym for the United Nations Children's Fund or VIBGYOR is the acronym for colours of a rainbow (violet, indigo, blue, green, yellow, orange, red).

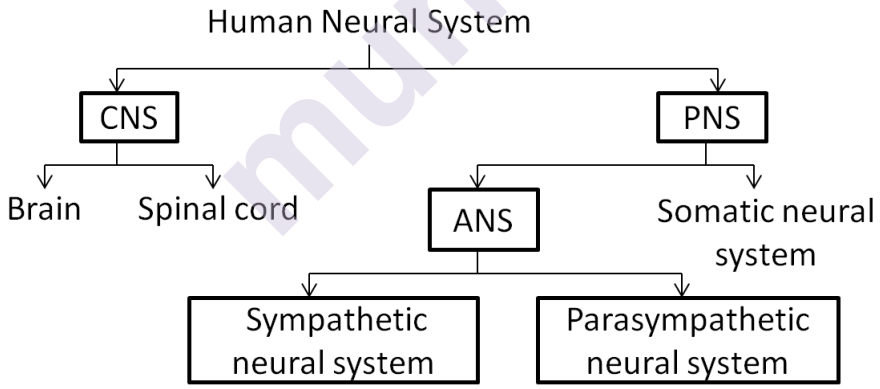
One can say something rhymes when words sound similar. They are easier to remember because our brain is fairly decent at encoding and retrieving acoustic information. An example of using rhyme to remember stuff by would be- 20th of May is my wedding day, or in two thousand three, we got married under the tree.

Compared to the other two, the peg word system can be a little challenging and requires us to memorize a list thoroughly. It works in such a way that we associate new words with the previously learnt list using mental imagery. Many cognitive psychologists believe that the pegs function in a manner similar to that mental hook that allows you to hang any piece of information on to it. The most typical pegword system includes the following format- one is a bun, two is a shoe, three is a tree, four is a door, five is a hive, etc.

3. Hierarchies:

A hierarchy in this context is nothing but a formal way of organizing information for better in coding there in it is broken down and subdivided into various categories. Hence it is called a hierarchy.

Diagram of nervous system



An experiment was conducted by Gordon Bower and his colleagues in 1969 wherein there were two groups of participants. One of them were shown words in an extremely random order, while the other group was shown information that was grouped into various categories like that of minerals, animals, medium of transportation, etc. Surprisingly the experiments found that when participants were presented with categorized information in an organized manner, their recall was significantly better than the other group who was presented with the words in a random manner.

4. Distributed practice:

Human memory is one of the most intriguing and frequently studied cognitive phenomena. There have been over 300 experiments in the last 100 years which have shown that we tend to remember and recall things better when the encoding is generally distributed over a span of time. This is called the spacing effect and was first noted by a pioneer in memory research, Herman Ebbinghaus.

One of the biggest sad realities is that despite knowing this information, students of psychology would still procrastinate in studying and learning until the last minute and try to grasp/study as much as information possible of few days before the exam. Such a crammed way of studying is termed as massed practice. Research by Ebbinghaus in the 1880s and many other subsequent studies have found that information that is learnt quickly has a higher probability of being forgotten quickly as well.

A distributed practice is a very organized schedule in which there are proper breaks and resting periods between practice sessions. Of course, studying using this kind of method will take a lot longer and may also make a student feel like they may not be operating at their full efficiency, but in the long run, distributed practice definitely shows more successful results than massed practice.

Harry Bahrick, most noted for his memory research found that the greater the time between study sessions, the better is the retention of that information. Not just this, hw also found that when people employ such techniques, the number of re-learning sessions they need are also lesser.

Another interesting finding was that once an individual has entirely mastered any information, overlearning or over-memorizing it will not add any significant value. If you need to retain the information for a later exam, results are best when we try and recall the master information once every 10-15 days or a month.

Harry Bahrick conducted a long-term study of 9 years along with 3 of his family members and concluded that if learning something is spread across several months, it can be retained for a lifetime.

Therefore, we can definitely conclude that it is more advisable to consistently study the syllabus for an annual exam across several months rather than cramming it all up just a few weeks before the exam.

Testing effect:

In 2006,Henry Roediger and Jeffrey Karpicke advocated repeated self-testing as an effective way to follow distributed practice. They said that instead of nearly re-reading material, one will get better results in practice retrieval by answering the questions as if they were actually writing an exam.

The basic premise here being that if you write an answer as if you were in an exam during practice, you would be using the cognitive faculty of

recall, as opposed to just re-reading material- which justuses the cognitive faculty of recognition, putting us into an illusion of having mastered the content which may not be the case all the time.

Levels of Processing:

Cognitive psychologists have always believed that the depth at which we process information exerts a great deal of influence on the extent of long-term retention for that information. There are different levels of processing and they can be classified as shallow and deep.

Let's take a look at each of them

Shallow processing:

This type of processing encodes information merely by memorizing words based on their appearance or sound. Information processed in such a manner is not deep and is at a very basic level.

Deep processing:

This kind of processing typically encodes information at a deeper semantic level not only by understanding the meaning of what they are reading but also by linking it to something previously learned. Many psychologists believe that the self-reference effect is high when encoding information at a deeper level. We shall talk about the self-reference effect later in the chapter.

In the year 1975, Fergus Craik and Endel Tulving conducted a series of experiments to study the effect of different levels of processing on the recall of information. In these experiments, participants were presented with three categories of words-

- **Physical** (based on appearance, like written in capital letters)
- **Acoustic** (based on sound, like rhyming words)
- **Semantic** (based on meaning, like a meaningful sentence)

Results of this experiment indicated that the words that were processed at deeper levels based on their semantic meaning, were recognized better when tested at a later time compared to the words that used shallow processing. Thus, we can conclude that rote learning something without really understanding what it actually means would not be very useful in light of long-term retention.

The self-reference effect:

We always find it difficult to remember information that does not seem to be too meaningful to us. For example, when your mother told you that guests are going to come tomorrow so you need to clean the house- chances of us forgetting this are higher, as opposed to her telling you that she will gift you an iPhone if you score above 75% in your final exam.

The self-reference effect simply means that we generally tend to remember things better when they are personally relevant to us.

Wayne Wickelgren (1977) said, "The time you spend thinking about material you are reading and relating it to previously stored material is about the most useful thing you can do in learning any new subject matter".

In a study conducted by Symons and Johnson in 1997, it was found that the self-references effect was more profound forpeople belonging to individualistic cultures.

Now let's take a look at a few possible explanations for self-reference effect:

- We tend to process information relevant to us more deeply and may also rehearse it more often. Therefore, better elaboration causes the information to be more accessible and readily available in mind.
- Information that is relevant to us causes a higher level of arousal which could have positive effect on our memory.
- Another explanation being that we have specialised mechanisms enable us to encode subjectively relevant information better.

2.2.2 Mental Images, Maps, and Propositions:

Communicating Knowledge: Pictures versus Words:

Knowledge may be stored in your memory in a variety of forms, such as an image, words, or some type of abstract statement. This chapter focuses on the distinctions between these types of knowledge representation. Of course, cognitive psychologists are primarily concerned with our internal mental representations of what we know.

However, prior to diving into our internal representations, let's look at external representations, such as books. A book has the ability to convey ideas via words and images. What distinguishes external representations in words from representations in pictures? Some concepts seem to be better comprehended and portrayed in images, but others appear to be better stated in words. When asked to describe something physical, such as a duck egg, you may find it more convenient to draw it rather than describe it; nevertheless, when asked to describe an abstract notion, such as justice or freedom, you may find it more convenient to explain it in words rather than drawing it.

Pictures in Your Mind: Mental Imagery:

Imagery is the mental representation of things which cannot be seen or sensed by the sense organs at a particular time (Moulton & Kosslyn, 2009; Thomas, 2003). We frequently picturize various objects, events, and settings.

For instance, try to recall one of your first visits to the college campus. What are the views, sounds, and smells that come to mind? The most common answers to this question would be the sight of tall buildings, roads with beautifully lined lush green trees on both sides, the refreshing smell of moist mud in the rainy season, or the sound of cars honking- if your college was on the main road.

Mental imagery can also allow you to view things from places you've never been to. For example, you can imagine how it would feel like to be in one of the pyramids in Egypt, or to be on the top floor of Burj Khalifa. It can also be applied to create or imagine things that actually do not exist. For example, imagining how you would look like if you had three hands and three eyes.

Visual imagery is one of the most researched topics in cognitive psychology, but that doesn't mean that mental representation doesn't involve other sensory modalities. Imagery occurs in other sensory modalities as well. For instance, we can imagine the sound of a ringtone, your favorite song; we can imagine the fragrance of our favourite perfume or the aroma of butter chicken; we can also imagine the taste of our favourite cake or ice cream.

In 1999, Kosslyn and Rabin hypothesized that we make use of visual imagery in order to solve certain problems. For example, answering questions like how many cabinets your kitchen has, or how many mirrors are there in your house. Kosslyn advocated that we use mental imagery to visualize the objects in question, in order to calculate the correct answer.

Psychologists from the other domains are also exploring applications of visualization to other fields like promoting health, pain management, immunity strengthening, overcoming phobias, etc.

Dual-Code Theory: Images and Symbols:

According to dual-code theory, we use visual and verbal codes in our thoughts to represent information (Paivio, 1969, 1971). These two codes organise information into knowledge that may be acted on and saved for later use. Mental pictures, according to Paivio, are analogue codes that resemble the things they represent. Plants and lakes, for example, may be represented by analogue codes in the same way as the movements of the hands on an analogue clock express the passage of time.

In contrast to analog code, a symbolic code is a type of representation that was arbitrarily chosen to resemble something that it doesn't naturally signify. The numbers on a digital clock don't naturally represent of the passage of time, but we arbitrarily assigned a representation of time to it. This is how symbolic codes work.

Symbolic representations are useful in depicting abstract concepts like freedom and justice.

Paivio wanted to prove that dual code theory and gather evidence to show that verbal information and pictorial information are processed in different ways. He conducted an experiment where the participants were rapidly exposed to a sequence of pictures and words, and then asked to recall them in 2 variations. One group of participants randomly recalled as many items as possible, irrespective of the order in which it was presented to them. The other group was told to recall items in the correct order of presentation. The results indicated that when participants were allowed recall in any order, their performance was better for pictures than for words. The opposite was true when participants were told to recall information in the sequence in which it was presented to them- here, recall for words was better than pictures. This difference in recall performance suggests that there is a strong possibility of the existence of two different systems handling the recall for pictures and the recall for words

Storing Knowledge as Abstract Concepts: Propositional Theory:

There still are many researchers who do not agree to the dual-code theory, and have deviced something called as the propositional theory aka conceptual-propositional theory as an alternative explanation. Anderson & Bower, and Pylyshyn are few of them.

The propositional theory advocates that even though we could experience are mental representations through image or word forms, we do not "Store" the mental representations in that form, they are rather an "epiphenomena". An epiphenomena basically is nothing but a mere secondary derivative of more basic cognitive processes.

A proposition can be typically defined as an underlying meaning behind a particular relationship among stimuli. Advocates of the propositional theory insist that our mental representations (sometimes referred to as "mentalese") reflect the abstract form of a proposition.

Current scenario of their proposed beliefs is that Anderson and Bower have moved on from there original ideation to a model that is more complex and encompasses not one but multiple forms of our mental representation. However, Pylyshyn and many others still hold on to the propositional theory.

Now, let's take a more detailed view on understanding how we use propositions:

Even though the concept of propositions is hypothetical in nature, it is widely endorsed by a lot of cognitive psychologists. Propositions same to be like the magical answer which can be used to describe any type of relationship whether talking about things in general, or attributes of that thing, directions of that thing, etc. Along with this insane capacity to represent numerous things at one time, a lot of propositions can also be combined in order to represent something larger and more complex.

Let's consider the example- "the Fury cat bit the dog and is now hiding under the bed".

The main idea behind the theory of propositions is that mental phenomena are not represented in the form of words or images, but rather, in some abstract form representing its underlying meanings. According to Clark and Chase (1972), when we read/hear a sentence or see a picture, we don't generally retain its auditory or visual properties; we retain its "deeper meanings" as representations, not as words or images.

Proponents of the propositional theory have concluded that verbal and pictorial information are typically encoded and stored as propositions, and when the time comes to retrieve this information from storage, the prepositional representation gets retrieved. Once the prepositional representation is retrieved, our mind recreates them in verbal or pictorial codes. This entire process may sound very cumbersome but is relatively faster and decently accurate.

2.3 LANGUAGE AND LANGUAGE IN CONTEXT

2.3.1 Language:

Language Development Stages:

Language development is divided into five phases. Let us go over each stage in depth:

1) Babbling stage:

Beginning about the age of four months, it is made up of babbles and various speaking sounds. Nonetheless, babies can distinguish speech sounds by 4 months of age (Stager & Werker, 1997). It's possible to make many of these sounds by simply bunching the tongue in front of the mouth, or by opening and closing the lips, to make combinations of consonants and vowels. By the time they're 10 months old, babies' babble has evolved to the point that a native speaker can pick out numerous sounds from the family's native tongue. If infants are not exposed to languages other than their own, they will not develop the capacity to hear and create sounds and tones that are not part of their own language. Babbling is not an imitation of adult speech; rather, it contains sounds from several languages, some of which may not even be spoken at home. Babies who are deaf and born to parents who are also deaf are more likely to babble with their hands and show interest in sign language.

