NEUROPSYCHOLOGY

UNIT 1: INTRODUCTION

Neuro Psychology - Definition-Nature - Scope -Brief History-Basic Anatomy of the Brain - Common Neurological Disorders.

Neuro Psychology -Definition

Neuropsychology is a branch of clinical psychology that studies how the brain and nervous system affect how we function on a daily basis, Neuropsychology is the discipline which investigates the relations between brain processes and mechanisms on one hand, and cognition and behavioral control on the other.

- Neuropsychology compares the performance among persons with known differences in their biological brain structures and attempts to find out the various sources that cause the variations in the brain which all produce differences in individual behaviours.
- These sources include the following: 1) biological factors (e.g., genetic, diseases, and injuries) 2) psychological factors (e.g., learned behaviours and personality) and 3) social factors (e.g., economics, family structure, and cultural values).

Nature

- Neuropsychology is usually broadly defined as the study of brain-behavior relationships.
- Of course, this definition does not capture the multiplicity of questions and approaches that have been used to explore how the central nervous system represents, organizes, and generates the infinite range of human capabilities and actions.
- Modern neuropsychology includes the study of the classic problems of psychology—attention, learning, perception, cognition, personality, and psychopathology—using techniques that include the methods of experimental psychology as well as the methodologies of test construction and psychometrics.
- The human brain is a fascinating and enigmatic machine. Weighing only about 3 pounds (1.36 kilograms) and with a volume of about 1,250 cubic

centimeters, it has the ability to monitor and control our basic life support systems, to maintain our posture and direct our movements, to receive and interpret information about the world around us, and to store information in a readily accessible form throughout our lives.

- It allows us to solve problems that range from the strictly practical to the highly abstract, to communicate with our fellow human beings through language, to create new ideas and imagine things that have never existed, to feel love and happiness and disappointment, and to experience an awareness of ourselves as individuals.
- Not only can the brain undertake such a variety of different functions, but it can do more or less all of them simultaneously.
- How this is achieved is one of the most challenging and exciting problems faced by contemporary science.
- Neuropsychology, as one of the neurosciences, has grown to be a separate field of specialization within psychology over about the last 40 years, although there has always been an interest in it throughout the 120-year history of modern scientific psychology.
- Neuropsychology seeks to understand the relationship between the brain and behavior, that is, it attempts to explain the way in which the activity of the brain is expressed in observable behavior.

SCOPE OF NEUROPSYCHOLOGY

- The fields of application of neuropsychology are very broad.
- The neuropsychologist can act in the health, educational, social or scientific research field.
- Neuropsychologists study the effects that psychological conditions have on the nervous system including the brain and spine and they may also research ways in which changing brain chemistry due to injury, hormones, or environmental factors can affect mental health.

CLINICAL NEUROPSYCHOLOGIST

Clinical neuropsychologists are mainly for adults and iron nice and treat the people who are suffering from certain brain illnesses like dementia or

Parkinson's disease. They are trained to assess the human brain and to find any disorder in the brain. They normally work with neurosurgeons and other professionals.

CHILD NEUROPSYCHOLOGIST

This field is called clinical pediatric neuropsychology. This field is quite similar to clinical psychology but the difference is that neuropsychologists deal with children. The look of the newborns or other children and find if there is any disorder present in the brain or not. They also work with other professionals like therapists, neurosurgeons, and parents and help the children to recover from neurological disorders. It is also important to know when a child need a psychologist.

NEUROPSYCHOLOGIST FOR COGNITIVE-BEHAVIOR

Neuropsychologists work in finding out how brain disorders and brain injuries can affect their cognitive functions like speech, memory, learning ability, language, etc. They work in finding out how the brain neurons connect and affect cognitive behavior.

COUNSELLING

Many neuropsychologists also work as **counsellors** and it is a good option to choose as a neuropsychologist career. They give both offline and **online therapy** to patients who have got their cognitive functions affected due to brain illness or injury. They give them therapy so that they can get back to their normal living. **Online counselling** in these cases has gained rapid growth.

REHABILITATION DIRECTOR

Rehabilitation directors work at rehab facilities where they direct and oversee all aspects of patient treatment and care. They design and implement plans for various types of rehabilitative treatment plans such as speech and physical therapy.