2) One-word stage:

Beginning around the age of 12 months, this is the stage of speech development in which the child usually communicates in single words. They are already aware that sounds have meaning. They now start using sounds, usually only one identifiable syllable like ma or da. Family members, on the other hand, rapidly learn to comprehend this. Throughout the world, babies' first words are frequently nouns that label objects or people. This one-word stage may be equivalent to a sentence.

1. Telegraphic two-word speech:

Around the age of 18 months, children's word learning accelerates from about one word per week to one word per day. Most children have reached the two-word stage by the age of two. In telegraphic speech, they begin with two-word sentences: This early form of speech, like old-fashioned telegrams is largely made up of nouns and verbs, for e.g.. Want juice. Like telegrams, it follows syntactic rules; the words are in a logical order. Adjectives are usually placed before nouns in English, therefore, the sentence formed would be like: big doggie rather than doggy big.

2. Language quickly develops into whole sentences:

The two-word stage of language development is swiftly followed by the development of lengthier sentences in children (Fromkin & Rodman, 1983). The same stages of language development apply to those who start learning a language later in life, whether because of a cochlear implant or international adoption. (Ertmer et al., 2007; Snedeker et al., 2007). Children understand complex sentences and begin to appreciate the comedy imparted by double meanings: "You never starve in the desert because of all the sand-which-is-there."

Table 10.1.: Summary of Language development

Sr. No.	Month (Approximate)	Stage
1	4	Babbles many speech sounds
2	10	Babbling resembles household language.
3	12	One-word stage.
4	24	Two-word, telegraphic speech.
5	24+	Language develops rapidly into complete sentences.

Explaining Language Development:

Noam Chomsky believed that all languages have some underlying components, which he called universal grammar. Grammatical building elements in all human languages include nouns, verbs, and adjectives. Chomsky believed that humans are born with an intrinsic predisposition to absorb grammatical principles, which explains why preschoolers learn and apply grammar so quickly. It happens naturally. Regardless of the language we learn, we start speaking with nouns rather than verbs and adjectives. Furthermore, research shows that 7-month-olds may learn basic phrase forms. After regularly hearing syllable sequences that followed one rule, babies listened to syllable sequences that followed a different pattern in one experiment. They were afterwards able to distinguish between two patterns. This suggested that babies are susceptible to picking up on grammatical rules. Before the window of language learning closes, childhood appears to be a vital (sensitive) phase for understanding specific components of language. Adults who study a second language often talk with the accent of their native tongue and struggle to master the second

language. The window for language learning gradually closes in childhood. Those who have not been exposed to a spoken or signed language by the age of seven lose their capacity to master any language quickly.

Language Communication:

When both parties to a conversation comprehend each other's words and phrases, we may say that we have successfully communicated in that language. And it's not only a linguistic thing. Through body language, we convey a wealth of information to others around us. We depend on our rudimentary knowledge of the rules governing language usage whenever we utilise any of the thousands of languages in use today. This linguistic experience, also known as linguistic competence, is used automatically and almost effortlessly to create and interpret meaningful communication. In all appearances, the capacity to communicate effectively via language is unique to the human species.

2.3.2 Language in Context:

Living in a silent world:

The use of audible speech symbols, or verbal language, in mind has so far been the primary topic of discussion. Can languages other from one's native tongue be used as mental tools? Studies involving the deaf have shed light on this topic. Standardized measurements of cognitive function have shown that even deaf children with little linguistic proficiency perform within the average range (Vernon, 1967), and that their cognitive and logical growth is quite typical (Furth, 1971). These results have been interpreted as showing that the deaf's lack of access to spoken language has no impact on their ability to think critically or advance their level of cognition. Many deaf individuals, however, are taught sign language, and it has been shown that deaf children will create their own sign language even if they are not explicitly taught it (Goldin & Feldman, 1977). This may suggest that humans are hardwired to communicate with one another in some fundamental way, whether via words or body language.

The conventional visual-gestural sign languages acquired by the deaf share many characteristics with auditory languages. For example, just as auditory-vocal languages develop meaningful language by combining a small number of basic sounds, or phonemes, so do deaf visual-gestural languages. Thus, the visual-gestural languages can represent an infinite number of thoughts by combining simple motions. According to some research, deaf children who know sign language perform better on a number of cognitive and thinking activities than those who do not (Vornon & Koh, 1971; Stuckless & Birch, 1966). Thus, deaf people with limited verbal language skills appear to have a nonverbal language tool of thought.

The burden of living without hearing may be greater for children. Signing playmates find it challenging to coordinate their play with speaking playmates because they are unable to communicate in traditional methods.

Because academic courses are based on spoken languages, their academic achievement may significantly decrease. Adolescents may feel socially alienated, resulting in low self-confidence.

Do other species have language?:

Language is said to be the most complicated method of communication that exists among humans. It is a system of verbal and nonverbal norms used by humans to convey their thoughts and desires. Humans utilise language to express their needs and desires, and they cry, slouch, and make faces to show their sentiments. Animals, or non-humans, exhibit signals of communication as well, such as a dog wagging its tail when excited or a bird singing a song to attract the opposite sex. Do animals, on the other hand, speak? According to researchers, animals and non-humans do not have real languages like humans. They do, however, interact with one another through sounds and gestures. Animals have a lot of inborn attributes that they employ to communicate their emotions, but they are not the constructed words we find in human language. When wailing and gesturing, human children exhibit the same modes of communication as babies. However, they gradually learn the language words and use them as a method of communication.

Human children that are removed from humans at birth will not acquire the language and will be unable to communicate with other people. They would mostly communicate through sounds and gestures. In the animal kingdom, however, if they are nurtured alone from birth, they can behave and communicate like other species of their sort.

So, what about creatures that understand commands, such as dogs or "talking" birds? Dogs may be trained to obey commands such as "sit," "come," and "turn over," but does this mean they understand and can use language as well? Dogs are recognised for being expert interpreters of their owners' intentions, and they respond not to actual words but to the tone in which they are given. As a result, if you say "bad dog" in a happy tone, the dog will wag its tail. The dog will place his tail between his knees if you say "great dog" in a serious tone. Although captive birds are known to "talk," it is considered that this means nothing to them and that they are merely mimicking sounds they hear. There is no doubt that animals communicate with one another in reaction to various stimuli such as hunger or fear. Human language is unusual in that it allows us to interact in abstract and analytical ways.

Thinking and Language:

While Philip Dale was true in saying that "thinking is more than language" and "language is more than thinking," there are linkages between the two that will be discussed.

Every day, we rely on language to think. The use of grammatical rules and word symbols in the formation of phrases and sentences is an integral part of many people's mental processes. Words, their definitions, and the rules for making associations between them are all stored in our semantic long-

term memory. As humans, we depend on this body of information whenever we use language as a mode of reasoning.

Some ideas go to the other extreme, claiming that language determines what kinds of thoughts we are even capable of having. However, the idea of linguistic relativity has been subject to increasing examination in recent years.

Because so much of thinking involves language, psychology developed the notion that thinking was fundamentally a type of inner communication, a kind of "under your breath talking to yourself." When humans think, they produce small movements with their vocal apparatus and continue to think by talking to themselves, according to this notion. A number of studies have demonstrated that vocal apparatus motions can follow thought, whereas other experiments have shown that such movements are not required for thinking (Smith et al., 1947). In one bold study, a drug completely immobilised a physician. He couldn't move a muscle and had to rely on an iron lung to breathe for him. The paralysing medication, on the other hand, had no effect on how his brain functioned; it just acted on the drug. The patient was given specific language problems to address; of course, he couldn't answer because the muscles essential for speaking were paralysed. There is no way to know whether he was thinking whilst being under drug intoxication, but all indications are that he was unable to do so because, after the paralysis was removed by a counteracting drug, he clearly remembered what happened while he was drugged and promptly provided solutions to problems.

Language influences thinking:

There are at least 5,000 living languages on the planet, 140 of which are spoken by a million or more people. Is language simply a useful set of symbols for expressing our thoughts? The answer, according to linguist Benjamin L. Whorf, is no. Whorf claimed that higher levels of thought necessitate language and that the quirks of a particular language can influence how its users think about things. There are two concepts here. The linguistic relativity theory asserts that thinking requires language, while the other asserts that thinking does not require language. This is the hypothesis that has gotten the most attention. In its most extreme form, it contends that people's perceptions of the world are determined by the language they use.

Whorf founded his theory on research into North American Indian languages, although it is said to be applicable to all languages. He observed significant differences between these languages and European languages and argued that these differences cause their speakers to think differently. Language grammar, for example, influences how people describe environmental changes. Because nouns and verbs are the essential elements of English grammar, English speakers typically think in terms of "things" and "activities." Whorf discovered that people who speak a different language do not always divide circumstances in this manner. Furthermore, every language has terms that do not have an

equivalent in any other language. An example of a term that may be translated to mean "world perspective" is the German word weltanschauungs. No English word comes close to capturing this sense. Furthermore, languages vary in the categories they use to describe events. It's snowing, yet there's only one name for it in English whereas the Eskimo have four. According to the notion of linguistic relativity, e skimos have a more refined ability to visualise snow than other people. While many English speakers may have varied understandings of what snow is, the Hopi language has a unified term for all other types of flying items. The hypothesis proposes that speakers of the Hopi language have a unique perspective on aerial things compared to others who speak languages that do not organise the world in this manner. According to legend, the Hanno people of the Philippine islands have names for 92 different types of rice (Con, 1954 cited in brown, 1965). Language relativity is a contentious idea. Many experts in the field of linguistics dismiss the notion as circular. Since Whorf discovered that different languages have different grammatical rules and different ranges of thoughts they can convey, he reasoned that different people must have different ways of thinking. Language, on the other hand, is a gauge of thought differences via its assessment of how it is employed. Techniques for analysing word ideas outside of a particular language are lost. Results from the few available experiments have been mixed. Perhaps the real issue is not the breadth of thought that a language allows, but the ease with which its speakers can dwell on certain topics.

Even though there is no easy way to express it, English-speaking intellectuals can consider the concept of "global perspective." English speakers may envisage a wide range of snow conditions and may need to use additional words to describe them. Recently, the emphasis in thinking has shifted away from relativity and toward universals, implying that the core cognitive processes in thinking are comparable even when languages differ substantially. Color perception reveals the potential universality of mind, despite disparities in how different languages define colours. It has been revealed that speakers of quite different languages choose certain "focal" colors—a maximum of 11—from a colour chart. Furthermore, it has been established that even when these focal colours are not mentioned in the language, they can influence thinking. This defies the idea of linguistic relativity. Eleanor Rrosch, for example, has carried out research with the Dani people of New Guinea. For "white," the Dani only have the words "black" and "mola." In these trials, Dani subjects looked at a colour graphic with arbitrary labels assigned to eight of the focus colours and eight of the non-focal colours on the chart. The names assigned to the focal colours were learnt and recalled by the Dani faster and better than the names assigned to the other colours. Despite the fact that the Dani do not have terms for the main colours in their language, they have an impact on their thinking.

Thinking in images:

Because the availability of the symbols that we employ in thinking is often words and language, thinking and language are tightly intertwined. The

fact that a language makes hundreds of thousands of possible language symbols available is what distinguishes human thinking from that of other animals. Although language is a powerful tool in human mind, such as when we "speak to ourselves," visuals are another form of symbol employed in thinking. People's usage of images in their thinking varies greatly. Some people indicate that they practically never utilise mental pictures, therefore they must be thinking with words or orally; others report that the majority of their thinking is done in image form. When we think with images, they are not always entire "pictures in our heads." They are frequently incomplete. Consider the images you use, if any, to solve the following problems. (1973, Huttenlocher). Assume you're standing on a street corner in a neighbourhood of a city you're familiar with. How would you go from this spot to another part of town by walking or driving? Another scenario where photography could be useful: where on earth could you go 1 mile south, 1 mile east, 1 mile north, and wind up precisely where you started? Did you try to tackle this problem with imagery? If so, how did you depict it? Most people indicate that their images are incomplete while handling situations like this. People normally create a visual map to tackle the first difficulty, but this one is unusual. Although it depicts turns, the lines linking the turns are of varying lengths. In order to solve the second problem (the answer being the north pole), individuals picture a globe—but only the polar area of the planet. Although some individuals see snow when they think of the north pole, such problem-solving images contain only a few characteristics, such as sidewalks, roads, buildings, or colour. In general, the visuals are abstractions of previously experienced aspects. The imperfect, abstract representations we employ to think appear to be built from elements retained in long term memory. The creative process of imaging has been explored through an experiment in which people were instructed to produce images of varying sizes. An elephant, for example, could be imagined as the size of a mouse, or a mouse as the size of an elephant. Variations in image sizes of this type suggest that images are constructed. However, studies show that the ease with which information is found in an image relies on the size (and other features) of the image generated (Kosslyn, 1983).

Differences among Languages:

Why are there so many languages on the planet? And how does the use of any language in general, as well as the use of a specific language, influence human thought? Various languages, as you know, have different lexicons. They also employ a variety of syntactical constructs. These distinctions frequently reflect disparities in the physical and cultural contexts in which the languages evolved. For example, the Garo of Burma distinguish between many different types of rice, which is understandable given that they are a rice-growing civilization. Camel has more than 20 different names among nomadic Arabs. These people definitely have a more specialised and comprehensive understanding of rice and camels than anyone outside their cultural groups. Do the Garo think about rice differently than we do as a result of these linguistic differences? And do Arabs have a different perspective on camels than we do? Think about

how we talk about computers. Many elements of computers are differentiated, including whether the computer is a desktop or a laptop, a PC or a Mac, and if the operating system is Linux or Windows.

A person from a non-computer culture would not need as many terms or distinctions to explain these technologies. However, based on these distinctions, we anticipate unique performance and features for a given machine. Obviously, we think about computers differently than folks who have never used one. Languages' syntactical structures also differ. Almost every language allows some form of communication between actions, agents of actions, and objects of actions (Gerrig & Banaji, 1994). The order of the subject, verb, and object in a typical declarative sentence varies by language. The range of grammatical inflections and other markers that speakers must include as significant aspects of a sentence also varies. In English, for example, we change (inflect) the verb form to indicate whether an action occurred in the past. For example, in the past tense, walk becomes walked. In Spanish and German, the verb must also specify whether the agent of action was singular or plural, as well as whether it was referred to in the first, second, or third person. In Turkish, the verb form must also express whether the speaker saw or experienced the action directly or indirectly. Do these and other distinctions in required syntactical features influence—or perhaps even constrain—the users of these languages to think about things differently as a result of the language they use to think? In the following two parts, we shall investigate the notions of linguistic relativity and linguistic universals in greater depth.

Bilingualism: An Advantage or a Disadvantage?:

Is bilingualism more difficult to think in one language than in another? The information is fairly inconsistent. Different participant populations, techniques, linguistic groups, and researcher biases could all have contributed to the literature's inconsistencies. Consider what occurs when bilinguals are balanced bilinguals, meaning they are nearly equally fluent in both languages and come from middle-class families. Bilingualism has a favourable influence in these cases. Bilingual people had stronger executive functions, which include talents like switching between tasks and ignoring distractions. In bilinguals, the development of dementia may be postponed by up to four years (Andreou & Karapetsas, 2004; Bialystok & Craik, 2010; Bialystok et al., 2007). However, negative consequences may occur as well. Bilingual speakers' vocabularies are often smaller, and their access to lexical objects in memory is slower (Bialystok, 2001b; Bialystok & Craik, 2010).

What could be causing this disparity? Let us differentiate between additive and subtractive bilingualism (Cummins, 1976). A second language is acquired in addition to a relatively well-developed first language in additive bilingualism. Aspects of a second language replace elements of the native language in subtractive bilingualism. The additive form appears to result in greater cognitive capacity. The subtractive version, on the other hand, leads in diminished reasoning abilities (Cummins, 1976). There may be a threshold impact in particular. Individuals may need to

have a reasonably high degree of ability in both languages for bilingualism to be beneficial. Bilingualism in youngsters is frequently discouraged by teachers (Sook Lee & Oxelson, 2006). Many teachers actively support subtractive bilingualism, whether through letters urging that only English be spoken at home or through subtle attitudes and approaches (Sook Lee & Oxelson, 2006). Furthermore, children from lower socioeconomic status (SES) families may be more likely to be subtractive bilinguals than children from medium SES families. Their socioeconomic status may play a role in them being harmed rather than aided by their bilingualism. Researchers also distinguish between simultaneous bilingualism, which occurs when a kid learns two languages from birth, and sequential bilingualism, which occurs when a person learns one language first and subsequently another (Bhatia & Ritchie, 1999). Fluency can be achieved through either type of language learning. It is determined by the circumstances under which the languages are taught (Pearson et al., 1997). However, it is known that neonates start babbling about the same age. This occurs whether kids are routinely exposed to one or two languages (Oller et al., 1997). Many individuals in the United States make a great issue of bilingualism, possibly because so few Americans born in the United States to non-immigrant parents acquire a second language fluently. Other cultures, on the other hand, take knowing numerous languages for granted. In some parts of India, for example, people commonly learn up to four languages (Khubchandani, 1997). Many people in Flemish-speaking Belgium learn French, English, and/or German. They frequently master one or more of these additional languages.

Language in a Social Context:

The study of language in its social context is a relatively new topic of linguistic inquiry. One component of the context is the study of pragmatics, or how humans use words. It encompasses sociolinguistics as well as other aspects of language's social environment. In most cases, you adjust your language use in response to contextual cues without much thought. Similarly, you frequently adapt your linguistic patterns unconsciously to meet different situations. For example, when conversing with a conversational partner, you aim to establish common ground, or a shared premise for engaging in a discourse (Clark & Brennan, 1991). When we are around people who have similar backgrounds, knowledge, objectives, or aspirations, finding common ground is likely to be simple and barely apparent. When there is little in common, however, such common ground may be difficult to identify. Nonverbal communication techniques such as gestures and vocal inflections can aid in the establishment of common ground. Personal space is one facet of nonverbal communication—the distance between persons in a conversation or other encounter that is deemed comfortable for members of a certain culture. Proxemics is the study of interpersonal distance or its inverse, proximity. It is concerned with the relative distance and location of you and your fellow conversants. In the United States, 2.45 feet to 2.72 feet is considered about right.

The appropriate distance in Mexico spans from 1.65 to 2.14 feet, while in Costa Rica it ranges from 1.22 and 1.32 feet (Baxter, 1970). Scandinavians anticipate further separation. Middle Easterners, southern Europeans, and South Americans anticipate less (Sommer, 1969; Watson, 1970). When we are in our own familiar territory, we take our cultural beliefs of personal space for granted. Only when we interact with individuals from other cultures do we notice these disparities. For example, while visiting Venezuela, the author found that his cultural expectations clashed with the expectations of others around him. He frequently found himself in a hilarious dance: he would back away from the person with whom he was chatting, while that other attempted to get closer. The closer two people are within the same culture, the more likely they are to share at least one of three qualities. Before everything else, the people believe themselves to be extremely connected. Second, they are participating in a social activity, like close dancing, that encourages a diminished sense of personal space. Third, the bubble's "violator" has the upper hand in the interaction. Discrepancies in the degree of privacy one is afforded exist even in our own culture. For example, when two colleagues interact, the personal space is substantially smaller compared to when an employee and supervisor engage in a conversation. When two women converse, they stand closer together than when two males talk (Dean, Willis, & Hewitt, 1975; Hall, 1966). Is interpersonal distance a factor in virtual-reality environments?

Many elements influence how believable virtual environments are when they are developed. People's clothing, the appearance of the streets, and the sounds in the background all help or hinder their ability to submerge themselves in that setting. For example, when you visit a virtual location in Latin America, you expect to see individuals who seem Latin American. It is equally important to consider how people react in interpersonal interactions while creating lifelike simulations. How close do they stand, how often do they stare at one other, and how long do they hold that gaze? Computational models are being created to simulate the behaviour of humans from various cultures (Jan et al., 2007). Personal space violations, especially in virtual situations, induce pain (Wilcox et al., 2006). People whose personal space is infringed in a virtual setting will leave if given the option (Bailenson et al., 2003). In video conferencing, physical space is also preserved (Grayson & Coventry, 1998). These proxemics findings highlight the relevance of interpersonal space in all interactions. They also show that proxemics is crucial even when one or more of the participants are not physically present.

Gender and Language:

Do men and women speak distinct languages in our own culture? Gender inequalities in what we say have been discovered. Young girls are more likely than young boys to seek assistance (Thompson, 1999). Older adolescent and young adult males like to discuss political opinions, personal sources of pride, and what they admire about the other person. Females in this age range, on the other hand, prefer to discuss their emotions toward their parents, close friends, classes, and their anxieties

(Rubin et al., 1980). In addition, women appear to reveal more information concerning themselves than males (Morton, 1978). Conversations between men and women are occasionally considered cross-cultural communication (Tannen, 1986, 1990, 1994). Through their same-sex friendships, young girls and boys acquire conversational communication in essentially separate cultural situations. As men and women, we then take our childhood conversational styles into our adult conversations.

Tannen proposes that male-female disparities in conversational style stem primarily from different understandings of conversational goals. Cultural variations result in contrasting communication approaches. As one partner attempts, somewhat unsuccessfully, to comprehend the other, this can result in miscommunications and even break-ups. Men see society as a hierarchy, with the primary goals of conversation being the advancement of one's position, the preservation of one's individuality, and the prevention of defeat (Tannen, 1990, 1994). The goal of each guy is to "win" the contest by coming out on top. Women, on the other hand, use communication to serve as a bridge between the two parties, to encourage and uplift others around them, and to foster agreement. To accomplish their aims in discussion, women often resort to strategies that level the playing field and prevent any one party from coming out as dominant. The importance of women's commitment to their partnerships has been emphasised as well. When there are differences of opinion, they negotiate to come to an arrangement that benefits the connection and makes sure each person feels their needs were taken into account. They do this regardless of how they feel about the final consensus conclusion. Males place a premium on having a good connection with others. Due to their upbringing in a gendered culture that places a premium on masculine status, however, men's conversations tend to be driven by different motives.

According to Tannen, men attempt to assert their independence from their conversational partners. In this way, they demonstrate their unwillingness to yield to the demands of others, which would imply a lack of power. Men also prefer to inform (implying a greater status granted by authority) rather than consult (implying a lower status) with their conversational companions. In a tight relationship, the male partner may wind up notifying his partner of their plans. The female spouse, on the other hand, expects to be consulted on their intentions. Cross-gender communication between men and women frequently results in misinterpretation because each partner misinterprets the intentions of the other. Tannen suggests that men and women become more conscious of their cross-cultural customs and traditions. They may be less likely to misread one another's conversational interactions this way. They are also more likely to attain their individual goals, as well as the goals of the relationship and the other people and institutions influenced by their relationship. Such awareness is essential not only in male-female dialogues. It is also significant in general conversations among family members (Tannen, 2001). Tannen could be correct. However, converging operations are currently required, in addition to Tannen's sociolinguistic case-based approach, to determine the

validity and generality of her intriguing findings. Gender variations in written language use have also been identified (Argamon et al., 2003). For example, a study that evaluated over 14,000 text files from 70 different studies discovered that women used more words connected to psychological and social processes, whereas men used more words relating to object properties and impersonal issues (Newman et al., 2008). These results are not conclusive. A blog study discovered that the type of blog, rather than the author's gender, predicted the writing style (Herring & Paolillo, 2006). So far, we've covered the social and cognitive contexts of language. Language use influences, but does not entirely determine, the form of thought.

2.4 NEUROPSYCHOLOGICAL BASIS OF MEMORY AND LANGUAGE

2.4.1 Neuropsychological basis of Memory:

Retaining Information in the brain:

In the beginning, many people advocated that our long-term memory has a limited capacity, is inelastic, and can be symbolically explained as an empty box or room that we could feel to store our memories. Eventually, psychologists were able to prove that our LTM storage is indeed elastic and its capacity to hold information is infinite.

The information stored in our brain is not at all similar to the way books are organized in libraries. There is a lot of interaction happening within our brain as we encode, store, or retrieve any piece of information from memory. Therefore, one could say that all our memories are stored in such a way that they are scattered across the brain and not in any single location.

In order to prove this, Karl Lashleydevised an experiment where rats were trained to locate their path out of a maze. Once the rats had learned their way out, he performed surgery on the rats' brain to remove pieces of their brains' cortex and, then tested their memories again. Surprisingly, they noticed that whichever small section of the brain was removed, the rats would always succeed in finding their way out because the rats had partially retained bits of their memory.

This hinted to the idea that different parts of our brain interact when memories are encoded and stored. As a matter of fact, the encoding of different types of memories have shown to activate different parts of the brain.

Let's have a look at each of them.

Long-term memory can be broadly classified into two types- explicit and implicit memory.

Explicit Memory:

The explicit memory also known as declarative memory, is responsible for the storage of facts, previous experiences, vocabulary, or any piece of knowledge that can be retrieved consciously.

The explicit memory network majorly includes the frontal lobes and the hippocampus.

The frontal lobes:

The frontal lobes play a very essential role in working memory. Recent developments in technology have found evidence suggesting that while processing or learning any kind of verbal material, like recollecting your Facebook or Gmail password, the left frontal lobe shows higher activation. On the contrary, while being involved in the recall of any non-verbal material, like trying to recall the decorations done for your birthday party last year, the right frontal lobe shows higher activation.

The hippocampus:

The hippocampus is a part of the limbic system which can be found within each temporal lobe. It is majorly responsible for the creation of new memories. A lot of studies have found that different categories of explicit memories like images, events, names, etc. are stored throughout the hippocampus, and obviously, any kind of damage to it will impair its recall.

In an interesting study done by Kaamil and Chang in 2001, it was noted that birds who have an intact, well-functioning hippocampus in their brain have the ability to remember the hidden places where they stored food. What's most astonishing is that they could remember even those places that were not marked. But in the event that their hippocampus was damaged, they couldn't remember things so well.

In another interesting study on human brains, it was noticed that if an individual's left hippocampus has been damaged, their ability to recall verbal information is severely hampered, however they showed no impairment in recalling visual designs and locations. On the contrary, if their right hippocampus has been damaged, their ability to recall visual designs and locations will be severely impaired, but their verbal abilities remain unaffected.

In a 2003 study by Maguire et. al on cab drivers in London, it was found that their excellence in navigational skills of deciphering the complex mazes that London Streets can be, is linked to the growth of the rear area in their hippocampus. It has also been found that when it comes to factual memory, vocabulary, or episodic memory, the left hippocampus seems to be more involved, whereas when involved in spatial memory, the right hippocampus seems to be more activated.

By now this is common knowledge that most parts of memory consolidation take place during our sleep. Many studies have consistently

and significantly shown that getting a good sleep of 8 hours after learning something new, can actually boost our recall for it the next day.

In a fascinating study by Euston et. al. in 2007, it was observed that during sleep, our hippocampus and the cortex showed simultaneous activity rhythms. After we fall asleep, what typically happens is- our brain replays the entire day's events in a descending order.

Many cognitive psychologists are of the opinion that the hippocampus and the new cortex seem to have some kind of communication with each other, which aids in transferring everything that happened throughout the day to the cortex for storing it in our long-term memory.

Along with the consolidation and strengthening of our memory, sleep is also known to enable integration of new information. This could probably explain how one could suddenly get creative inside after a good night's sleep. This is probably why people are recommended to sleep over a problem when they can't think of solutions at the moment.

Implicit Memory:

Implicit memories also known as automatic or nondeclarative memory. It typically consists of classically conditioned responses, primes responses, or skills, procedures, and habits that we have grown habituated to. Declarative memory typically expresses itself through recollections, however, non-declarative memory does not operate in that way and typically expresses itself through performance.

The beauty of implicit memory is such that even if we cannot consciously access the recollection of something, it will still find its way to influence our current behaviour. LeDoux (1996) spoke about an interesting case of a patient who was suffering from Amnesia as a result of brain damage. This patient was unable to form new memories. However, the knowledge of those memories could have been saved implicitly or unconsciously, because even when she was not aware of things, they were majorly guiding her behaviour.

Let's see what actually happened- she and her doctor had a shake hand everyday when he introduced himself. He had to introduce himself everyday because as discussed before, she could not form new memories. The catch here is that the doctor had a drawing board pin in his hand which had pricked her on several occasions before. On a particular day, as the doctor routinely shook hands with her, suddenly she jerked and pulled her hand away. The following day, when the doctor came back and routinely went ahead to give his introduction, she refusedto shake his hand. When probed further, she could not pinpoint the reasons behind refusing to shake his hand, she just knew that she didn't want to. This indicates that she had been classically conditioned, even though she had no conscious recall of it.

The implicit memory network majorly includes the cerebellum and the basal ganglia.

The cerebellum typically governs the creation and storage of classically conditioned implicit memories. Therefore, if this part of the brain is damaged, people are unable to develop more conditioned reflexes, and the existing one school also get impaired. Also, since cerebellum is responsible for our voluntary motor movements, it could also get impaired.

Procedural memory is a form of implicit memory that allows us to effortlessly engage in a lot of physical activities. Most of our implicit memories can be called as procedural in nature. This procedural memory realies heavily on the basal ganglia and cerebellum. Both these brain areas have their own respective contribution toward procedural memory. The cerebellum is responsible for governing fine tuning of motoragility or corrections of movement required for skills like playing a sport or musical instrument, painting, etc. In the unfortunate event that the cerebellum is damaged, the full potential relearning of those kills could be hampered.

However, that may not necessarily be the case with basal ganglia. The basal ganglia is a subcortical structure that majorly governs motor movements. The cerebral cortex sends inputs to the basal ganglia, however, unlike other areas of the brain, the basal ganglia does not send back these inputs to the cortex for the confirmation of the procedural learning's conscious awareness. Many cognitive psychologists, believe this is the reason once we learn a motor skill like riding a bike or swimming, we won't forget it, even if we don't remember having learnt it in the first place.

Synaptic changes:

When memories are formed, our neurons typically release neurotransmitters to help pass on this message to other neurons throughout the synapse. The more this process repeats, the stronger a memory gets, our synapses typically undergo something called as long-term potentiation (LTP) which causes our neurons to send the electrical signals across the synapse in a more efficient manner. This typically causes proliferation of neurotransmitter receptor sites, and as a result, the prompts required to send a signal across are reduced. This indicates that neurons typically exhibit behaviour that is history-dependent, and as a result of constant pairing, certain changes- both, chemically as well as structurally- are initiated which greatly strengthens active synapses, enabling the formation of stronger neural circuitry.

2.4.2 Neuropsychological basis language:

The Brain and Language:

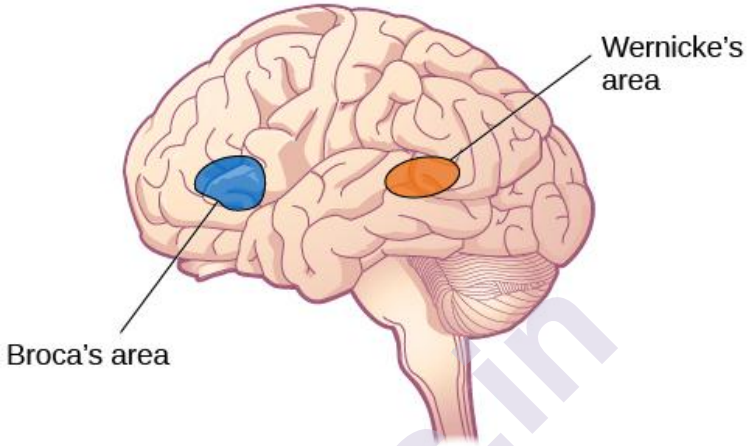
We all understand and acknowledge how importantlanguage is for understanding and having any kind of communication with someone else. In a fascinating study by Caplan in 1994, it was found that participants recognized words while most of the words were still being spoken. There is no doubt that the brain mechanisms cognitively supporting language are indeed very sophisticated. Many neuropsychologists have always been

curious to locate the underlying brain structures governing language and understand its operations.

Let's have a look at the two language disorders that are caused as a result of some form of brain damage in a particular area.

Broca's Aphasia:

Brain structure involved with languages.



In the 1860s, when we didn't have such sophisticated brain imaging techniques, localizing different brain functions, heavily on postmortem autopsies. One such interesting case was reported by Pierre Paul Broca- in 1861, a patient nicknamed "Tan" had lost his ability to speak any word saved for tan. Upon postmortem autopsy, it was found that this patient's left frontal lobe had a lesion. The patient "Tan" and many other patients suffering from a similar loss of ability to speak- had a common ground- all of them had a lesion in a particular part of their left frontal lobe. These findings led to the understanding that there is a particular area of the brain in the left frontal lobe which is responsible for our ability to speak- it has been named as the Broca's area. Any damage to this part of the brain causing someone's inability to speak is called as Broca's aphasia aka expressive aphasia. In this condition, while somebody's ability to speak is hampered, they would still be able to comprehend speech and could even sing songs that they know.

Wernicke's Aphasia:

13 years after it was discovered that the area named Broca's area is responsible for production of speech, Carl Wernicke, a neurologist, found that there is a particular brain area in our temporal lobe which is responsible for comprehension of spoken language. This area has been named as the Wernicke's area. If the Wernicke's area is damaged, people have extreme difficulties comprehending language, however their ability to speak still prevails (even though most of what they speak is gibberish). This phenomenon with damage to the Wernicke's area that causes extreme difficulty in comprehension of language is termed as Wernicke's Aphasia.

2.5 QUESTIONS

1. Explain in detail Atkinson and Shiffrin's three – stage information processing model of memory.
2. Discuss in detail short-term memory and working memory.
3. Distinguish between automatic and effortful processing of information. What are some effortful processing strategies that can help us remember new information?

2.6 REFERENCE

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3

THINKING AND INTELLIGENCE

Unit Structure

3.1 PROBLEM SOLVING AND CREATIVITY

3.1.1 Problem solving:

Broadly speaking, a problem can be defined as any kind of conflict between two contradictory things or an obstacle which restricts us from reaching our goal. In the process of trying to solve the problem we've encountered, we use available information from our long-term memory and our current perception of the problem situation before we begin to determine our options to solve the problem. Many cognitive psychologists consider problem-solving to be a form of motivated processing of information which is guided by certain rules of the presenting problems.

Problem-solving Strategies:

Most of the rules used in solving problems revolve around changes that are allowed while moving from one point to another. Let's have a look at different strategies that can be used for solving problems

1. Algorithm:

An algorithm basically is a set of rules which guarantees the problem to be solved, if followed correctly. It includes a meticulous step-by-step procedure and can be frustrating to put into practice sometimes, especially since the steps are elaborate and more in number.

2. Heuristics:

A heuristic basically includes extremely simple, quick, and easy strategies to solve problems which are typically based on our past experiences.

Heuristics can possibly lead to a solution but they do not always guarantee a successful outcome. One of the most common strategies is to break down a larger problem into smaller chunks, very closeto our desired goal with each little step that we move forward. There are many types of heuristics and some of them can occur without our conscious awareness too. For example, availablity heuristic. Other examples of heuristics include representative heuristics, anchoring and adjustment, take the best heuristic, etc.

3. Trial and error:

This method is probably by far the one that is most commonly used. All of us at some point, have used the trial and error method. It comes to our rescue in situations when we usually do not have a strategy for systematically solving a problem or cannot think of one. In this method, we keep trying one thing after another until we stumble upon the solution by some random chance. Insight and creativity can also play a part in this method.

4. Insight:

One of the most interesting ways of solving a problem, or should I say getting the problem solved is by using the method of insight. It is something that comes to us suddenly, and many times it just comes randomly to us long after we have exhausted our thinking capacity trying to reach a solution.

One of the best and most famous historical examples of solving a problem by insight is that of Archimedes who ran out of his bathtub naked shouting "Eureka" when he had finally found an answer to a problem that afflicted him for a long time.

Kohler was the first person to suggest the idea that learning takes place by insight. Inside is extremely influential while solving the most creative problems. When we typically solve a problem using insight, the amazing feeling that we get as a result of it is termed as the "aha" experience.

Obstacles In Problem Solving:

Solving a problem has never been easy task to accomplish. Every problem comes with its own set of obstacles or difficulty level. Even though we are the most intelligent species on this planet, our intelligence comes with certain limitations that could lead to us committing of you errors while trying to solve our problems.

Let's look at some of the most frequent barriers to the process of problem solving:

1. Functional fixedness:

Functional fixedness is one of the most common cognitive biases that typically leads us to utilize something only in the way that we have used it before. It creates some kind of a mental block that mentally restricts us in

a way that we can't think of utilizing the object in any other alternative beyond what it is typically used for. This block is created because we cannot move beyond the original purpose or intent of that object and wavelength to associate tools for their obvious functions.

One of the best ways of overcoming functional fixedness would start with the most obvious realization that a particular object could be used for multiple purposes and not just one function! We also need to start being cognitively flexible about theutilization of regular objects in ways that haven't been thought of before.

2. Mental set:

A mental set is a type of functional fixedness wherein we typically exhibit the tendency to choose a particular strategy or framework that directs our cognitive processes towards solving all our problem using the same solution that we utilised in the past and have worked for us, despite having more efficient and effective ways of solving the problem. This also indicates that most humans don't prefer getting out of their comfort zones and generally prefer to do things in ways that they are familiar with.

One of the best examples of the existence of mental set is the nine-dot problem. One of the earliest studies on the phenomenon of mental set was done by Luchin in the early 1940s and he found that almost 75% of the students continued to use the same strategy to solve the task at hand that they learnt in the practice condition, and were to some extent unable to see the easier solution.

3. Confirmation bias:

Confirmation bias is one of the biggest obstacles in the objective appraisal of something. It is a phenomenon which leads us to selectively notice or seek out evidence that confirms our original belief or theory, while ignoring or undervaluing the relevance of contradictory evidence.

Apart from these three, sometimes having incomplete information or lack of expertise can also lead to a set of difficulties towards solving problems.

3.1.2 Creativity:

In the 1920s one of the first people to have found that highly intelligent people are not inevitably creative was Lewis Terman and his colleagues. They also found that creativity is notentirely limited to or entirely bound by intelligence. Because people who won't be considered as highly intelligent also came up with creative ideas. In a fascinating long-term study that followed up on people considered as "gifted" for intelligence throughout their adult life, very expectedly found that not a single one of them was well known for their "creativity" in any field.

Other researchers have also found that anyone can be creative regardless of their intelligence. Thus, intelligence all alone does not guarantee creativity.

However, it is also important to note that there is a positive correlation between intelligence and creativity because any kind of creativity definitely requires some amount of capacity to accumulate knowledge along with the ability to understand and retrieve it.

Let's take an example- in order for authors and writers to be creative, they obviously need to be good with language.

Just as intelligence has different types or attributes, creativity also can take many forms. There are a lot of individual differences also while talking about intelligence and creativity. Why some people have more of intellectual abilities, others may have more of creativity, and there may also may be some who have the blend of both.

While considering intelligence and creativity, it is important to note that there is a lot more to the process of creativity then what can be measured through the use of intelligence tests.

Have you heard of convergent versus divergent thinking? The biggest difference between these two is that convergent thinking typically focuses on coming up with one effective solution, divergent thinking focuses on coming up with many possible creative solutions. Therefore, we could conclude that we need better psychometric procedures to test creativity since tests measuring intelligence require convergent thinking and creativity leans more towards divergent thinking.

Robert Sternberg and his colleagues have talk about various components of creativity. Let's have a look at them:

1. Expertise:

We can call someone an expert in something when they have thorough knowledge about it. This well-developed knowledge base in an individual allows them to generate different ideas, concepts, or images that form some kind of cognitive building blocks. Many cognitive psychologists believe that the higher the availability of such building blocks, the higher is the possibility of us combining them in a creative way.

2. Imaginative thinking skill:

We can call someone as possessing an imaginative thinking skill when they have not only mastered the basic elements of the presenting problem but can also redefine them in newer ways. This enables them to identify patterns and make connections.

3. A venturesome personality:

We can call someone venturesome when they seek out new experiences and also possess a unique peculiarity which enables them to have a higher threshold for ambiguity and risk and the necessary resilience required to conquer the obstacles.

4. Intrinsic motivation:

When someone is motivated by internal factors like inner satisfaction, fascinating interest, or overcoming an intriguing challenge, rather than external factors like money and deadlines, he or she can be called as operating from intrinsic motivation. Creative people by nature possess very strong intrinsic motivation and generally careless about extrinsic factors like impressing someone, revenue generation, meeting the deadline, etc. These people find the task at hand cognitively stimulating and derive immense pleasure from it.

5. A creative environment:

Dean Keith Simonton was fascinated by the role somebody's upbringing and environment have on their accomplishments. He and his colleagues studied 2026 famous inventors and scientists and their respective careers. This study brought a new leap of faith for the advocates of nurture in the classic nature versus nurture debate, because they found that most of those distinguished scientists were supported, challenged and mentored by their peers. But this was not all that they found. Another crucial finding was that out of all the people studied, many also had a strong emotional intelligence that enabled them to work effectively with their peers. Therefore, we can conclude that environments which not only foster better communication but also creativity, lead to higher rates of innovation and greater team building.

From a neuropsychological standpoint, in case the frontal lobe of an individual is damaged, sometimes their ability to read write, and calculate could still be intact but their capacity for imagination could be hampered.

3.2 THINKING, DECISION MAKING AND REASONING

3.2.1 Thinking:

Thinking is an extremely inseparable part of our existence. We think in most of the time that we are awake or even sleeping and dreaming! As you are reading this textbook, you are thinking about what it is that you just read, and even if you stop thinking about it and contemplate what you would be having for dinner tonight or what you can gift your bestfriend whose birthday is in the next month, You would still be thinking.

Researchers in the domain of cognitive psychology have always been intrigued by what goes on in the mind when we think. Broadly speaking, thinking includes cognitively processing information that we are receiving from our environment with the help of existing information stored in our long-term memory.

Many cognitive psychologists believe that thinking refers to a set of mental processes that intervenes between a stimulus and response which ultimately guides our behaviour. Let's take a very simple example- imagine the last time you went to buy a mobile phone- you may have told the shopkeeper your budget (stimulus), which led him to show you all the

good mobiles within the price range you gave them. This is then followed by you considering the pros and cons of all the options you shortlisted and then eventually you buy the one that you liked the most (response).

How do people think?:

Thinking is not only one of the most complex things that humans can accomplish but also one of the highest forms of intelligence. Thinking about thinking became a point of study only in the 1960s when cognitive psychology was strengthening its foothold. This was the time which was kind of dominated by the behaviourists who were not much in favour of studying thinking as it was more of a mental phenomenon and not an observable construct.

Difference between thinking and cognition:

Both these terms are often used as synonyms for each other, but it is important to note that there is a good amount of difference between the two. We've previously looked at how thinking is the catalyst mediating between a stimulus and a behavioural response. Cognition, on the other hand, is broader in scope in comparison to the process of thinking.

According to Watson, 'thinking' is 'sub-vocal speech'. Thinking is also defined as "mental activity that goes on in the brain when a person is processing information such as organizing it, understanding it, and communicating it to others."

Thinking by nature is not just verbal, but also includes the involvement of mental representations.

Let's have a look at a few elements that are important in the process of thinking:

Concepts:

A concept can be defined as a symbolic or representative construction of the most general and basic features of something. Symbols of language are crucial in the process of thinking, and these concepts are an important aspect of language. Some of these concepts are innate and can be seen as appearing earlier in life and are acquired with ease compared to others.

Let's have a look at different types of concepts:

1. Superordinate concept:

This is the most broad and generic type of concept. For example, the category of fruits or vegetables.

2. Basic level type of concept:

This typically includes one kind of concept around which similar once can be organized. For example, consider mango or grapes- there are many different types of both- red grapes, black grapes, green grapes or alphonso mango, badami, kesar, totapuri mangoes.

3. Subordinate concept:

Out of all the concepts, this represents the most specific type. For example, you may like apples, but your favourite apple could be the washington apple. Similarly, for dogs, you may be a dog lover, but Labradors could be your favourite.

4. Formal concept:

All those concepts that are governed by a well-defined set of unbendable rules or rigid features can be called as a formal concept and are generally non-negotiable. Broadly speaking, formal concepts are typically thought as a part of academics in educational institutions.

5. Natural concept:

Unlike formal concepts, natural concepts are not well defined and are developed as a result of our personal experience in the world outside. For example, the answer to the questions- Is tomato fruit or a vegetable?, Is a whale a fish or a mammal? The answers to these questions will majorly depend on our personal experience and level of exposure or accumulation of knowledge.

Being an intelligent human being includes the attainment and mastery of these concepts. Therefore, it is crucial to understand what aids in the attainment of concepts. Transfer of knowledge, the distinctive features of elements, having such properties of materials that can be easily reorganised or rearranged, the set of instructions received by us, availablity of all the relevant information given to us at the same time, as opposed to receiving it in bits and pieces- all of these are essential components for the attainment of concepts.

Without concepts, categorization of objects, ideas, or anything, as a matter of fact, would nearly be impossible! Imagine keeping a set of different toys in front of a child and telling him or her to "throw a ball", a child will not be able to comprehend this if they have not yet formed a concept of a ball or throw. Therefore, we can conclude that accumulation and understanding of concepts gives as a vast array of information with very little cognitive efforts.

Mental imagery:

Our ability to comprehend the pictorial representations of various objects/phenomenons is called as visual imagery or mental imagery. It is an inseparable aspect of human cognition.

Allan Paivio, Stephen Kosslyn, and many others have done some amazing research in the area of mental imagery.

Kosslyn and his colleagues did a study in the 1990s, and they found that most of our imagery is visual in nature. They primarily focused on the mental rotation of visual images, and concluded that when a mental image

is formed, its experience for us is pretty much like vision where we are seeing something but it is in our mind.

When an image is formed in our mind, we can twist it, turn it, bend it, in order to solve problems that involve visual imagery. It has also been found that even though mental imagery can hold a lot of details, in comparison to the actual perception of something, it typically tends to be less detailed.

Other important findings of Kosslyn's research include the following:

- When making judgements about its features, people take longer to evaluate mental images that are small compared to those that are large.
- When the images are different from each other, it takes more time to travel or cover a large mental distance, for obvious reasons.
- One of the best applications of visual imagery is the effect that it has on our memory when used properly. Many cognitive psychology researches have significantly shown that our prowess for memory can be most effective when we use visual imagery while encoding and learning information, especially if they are depicted in interaction with each other.

Prototypes:

While concepts can simplify and aid in our thinking, prototypes refer to a mental model of a concept that closely matches the peculiar characteristics of a concept/object/phenomenon.

Prototypes typically provide us with a mental framework that depictsa typical representation of a category. For example, we all have prototypes for a professor, a politician, a doctor, an actor/actress, a criminal, etc.

Prototypes also provide us with a baseline to compare new people we meet and help us to decide if they fit into a category or not.

Sometimes there can also be certain contradictions that hamper the placement of a new individual into a particular category. For example, let's say a young woman telling you that she does not like fancy clothes, makeup, and parties, and would rather prefer at home reading a book away from the lime light; later on you find out that she was a film actor; now, imagine your surprise! This happens because the young woman you encountered does not fit into your typical prototype of film stars.

Prototypes can vary and are built as a result of past experience, culture, geographical region, knowledge, etc. They also help us navigate social thought and guide our social behaviour.

The Prototypes we've developed or hold on to- exert a strong influence on our thought processes and help us while solving a problem or making a decision.

One of the most prominent names that comes up for their research on prototypes is Eleanor Rosch whose work has been very influential in cognitive psychology and related fields.

3.2.2 Decision Making And Reasoning:

One of the crucial factors involved in the process of problem solving is decision making where an individual has to choose one alternative from several others. This process of choosing comes with certain levels of risks and are typically guided by heuristics.

There are many types of heuristics, but for now let's look at two of the most commonly used-

1. Availability heuristic:

Availability heuristic is a mental shortcut that is based on how easily something comes to our mind. Information that is vivid, distinct, and recent, pops up automatically in our thought and is assumed to be a common phenomenon because it came to mind so readily. This greatly influences our judgement, and can frequently lead us into fearing things. For example, people who have recently watched any movie of "The final destination" franchise would be petrified of sitting on the rides in the amusement parks, compared to those who haven't. Another example could be that people staying closer to the sea, think about tsunamis more frequently than those who don't; or people who are either currently travelling on a path through the mountains or planning to, would be more frequent to think about landslides.

2. Representative Heuristic:

A representative heuristic is a mental shortcut that aids in the decision-making process by processing the information received and matches it with a prototype that best describes it. For example, imagine someone told you about an older woman who had tremendous love for children and was very warm, you would automatically assume that she is a very good grandmother to her grandkids because the description you received fits the most typical mental representation we have of a grandmother, therefore, we automatically tend to put her into that category.

While evaluating and deciding which outcome is more likely, we not only use rules based on available and representative information, but also use anchoring and adjustment to reach an estimated probability of a particular outcome. Even though these heuristics sound fancy and helpful, they induce a significant amount of bias in the process of decision-making.

Bad Decisions:

1. Overconfidence:

Sometimes the decisions we make can go horribly wrong because their correctness does not match up to our confidence level. All of us have over-estimated our ability to finish a particular task in a given amount of time.

One of the best examples relevant to students would be the time you have estimated to finish preparing for the upcoming exams. The preparation almost always takes more time than we initially predicted.

Before we jump to conclusions about our faulty attributions, let's consider if overconfidence also has some kind of adaptive value.

Many studies have found that even when people have errors in their judgement as a result of their overconfidence, they tend to live a more happy life than those who are underconfident.

On the contrary to people who appear less confident, overconfident people somehow appear to be having more credibility than others and are able to make difficult decisions more easily.

To conclude, there are a few things to keep in mind:

- While estimating the time taken for completing something, we must take into account the time taken to do something similar in the past and not hold unrealistic expectations of our abilities.
- The wisdom to decide whether we know we can do something or not, comes with experience, and we should first be open to knowing our limitations, and embracing them, before actually working on overcoming them.

2. Perseverance of belief:

Our tendency to faultily hold on to our beliefs, despite having contradictory evidence can be termed as belief perseverance. Sometimes, it has a strong potential to cause social conflicts especially when beliefs clash or are contradictory in nature. The more strongly we believe in something, the more tightly we will hold on to them.

Imagine a school teacher who has made up her mind and believes that one of our students suffers from a learning disability. She may tend to ignore the information that is contradictory to her belief.

Once a belief is created in our mind and gets validated, it will require stronger and more pressing proof to change it than it took to create that belief.

One of the best ways to overcome belief perseverance is to tell people to imagine the opposite. Many studies have found that when people are told to imagine and think about opposite things than their actual orientations, they have the capacity to become less biased while evaluating the evidence.

3. The effect of framing:

Framing can be defined as the way we choose to present something, and exerts a very powerful influence on the decisions we make. For example, imagine two patients who need to have the same surgery performed on them, and have equally qualified doctors to do so, but the only difference

here is the way success rate information is presented to them. Let's say, the first patient was told that this surgery is fairly common and 90% of the people, have successfully survived it. Imagine, the second patient is told that 10% people have died during this surgery.

Even though the information given to both the patients is same, the effect it will have will be extremely different. Obviously, the second patient who was told that there is a 10% probability that he or she may die during the surgery, will conclude it to be far more risky than the first patient who was told that there is a 90% chance of success (unless, the first patient is an over thinker and automatically wonders whether he or she will fall into the category of those 10% people who did not have a successful run).

Thus, we can conclude that framing is a very powerful tool and majorly influences whether somebody will be persuaded or not.

3.3 HUMAN INTELLIGENCE: ORGANIZATION OF KNOWLEDGE IN THE MIND

Introduction: What Is Intelligence?:

Intelligence is one of the most important mental constructs that has the potential to distinguish one individual from another. It can be defined as our cognitive capacity to gain knowledge from experience, our ability to reason logically, and our competence to effectively adapt to our environment.

The term "intelligence" is assigned by people to different to different attributes that enabled success in their own time and culture.

There are different definitions of intelligence given by different psychologist, some of which are given below.

- Alfred Binet was one of the first psychologist who worked on intelligence. According to him, Intelligence is the ability to judge well, understand well and reason well (Alfred Binet, 1973).

- According to Wechsler, Intelligence is the global and aggregate capacity of an individual to act purposefully, to think rationally and to deal effectively with his/her environment. (Wechsler, 1950).

- Other psychologists such as Gardner and Sternberg have defined intelligence as well. Intelligent individual not only adapt to their environment but also actively modifies or shapes it (Gardner & Sternberg).

In short, we can conclude that intelligence is the synthesis of all our combined abilities. Different theorists in psychology have advocated their own beliefs.

Let's take a look at them:

Alfred Binet, who is typically given the credit of being the father of intelligence testing, strongly believed that intelligence reflects our general ability for comprehending and reasoning that can manifest in many ways.

Charles Spearman, another distinguished gentleman in the history of psychometric testing, advocated that all of us possess a general intelligence factor but in different amounts. He believed that intelligence is a global combination of multiple abilities.

Louise Thurstone, another pioneer, contradicted Spearman and was of the opinion that intelligence can be further divided into a lot of primary abilities.

Joy Guilford also criticized Spearman's view of intelligence, and built on that of Thurstone. He believed that intelligence is made up of multiple intellectual abilities. He also stated that there are different aspects of intelligence can usually get ignored when the items on a test measuring intelligence are clubbed together.

Individual differences in intelligence:

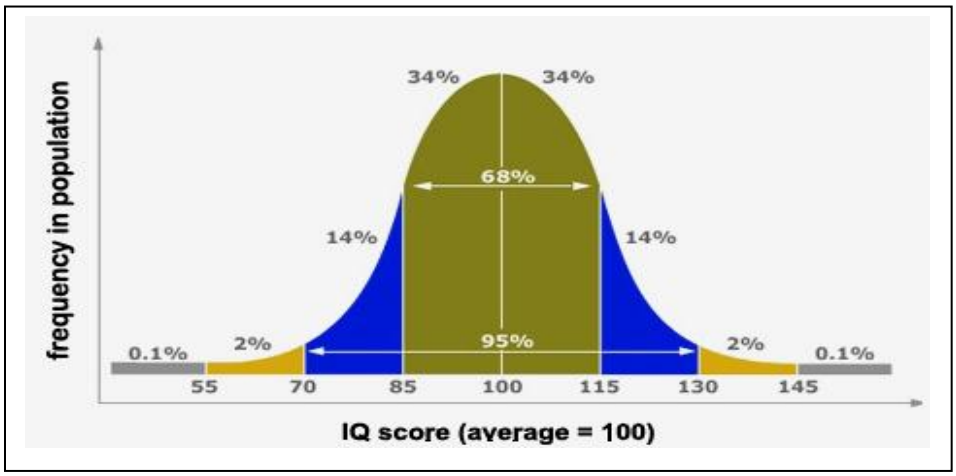
Broadly speaking, no two individuals can be exact duplicates of each other. Even identical twins exhibit behavioural differences once they grow up.

Consider anything and you will realise that there are individual differences in everything, right from our physical appearance to our psychological characteristics. Our height, our weight, our skin colour, the length and type of our hair, the extent of our approachableness, our talkativeness, etc. Similarly, the psychological construct of intelligence is also bound by a lot of individual differences that occur due to everyone's unique genetic heredity, environment, and the interdependent interaction of both the factors.

We inherit many characteristics directly from our biological parents through genetic material (genes). The entire hereditary information that we possess is called the genotype. The inherent characteristics that are physically expressed are called the phenotype. Phenotypes majorly depend on the social cultural as well as geographical environment of an individual. That is the reason we may share many similarities with our parents and grandparents like height, weight, eye colour, creativity intellectual competence.

Extremes of Intelligence: Retardation and Giftedness:

Figure: Normal Distribution Curve of Intelligence: Bell Curve



Multiple studies that tried to measure intelligence across different populations have shown that it typically represents a bell-shaped curve. This indicates that majority of the people are average in their intelligence, few people are either above average in below average intelligence, and extremely few people are either highly intelligent or immensely dull.

Mental retardation:

In the entire population, only about 2% of people have an IQ lower than 70 and a diagnosed with varying degrees of mental retardation. One of the most common causes of mental retardation is down syndrome. It is a chromosomal disorder caused due to an extra 21st chromosome.

The attitude of people towards those suffering from mental retardation has slightly changed over the last 20-30 years, and most of us don't use derogatory terms like idiot and stupid to describe them anymore.

Recent laws like the Persons With Disabilities Act (PWD) has declared it illegal to discriminate in terms of any kind of disability- physical as well as mental.

Our society is also changing and becoming progressively better because such individuals are also being trained and hired into some workplace. The very fact that today we have so many dedicated schools catering to the personality development, vocational guidance, and intellectual needs for such people, itself is proof that we have progressed for the better and have become more inclusive.

Intellectual giftedness:

At some point or the other, many of us may have wished for being more intelligent or having a greater memory prowess or even envied the first ranker in our class/college. There are always multiple sides to a phenomenon. For all you know, these intellectually gifted school children

would be envied so much by their classmates, difficult for them to create meaningful friendships in class.

Lewis Terman and his colleagues conducted an interesting study in the 1950s, where they made high school students take the Stanford-Binet test along with other similar IQ tests. They approximately selected 1,500 students who fell into the top 1% category. These kids had intelligence questions of more than 130 and work closely studied for more than 70 years. The most initial findings of the study were that these students were significantly better than the others in their health and were also taller and heavier than other kids of their age. Another interesting finding was that their social relationships were above average too and therefore, the probability of them getting divorced was also lesser.

It is important to also note that there are different kinds of giftedness. Some maybe exceptionally good at science or history or some form of art, some maybe extremely amazing at sports while others may possess an unmatched ability to lead.

There is a serious debate among academicians about whether weather it should be considered appropriate to provide such intellectually gifted children in schools and colleges with more advanced classes or programs that are obviously not available to the other students. Such provisions will not only isolate these kids from their peers but also make the other "not so gifted" kids feel like they are unworthy and are being deprived of something.

David Wechsler as classified IQs into the following categories:

Sr. No.	IQ Range	IQ Classification
1	130 and Above	Very Superior
2	120-129	Superior
3	110-119	Above Average Intelligence
4	90-109	Average Intelligence
5	80-89	Below Average Intelligence
6	70-79	Borderline Intelligence
7	55-69	Mild Mental Retardation
8	40-54	Moderate Mental Retardation
9	25-39	Severe Mental Retardation
10	24 and Below	Profound Mental Retardation

Figure A: Classification of Intelligent Quotient by Wechsler

Nature versus nurture controversy:

Even though it is widely accepted that intelligence has both genetic as well as environmental factors there has been a great deal of debate about the extent of influence both the factors exert. In an attempt to finally solve this

controversy, extensive studies have been conducted by a lot of researchers- Neisser et.al., Plomin, DeFries, and McGuffin- to name a few.

Studies done in 2004 by Plomin, Spinath, and colleagues have found that approximately 60 to 80% of variance in Intelligence Quotients can be attributed to genetics. This indicates that while the environment has its own part to play in one's IQ, genetics seem to play a significantly stronger part.

Another study done in 2004 by Deary, Whiteman, Starr, and colleagues found that the intelligence of children who are less than 3 years old does not help too much while predicting their intelligence in adulthood, however, as they grow older their intelligence remains stable. It has also been found that compared to the IQ scores of fraternal twins who are less similar in genetic terms (r= .60), the IQs of identical twins have a stronger correlation (r= .86).

The very fact that our IQs tend to become more and more stable as we grow older is enough evidence to conclude that early environmental experiences matter significantly more (speaking purely in comparative terms).

In an interesting study done by Turkheimer, Haley, Waldron, and colleagues in 2003, it was found that environmental factors also account for a higher proportion of intellectual variability in children from lower socioeconomic households than for children from upper social economic backgrounds. This difference could probably be because parents from a higher socioeconomic status typically provide a consistently safer, more supporting, and more enriching environment for their children, whereas these factors are highly variable in parents from a lower socioeconomic status (most probably due to lack of financial stability and consistent income).

Another well-established fact is that social and economic deprivation has detrimental effects on our Intelligence Quotient. This is because children raised in poverty typically have fewer resources at their disposal. They could lack basic educational opportunities, may not receive food with good nutritious value, and could also be exposed to certain toxins as a result of living in dangerous conditions which could affect their brain development and intelligence levels.

This brings us to an interesting question- if under-nourished environments detrimentally influence intelligence; can enriching environments improve it?

The answer to this question is simple- a consistently enriching and intellectually stimulating environment will certainly allow the individual an opportunity to rise up to the optimal potential of their intellectual prowess, but will not increase the genetic intellectual potential, magically converting somebody with lower or below average intelligence into a gifted intellectual.

Another interesting observation linking the role of nature and nurture could be the fact that a child who has above average intelligence will be treated differently compared to the child who has below average intelligence. Initially these differences maybe minute, but as both the children grow up, the differences in the opportunities given and resources provided to both the kids will most certainly amplify the initial differences.

Theory of Multiple Intelligences:

Howard Gardner was an American psychologist who staunchly advocated that we don't possess a single general intelligence, rather we have a set of multiple intelligences.

Let's take a look at the different types of intelligence proposed by Howard Gardner:

Linguistic Intelligence:

People who possess this kind of intelligence typically relish writing, reading, narrating stories or solving crossword puzzles. It generally depicts an aptitude for eloquence in language, both spoken and written. For example, any good author like Emily Bronte, Paulo Coelho, Paramhansa Yogananda, etc

Logical-Mathematical Intelligence:

People who posses this kind of intelligence are intrigued by different patterns, and their relationships. They are attracted to solving mathematical problems, and games involving strategy and experiments. For example, Albert Einstein.

Spatial Intelligence:

People who posses this kind of intelligence are generally very good at perceiving visual and spatial information and comprehending the world in tasks not just involving forms of art but also those that require geographical navigation. For example, the Painter, Pablo Picasso

Musical intelligence:

People who posses this kind of intelligence have a superior aptitude to understand, appreciate, compose, and perform any form of music. For example, A. R. Rahman.

Bodily-kinaesthetic intelligence:

People who posses this kind of intelligence are capable of using different parts of their body to successfully accomplish various activities and typically have superior hand-eye coordination. For example, Martha Graham, the famous dancer and choreographer, is a good example of bodily-kinaesthetic intelligence. The most distinguished athletes, dancers, and surgeons, or for that matter anyone who possesses tremendous control

over their body, their hands and legs, their fingers and toes can be said to have this form of intelligence.

Interpersonal intelligence:

People who posses this kind of intelligence are typically superior at understanding other people and behave in ways which are in accordance with that understanding. These exceptional people can easily gauge someone else's mood, their temperaments, and their motives too.

Intrapersonal intelligence:

People who posses this kind of intelligence have the capacity to fully understand themselves. They have an amazing insight into what they are feeling at a given point in time. For example, Mohandas Karamchand Gandhi.

Naturalist Intelligence:

People who posses this kind of intelligence are capable of recognizing and classifying different species of plants, animals, and minerals, and most typically pursue some aspect biology. For example, the most renowned naturalist, Charles Darwin. Naturalistic Intelligence is defined as the ability to observe and/or interact with diverse species in nature.

Existentialist Intelligence:

People who posses this kind of intelligence are capable of identifying the "big picture of the human world by raising the right questions about life, death and ponder about ultimate reality of human existence.

Emotional Intelligence

Most psychologists have believed intelligence to be a cognitive component, but intelligence isn't the only thing people use to solve their problems. Most of us take decisions emotionally and make use of emotions to direct their problem solving pursuits. They not only relate better to others but also have better and stronger meaningful relationships with others.

Emotional intelligence as a concept was first proposed by Salovey and Mayer. They defined Intelligence as our ability to monitor emotions, discriminate among different emotions, and using this information to effectively direct thoughts and behaviours- not just in us, but also in others. The concept of emotional intelligence is also mentioned in Howard Gardner's interpersonal intelligence.

Emotional Quotient (EQ):

Just as the term Intelligence Quotient (IQ) is used to signify intelligence, the term Emotional Quotient (EQ) is used to signify emotional intelligence. It can be calculated as follows- divide one's chronological age by their emotional age and multiply it by 100.

Therefore, **EQ = Emotional Age/ Chronological Age* 100**

Emotional intelligence governs correct appraisal, expression and regulation of our emotions. It is most typically called as the feeling side of our intelligence. A decent IQ and good academic record is not sufficient and doesn't guarantee success in life.

We may have encountered many people whose academic performance is splendid but their personal life could be miserable. What could be the possible cause behind the problems they experience in their personal and professional life? What do they lack? Most psychologists advocate that this can be explained by their low emotional intelligence.

Let's take a look at the peculiar characteristics possessed by most of the highly intelligent people:

- Accurately perceiving others' emotions
- Good observational skills that are highly sensitive to body language, facial expressions, and tonality of an individual
- Identifying the underlying emotions behind your thoughts
- Comprehending the intensity of your emotions.
- Ability to patiently monitor and regulate emotions.

Daniel Goleman is an American author and psychologist, most famous for the book "Emotional Intelligence" that he published in the year 1995. He broadened the concept of EQ and incorporated the aspect of general social competence.

Daniel Goleman believes that Emotional Intelligence represents a master aptitude that holds the capacity to exert great influence on all other abilities, either by helping or interfering in the process.

According to Daniel Goleman, EQ must encompass the following characteristics:

1) Self-Awareness.
2) Managing Moods
3) Motivating Oneself towards accomplishments of goals
4) Verbal as well as nonverbal Empathy
5) Managing and modulating relationships

Emotional intelligence is not synonymous self-esteem and optimism. According to Lopes and colleagues, people blessed with a higher EQ are precisely aware and possess exceptional people skills which enable them to create and maintain higher quality of interactions with others. They are better at dealing with feelings of depression, anger, and anxiety. They are

bestowed with an amazing ability to know what to say to calm down an anxious friend, encourage a loved one, or soothe someone who is troubled.

According to Fiori, EQ empowers the unconscious processing of emotional information. Numerous studies across different cultures have found that individuals with a higher EQ report better performances and satisfaction not only in one's career and marriage but also in parenting.

Being able to monitor one's impulses and delay immediate gratifications are crucial aspects of emotional intelligence, and definitely go a long way in the pursuit of one's long term goals.

3.4 NEUROPSYCHOLOGICAL BASIS OF EXECUTIVE FUNCTIONS

3.4.1 Social Determinants &Biological Determinants of Intelligence:

Biological and social influences have always been the most basic factors to have affected the human intelligence. Psychologists from different specializations have always been debating about the classic nature versus nurture issue, and this debate has been most profoundly focused on the domain of intelligence. Even though there isn't anyone who denies the genetic factors of intelligence, there are many who have different beliefs about the level of influence exerted by heredity and environment.

A decent amount of evidence which proves that our intelligence is what it is due to genetic inheritance. These studies typically test for correlations between the intelligence quotients of people who share different degrees of genetic relatedness.

One of the most consistent findings has been that on an average the correlation found between biological parents and their offspring is 50, and that of adopted children with their foster parents is exactly half, which is 25. Not surprisingly, the correlation between IQs of identical twins has been found to be 90. An interesting finding was that fraternal twins who are raised together, had a higher correlation of 0.75, which is significantly higher than those of fraternal twins who were raised separately in different homes by different people. Thus, researchers Skodak and Skeels (1949) concluded that being brought up together typically exerts an influence of having similar IQs even for people who are not biologically related to each other.

Racial differences:

After the classic nature versus nurture debate on intelligence, if there is any other hot topic discussed in this domain that is whether racial differences exist in intelligence, and many researchers have wondered whether Africans are inherently less intelligent than Americans. In order to test this controversy, a lot of research and studies have already taken place and proved it with a statistical difference that African Americans score at least 10 to 15 points lesser than Americans. But the biggest criticism to such studies is that these tests are heavily standardized on the

basis of American populations and are not culture-fair, and hence, cannot be used on populations of other ethnicities, majorly because most people of different ethnicities grow up in different environments, have different experiences, and have an understanding of the world that is quite different from one another and hence an African American child may react very differently on certain test items especially if he or she was being tested by an American examiner.

3.4.2 Is intelligence neurologically Measurable?:

Since the methods of investigating the brain have become so advanced, we can use these technological advancements to study the difference between the brains of different people and the corresponding differences in their performance on intelligence tests. Many researchers live in the hope that in the future there could be a test of intelligence based on our marvelous brain itself. Recent studies done by Carey in 2007 and McDaniel in 2005 have found that there is a correlation of +.33 between intelligence scores and an individual's brain size. In a recent meta-analysis done by Jung and Haeir in 2007, 37 brain imaging studies were thoroughly looked at, and it was found that the correlation between intelligence and size of the brain was strongest within the frontal lobe and parietal lobe.

Researcher, Sandra Witelson and her colleagues were among the lucky few who had the once in a lifetime opportunity to study the brain of Albert Einstein. They found that compared to the total size and weight of other typical 91 Canadian brains, the lower region in the parietal lobe of Einstein's brain was 15% larger, and certain other areas seemed smaller as well. Famous evolutionary psychologist and author, Steven Pinker believes that we have different mental functions that compete with each other for the brain's real estate, and that could probably be the reason why other great physicists like Richard Feynman and Edward Teller were slower while acquiring the ability to talk.

The fact that learning leaves behind traces in the brain's neural connections that can be detected. Psychologist, Dennis Garlick believed that intelligence exists because neural connections developed as a result of responding to the environment.

A lot of postmortem studies of the brain have revealed that people who are highly educated typically have 17% more synapses in their brains compared to people with less education (Orlobskaya et. Al., 1999). This finding races a big question which is not yet answered- do people with more synapses seek more education, or is it the other way round where synapses grow as and how people receive more and more education, or is it a combination of both. If you recall, we discussed in the first chapter that people who are more intelligent have greater neural plasticity and hence can grow neural connections better in response to their environment.

Does this new research decrease the importance of what we have termed as the "g factor" of intelligence in the favour of underlying brain activity? Or have we been totally wrong about these theories, and what we call

intelligence is not one single trait but a set of multiple skills that are culturally adaptive. Even when the neurological understanding of mental phenomena that we have today is at its peak, the debates and controversies revolving around the nature of intelligence are far away from being resolved.

3.5 QUESTIONS

1. Discuss Problem Solving and Creativity in brief.
2. Write detail note on Human Intelligence. Organization of Knowledge in the Mind
3. Is intelligence neurologically Measurable? Explain
4. Write short notes

   a) Thinking

   b) Decision Making and Reasoning

   c) Social Determinants of Intelligence

   d) Biological Determinants of Intelligence

3.6 REFERENCES

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4

PSYCHOLOGY OF EMOTIONS

Unit Structure

4.1 INTRODUCTION

Most psychologists define emotions as a complex state of feelings which lead to certain physiological and psychological changes that have magnanimous potential to influence our thoughts and behaviours. Emotions can compass everything we feel ranging from happiness and pleasure to sorrow and hate. Many scientists also believe that emotions are an adaptive response of our body and they aid or support our survival. Like any other psychological construct, emotions also include a set of physiological activations (for example, increase in the heart rate) coupled with certain feelings which guide our ultimate expressive behaviours (for example, fastened pace).

Researchers have always been interested to understand whether emotional feelings come before or after physiological activations, and if there is any kind of interaction between the way we feel and what we think.

4.2 THEORIES OF EMOTIONS

4.2.1 Historical Emotion Theories:

1) The James-Lange Theory:

Common logic dictates that typically we shall first experience an emotion and after that experience what follows is the consequent action. For example, when we are sad, we cry. However, the James Lange theory proposed something on the contrary, and advocated that feelings are a consequence of actions and are felt after the action has taken place. In short, what they were trying to say is we feel sorry as a consequence after we cry or because we cried.

To elaborate further and shed more light on what they are suggesting, imagine walking alone in the Jungle and you see a tiger, and naturally you would start trembling, your heart rate would increase, and these physiological sensations make a person realize that they are scared. In other words, in the absence of any evident physiological arousals leading to a perception, an individual in a similar situation would react purely in a cognitive form (lacking emotional warmth) like deciding to run or attack the tiger, but not actually feel scared.

2) The Canon-Bard Theory:

Canon and Bard couldn't agree with theory given by James and Lange. They advocated that typically people have the same physiological arousal for different emotions. For example, people cry not just when they are sad, but also when they are happy, or our heart rate can go up as a sign of fear or love or even anger.

Canon and Bard believed that in some instances physiological reactions could occur in the absence of any motion as well, for example, exercise also can increase our heart rate and have no emotional significance for it. This observation led them to propose their own theory of emotion where they pointed out that our experience of emotions and our physiological arousal towards it usually occur separately but simultaneously. They elaborated further by saying that the stimulus triggering our emotions travel simultaneously to the sympathetic nervous system and the brain's cortex leading to our body's physiological arousal and awareness of emotion experienced respectively.

However, some unsettling evidence came to light when people were doing research on patients who had severe spinal cord injuries and found that the patients who could not feel anything below the neck reported drastic changes in the intensity of their emotions. These patients reported that their experience of anger had reduced drastically but other emotions that are expressed mostly above the neck were felt more intensely, example they reported crying more often and getting more emotional while watching a movie or saying goodbye than they used to before the spinal cord injuries. This can be enough evidence to prove that our emotional experience is in part fed by the physiological responses in our body.

4.2.2 Cognition Can Define Emotion: Schachter and Singer's Two Factor Theory:

Schachter and Singer believed that the knowledge of when we are happy, angry, or jealous doesn't come automatically to us, rather, we tend to consider the situational cues first and then label our emotions. Basically, what they are suggesting is that emotions are created by our thoughts and physical reactions. Thus, the two factors are physiological arousal and cognitive appraisal.

In their theory, you also mention a phenomenon called the spillover effect, wherein other elements (for example, excercise) could also trigger a general and non specific arousal that causes our heart rate to increase or tightens our stomach and/or causes our breathing to become rapid.

4.2.3 Cognition May Not Precede Emotion: Zajonc, LeDoux and Lazarus' Theory:

Zajonc proposed that some emotional reactions that we have don't involve a deliberate form of thinking. He elaborated further by saying that our brain has two different pathways for processing our emotional responses. He called them the High Road and the Low Road. The Low Road typically denotes a shorter route consider it like a shortcut, which enables our emotional responses before are intellect could interfere. The High Road, on the other hand typically denotes the long route which also involves cognitive processing.

Lazarus specified that our brains can process large quantities of information outside our conscious awareness and a few emotional responses therefore don't seem to need conscious thinking. He also believed that a large part of our emotional life tends to function via the automatic and speedy Low Road. However, he also mentioned that before determining how to react we obviously need to appraise the situation, and sometimes this appraisal is so effortless that we probably may not even be consciously aware of it.

Lazarus also proposed that emotions arise after we have appraised any event as threatening or harmless and have confirmed it! For example, imagine you hear the sound of rustling bushes and appraise it as a presence of danger, upon looking into it further, you realize that it was just the wind, and therefore not a threat.

It is interesting to note that many studies have found some people to be highly emotional and intense partly because of their interpretations of emotional stimuli. Therefore, even though the low road functions automatically, the high road could overtake some control over our emotional life and its interpretations.

4.3 BIOLOGICAL BASIS OF HUMAN EMOTIONS

This is a well-established fact that we cannot distinguish between emotions with respect to signs of physiological arousals like heart rate,

breathing, and sweating because regardless of the type of emotion, positive or negative, our body's physiological response is the same! Fortunately, we can still differentiate between emotions based on subtle brain activity and the facial expressions.

4.3.1 Emotions and the Autonomic Nervous System:

The Autonomic Nervous System is further divided into Sympathetic and Parasympathetic Nervous System. While the sympathetic nervous system is involved in the fight or flight response and prepares our body for such action, the parasympathetic nervous system helps in calming the body down once the stress is over and dealt with.

Let's see how this works in greater details- whenever we encounter any challenging situation, our Sympathetic Nervous System initiates a series of many quick adaptations, for example, our adrenal glands secrete catecholamines, more sugar is released in the bloodstream so that our body can draw more energy, our respiration rate also increases so that we can receive more oxygen. Apart from this, the process of digestion also takes a back seat so that more blood and energy can be provided to our muscles, and in the event that one is wounded, formation of blood clots also happens quickly to stop the bleeding. Simultaneously, the pupils in our eyes dilate too so that more light enters our visual perception systems and we are able to see better. Not only this, our rate of perspiration also increases so that it can help our stirred-up body to cool down. This kind of physiological response from our body is helpful in successfully performing the actions that govern our fight or flight response. However, it is important to also bear in mind the fact that too much of arousal/tension or too little, both will be detrimental for our performance. Therefore, we should try not to be too relaxed or too tensed before and while undergoing any important activity.

Once the challenging situation has been dealt with and there isn't any more threat, our parasympathetic nervous system takes the front role and aids in gradually calming the body down while all the elevated levels come back to equilibrium.

4.3.2 The Physiology of Emotions:

Different emotions do not typically have very different biological reactions and they also don't seem to originate from specifically distinct brain areas. Consider the case of the insula in the brain- it gets activated when we are experiencing social emotions like disgust or pride, irrespective of the different sources that these feelings arise from. For example, we could feel disgusted at many things changing from the smell of spoilt food or the taste of bad food or just the idea of disgusting food or probably from watching some appalling news about bureaucratic corruption.

Nonetheless, there is a vast amount of research which has proven that the brain regions involved in different emotions and our biological reactions to them seem to be similar, researchers have been able to pinpoint subtle

differences in our brain patterns and physiological arousals for different emotions. For instance, the temperature of our fingers and the secretion of hormones are different when we experience fear in comparison with when we experience rage. When we typically experience fear, our eyebrow muscles seem to be tensed and when we typically experience joy, the area under our eyes and our cheeks are pulled to form a smile.

It is interesting to note that different emotions can activate different brain circuits. For instance, it has been well-established that when we are exposed to fearful faces, the amygdala shows more activity compared to when we are exposed to angry faces. It has also been found that when people feel negative emotions such as disgust, the prefrontal cortex in our right hemisphere shows more activation than the left. Another intriguing observation made by neuroscientists was that people suffering from depression typically tend to show more activation in the right frontal lobe, whereas people who have relatively positive personalities, are consistent in their goal directed activities, have high enthusiasm and good energy levels, typically show more activation in the left frontal lobe than the right one.

Therefore, we can conclude that even though different emotions can't be distinguished in terms of reactions in the body, other things like activity in the brain and facial expressions can definitely be a game changer.

4.3.3 Gender, Emotion and Nonverbal Behavior:

There has always been a significant gender difference when it came down to reading emotional cues. Many researches have consistently found that women compared to men are far more advanced while picking on emotional cues. This is applicable even when they are briefly exposed to other people's behaviour. For example, they are faster and more accurate in detecting if a couple is genuinely in love or are just pretending.

Psychologists believe that this difference is mainly due to the fact that women's sensitivity to nonverbal cues is greater because of their emotional literacy compared to men. In an experiment conducted in 2000 on emotional literacy by Barrett et. al., when asked how would they feel while saying goodbye to a friend, most men only said that they will feel bad, whereas women said that it will be bittersweet and that they will feel both happy as well as sad.

The fact that women tend to be more emotional than men is well documented. There is a major gender difference in the attributions behind reactions- women's reactions are typically attributed to their emotions, unlike men's reactions which are typically attributed to circumstances, except for anger because it is categorised as a more masculine emotion. Another gender difference found in multiple studies is that women not only describe themselves to be more empathetic but they are also more likely to have an increased heart rate or cry when they see someone in distress.

4.4 MEASUREMENT OF EMOTIONS

4.4.1 Detecting Emotions in Others:

Most of us are pretty decent at reading nonverbal cues, especially when detecting threats. For example, amidst a crowd of faces, an angry face is easier and faster to detect than a happy one. We often pay close attention to voice tones, facial expressions, body language, etc. while trying to determine the emotions of other people.

There are many subtle cues which give away crucial bits of information. For example, a firm handshake typically represents a confident and outgoing personality, and a gaze or a stare typically indicates intimacy or dominance depending on the context.

In an interesting study, where all the participants were total strangers to each other, male-female pairs were made and they were asked to look into each other's eyes for at least 2 minutes. Not so surprisingly, at the end of this task, they reported feeling attracted towards each other.

It has also been found that experience has the potential to cause sensitization towards particular emotions. For example, physically abused children are faster at detecting signals of anger.

Lie detection:

Forensic psychologists, researchers, and crime investigators, frequently use polygraph tests to detect lies. However, it's effectiveness and reliability at depicting lies have always been in question. A polygraph test typically is based on the fact that certain emotions can lead to certain physiological changes in cardiovascular activity, breathing, sweating, etc whenever a person is lying. The underlying assumption behind this being that comparatively speaking, one can control their facial expressions but not their physiological reactions.

The typical process of a polygraph test works in such a way that basic, regular, and control questions like name, address, occupation, etc are asked in order to establish a baseline of physiological responses; and once the baseline is established critical questions about the investigation are asked. And based on the changes and intensity in physiological response on the polygraph test, a conclusion is made. Thus, if the level of physiological arousal while answering the critical questions is weaker than the baseline, one can typically say that a person is telling the truth, and if the physiological arousal for the critical questions is higher than the baseline, one can conclude that there is a higher probability that the person is lying.

4.4.2 Culture and Emotional Expression:

Many studies across the globe have proven that facial expressions are universal throughout different cultures. Children typically cry when they are distressed and smile when they are happy. This is validated by the fact

that even those people who are born blind typically show similar facial expressions that are correlated with happiness, sadness, fear, and anger.

Charles Darwin advocated that before the formal establishment of language as a means of communication, our ancestors in the prehistoric times communicated with each other through facial expressions and this provided them with a very high survival advantage.

4.4.3 The Effects of facial Expression:

Many researchers have found that facial expressions don't just signify emotions, they also tend to regulate, amplify, and influence them. For example, it has been observed that the more we explicitly smile, we also tend to feel better. This phenomenon is called as the facial feedback hypothesis which advocates that our facial expressions also have the ability to influence our experience of emotion and not just the other way around.

There have been many interesting experiments which have yielded many fascinating findings. One such experiment was done on patients suffering from depression who were administered botox injections. Now, it is a well established fact that botox injections tend to paralyze the facial muscles, and when these patients suffering from depression were given Botox injections, their faces typically frowned less, which led to the patients reported feeling better.

Another interesting experiment was able to prove that the finger that we use to scroll or move up and down while reading a story can also influence our reactions to it. They found that when participants read the story while moving an extended middle finger, the story seemed harbouring more hostility and when participants of this experiment read it with a thumb up, they reported feeling more positive.

4.5 EMOTIONAL DEVELOPMENT AND REGULATION

4.5.1 The Need To Belong: Introduction:

The fact that we all are social beings and have a strong need for affiliation with others is very well documented. Aristotle also spoke about how people would prefer to live with others even with lesser resources rather than living abundantly and alone. Alfred Adler called our urge to form long-lasting, close relationships with others as an "urge to community". Psychologists have always believed that the need to affiliate has been advantageous for human beings.

Aiding In Survival:

Evolutionary psychologists have elaborately advocated that being in a group while living in forests and caves, not only gave our ancestors a survival advantage by collectively fighting against wild animals and protecting oneself but also evolved and enhanced our cooperation. Our ancestors must have realized at some point that hunting in a group is

always more beneficial than hunting an animal larger than oneself individually.

Evolutionary psychologists believe that all living beings are born with many instincts that have evolutionarily evolved with time. Survival and reproduction are two of the strongest instincts. In the olden times, the adults who are able to form attachments with others had more probability of reproducing and propagating their genes. Thus, ensuring that a part of their genes and biological existence is carried forward. Those people who felt the need to belong and created affiliations with a group, had better chances of survival and reproduction compared to others who didn't feel the need to affiliate with anyone. Therefore, evolutionary psychologists have concluded that being social is inherent to us.

Many studies have also reported that people who form close and meaningful relationships with others, tend to feel more supported, more loved, more happy, and those are at a lower risk of being inflicted by any psychological disorder like depression or suicidal ideation compared to those who do not have such social support systems.

Wanting To Belong:

Another well-established fact is that we derive a lot of gratification, happiness, and meaning from the kind of relationships that we share with our loved ones. Many studies have also shown that- comparatively speaking, a happy relationship is more satisfying to an individual than being rich. In a recent study done by Deci and Ryan in 2002, it was reported that we feel a profound sense of well-being when our need for affiliation is balanced with our need for autonomy and competence.

We all tend to feel good and have a better and healthier self-esteem when we feel loved, accepted, and appreciated. Hence most of our actions are directed towards activities which will lead to a higher social acceptance and we also tend to conform to norms of our society or group, in order to make a favourable impression of ourself and avoid rejection.

To understand fully how much our affiliations with other people matter to us, just consider how most people typically describe themselves. For example, when introducing oneself, people tend mention which family, community, school / college, organization or institution they belong to.

Sustaining Relationships:

The fact that familiarity generally leads to liking is also well documented. Imagine joining a new school or college full of strangers. Initially, when we do not know anyone, we may feel indifferent towards them. However, at the end of that degree or course, parting ways can be very painful and distressing because of the emotional bonds that we formed with some people in that group, and promise to be in touch with one another.

Many studies on abusive relationships have found that people tend to remain in an abusive relationship because they would rather suffer

physically and emotionally than be alone. The fear of being alone is so powerful that people are willing to suffer emotional and physical trauma but not break away and get separated from their abuser.

A study by Oishi and Shimmack in 2011 found that the children who grew up frequently relocating to different foster homes, and lacking opportunities to form long lasting attachments or disruptions in the process of one, have immense difficulty in creating meaningful attachments with others later in life. It has also been found that children who are neglected severely have difficulty feeling a sense of belongingness and are typically withdrawn or frightened.

Some of the best moments of our life are when we have formed close affiliations whether in terms of forming deep friendships or romantic relationships. On the contrary, some of the worst moments of our life are when such important relationships come to an end either due to death or irreconcilable differences, and we feel lonely, angry, anxious, guilty, jealous, and/or empty.

The Pain of Ostracism:

Forcibly excluding somebody from a group or society is formally termed as ostracism. For years together, people have controlled social behaviour by using ostracism as a form of punishment. In its extreme, ostracism can take the form of being exiled or being imprisoned in solitary confinement. Being ignored by a friend or being given silent treatment or being avoided are milder and commonly found forms of ostracism.

Williams and Zardo spoke about how one's need to belong is threatened when one is given the cold shoulder or silent treatment or simply avoided. They emphasized that this probably is the meanest thing one can put someone else through especially when the victim can't fight back. It has also been found that just being in a group that speaks a language that you don't understand and speak can make you feel extremely excluded and left out.

When somebody is being socially ostracized, initially they may try to get their acceptance restored, and if they fail to do so, they may go into withdrawal. This will also have a detrimental effect on their self-esteem.

An interesting study was conducted by Williams et. al. in 2006 wherein they found that the experience of cyber-ostracism was equal to the experience of real pain. Cyber-ostracism can we typically termed as being ignored on various digital platforms of social media. Social ostracism by not just our loved ones but even by strangers takes a toll on its victim and was shown to activate the same brain area that typically gets activated when we are in some physical pain.

It has been found that whenever anyone experiences any form of rejection and cannot pacify or change the situation, they typically tend to seek new friends or relieve their stress by strengthening their religious faith; or they may also resort to behaviours that are self-defeating, develop a lack of

empathy or tend to behave aggressively, especially with those who made them feel excluded.

Social Networking

Technology, today, has led to a considerable change in how we connect and communicate with other people. Since social networking has spread through all aspects of our life, it is essential to understand the effect that it has on us.

The social effects of social networking

Research has found that the more time we spend communicating online in chat rooms or playing online games, we spend less time with the people around us and relationships in the real world have immensely suffered because of that. Since communicating on digital social media platforms has become the new normal, psychologists are intrigued by the question- "Are Social Networking Sites Making Us More or Less Socially Isolated?"

In a study done in 2010 by Bonetti et. al., it was found that people who feel lonely usually tend to spend more time online than those who don't. It has also been observed that compared to non-internet users, people who spend most of their time online typically don't know much about their actual neighbours than they know about their internet friends.

Networking on social media isn't always bad and can also have multiple advantages. For example, it is easier to connect with like-minded people who have similar interests from all over the world thereby breaking geographical boundaries. Other examples of benefiting from social media include connecting with different groups on Facebook or WhatsApp- increasing our social network, or when any difficulty that gets posted online, garners support which not only makes us feel that we are not alone but also provides the much-needed encouragement. The most obvious advantage of social media is that it allows us to stay in touch with our friends and family who stay in a different city or country.

Another interesting phenomenon which was noticed on social media is that people usually feel more comfortable while disclosing personal information online rather than confiding in actual people in their own life. This lead psychologists to be puzzled by another question- "Does Electronic Communication Stimulate Healthy Self-disclosure?"

The incidences of people posting a suicide note or video before actually committing suicide on Facebook are also increasing each day, leading to the question- "why do people share their distress so openly on social media rather than talking to someone around?".

There can be multiple explanations for this. Most obvious one being that these people may not have anyone with whom they could talk face to face about their problems; Or probably because making oneself vulnerable to someone in person could make a feel weak, self-conscious or harm our self esteem.

Some people try to depict their true life and share it with their online friends while some others are probably predators trying to find another gullible victim to prey on and devour. This made psychologists also wonder-"If Social Networking Profiles And Posts Reflect Actual Personalities of People!"

A concerning observation was that people on social media mostly talk about themselves- their likes, their dislikes, their experiences, their thoughts, basically it's all about their life. This has leads psychologists to wonder "If Social Networking Promotes Narcissism?!"

To answer this question, to an extent it does, who is these people enjoy being the center of attention and typically compare the number of friends or followers they have on social media websites or the number of likes that they get on their posts compared to that of other people. They are tremendously active on social media and derive a great deal of pleasure by having the maximum number of likes or followers. They are trapped in a vicious cycle where they try to post more glamorous photos to get more likes.

Maintaining A Balance And Focus:

Mental health experts have suggested a few things that we can do in order to balance our real and virtual world.

Monitor your time:

One can monitor the time that we spend on everything during the day and analyze whether the time that we have spent on things reflect our actual priorities.

Monitor your feelings:

It has been suggested that we keenly observe how we feel when we aren't online. If at all one feels too restless or anxious all the time when they are not online, it is a clear indication that you are addicted to social media and need help.

Filter information:

It is also prescribed that before posting anything we must ask ourselves if we would be interested in reading this if someone else had posted it! We also have the option to hide posts from people who can be anxiety-provoking or distressing or simply unfollow/unfriend/block them.

Turning off your mobile phones or keeping them somewhere else:

Many cognitive psychologists have identified that we can't pay full attention to two things at the same time, and if we do at least one task suffers.

Going on an internet "fast":

Many ancient Indian texts talk about fasting (upwaas) as a means of detox, the same logic can be applied to our addiction to social media as well.

Recharge yourself by reconnecting with the nature:

The benefits of walking in a quiet garden and its effect on our capacity to focus, concentrate, and feel inner peace is very well documented, and we must follow this practice as and when we get the time to do so or probably find time to inculcate this practice into our daily or weekly schedule.

4.6 SUMMARY

In this unit, we have touched upon three learning items - need to belong, emotions and happiness.

In need to belong, we looked at the definition and usefulness of need to belong. We also discussed how ostracism is painful for anybody and in social networking topic we discussed how technology has impacted our social communications. We also looked at the ways and means of maintaining a balance between real world and internet world.

In emotions we first talked about its definition, and we discussed four historical theories of emotion to see the link between cognition and emotions. The James Lange theory proposed that first comes bodily response and then we label emotions based on those bodily responses. Cannon-Bard's theory argued that emotions and autonomic responses occur simultaneously but separately. One is not the cause of the other. The individual's appraisal of the emotion producing situation largely determines the emotions.

Schachter and Singer believed that to experience emotions, we must consciously interpret and label them. Zajonc, LeDoux and Lazarus noted that we have many emotional reactions without interference of intellect. Many emotions occur without our being aware of them. Then we discussed the physiology of emotions and how emotions can be detected by others. We also dwelled upon how gender and culture can influence the expression of emotions, and how facial expression can influence the actual experience of emotions.

4.7 QUESTIONS

1. Explain the usefulness of need to belong and pain of ostracism.
2. What is social networking and how can we maintain balance between real world and virtual world.
3. Define emotion and discuss various theories of emotion.
4. How can we detect emotions in others and what role is played by gender and culture in detecting emotions?

5. Write a short note on

   a. Effects of social networking

   b. Maintaining balance between real world and virtual world

   c. Cannon-Bard theory of emotion

   d. Schachter & Singer's theory of Emotion

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