Rehabilitation directors also perform administrative duties to maintain operations at rehab facilities. Some of their duties involve budgeting, staffing,

compensation and stakeholder management. While rehabilitation directors may get involved with patient treatment, they may not interact with patients directly. Instead, they monitor patient behavior via reports provided by caregivers.

FORENSIC NEUROPSYCHOLOGIST

A forensic neuropsychologist applies neuropsychological assessment techniques to the legal field. They evaluate litigants and assess their emotional and cognitive functioning. Forensic psychologists offer assistance when disputes arise over the emotional, cognitive or behavioral functioning of parties in a legal case. For example, they may conduct rigorous assessments to verify a defendant's insanity plea.

In addition to these duties, forensic neuropsychologists may also diagnose victims of violent crimes to determine the level of trauma and the trauma's implications. They also conduct neuroimaging and neuropsychiatric analyses if necessary.

COGNITIVE NEUROPSYCHOLOGIST

Cognitive neuropsychologists evaluate the brain structure and its connection to cognitive abilities. These neuropsychologists also explore the consequences of brain injuries and neurological diseases on speech, reasoning, perception, memory and language acquisition.

Most cognitive neuropsychologists are researchers. However, unlike their other counterparts, they create models to understand and explain how humans gain and exercise their abilities to speak, recall, learn, memorize and perceive things.

RESEARCHER

Research in neuropsychology is mainly about the study of neurons, the nervous system, and the human brain. The researchers mainly study the

dysfunction of the human brain and how it can affect human behavior, emotion, and other human brain functioning. They diagnose neurological disorders and help professionals to treat the patients. Moreover, their work also extends to developing methods of treating patients with brain disorders.

PROFESSOR IN NEUROPSYCHOLOGY

Professors in neuropsychology work in universities and institutes and conduct research over there. The neuropsychology professors publish their research and reports and also teach students. Their work extends to lectures, conducting tests, and examining the performance of students under them.

REHABILITATION DEPARTMENT

Many neuropsychologists also work in the rehabilitation department. They work in guiding the patients and provide
them **therapy** or **counselling sessions**. Most of the time after brain injury patients lose their memory or have difficulty in speech or understanding. The neuropsychologists in the rehab department work in treating these patients and administering them

NEUROPSYCHOLOGICAL ASSESSMENT

Neuropsychology is critical for diagnosing brain damage. This has been the first role that neuropsychologists have played. Standardized procedures and tests are used that evaluate intelligence, attention, orientation, memory, planning and organization, visuospatial and motor functions, among others. Neuropsychological assessment is recommended when there is suspicion of any cognitive deficit. It is especially used in traumatic brain injury, Stroke, in learning difficulties, in epileptic pictures, in attention deficit disorders, in suspicion of degenerative processes Dementia, etc. The evaluation allows to know where the deficits are and their level of gravity. This is essential to be done correctly and to be exhaustive, since according to the results obtained will be fixed a particular treatment. Neuropsychological assessment is also performed at follow-up to see if the intervention is being effective or modifications are required.

Brief History

- The First Anatomical Studies Vesalius (1514-1564) was the first to conduct careful observations of brain anatomy and qualify the teachings of the cell doctrine in which he was trained.
- He represents the beginning of a period in which careful observations and empirical science began to triumph over the ideas that had been handed down since the time of Aristotle and Galen.
- Vesalius introduced the anatomical theater in which students and doctors could watch dissections from above. Vealius made careful diagrams of human anatomy.

Mind-Body Dualism

- Descartes (1596-1650) introduced the concept of a separate mind and body.
- He believed that all mental functions were located in the pineal gland, a small centrally located brain structure which is now believed to play a role in sleep wake and dark light cycles.
- The dualist philosophy suggested a complete split between mental and bodily processes, and explained automatic bodily reflexes (body) while purposeful behaviours were a product of free will (mind).
- Descartes subscribed to some of Galen's theories (that the brain was a reservoir of fluid, in which the fire displaces the skin, which pulls a tiny thread, which opens a pore in the ventricle allowing the "animal spirit" to flow through a hollow tube, which inflates the muscle of the leg, causing the foot to withdraw.
- This would now be described as a reflex, for which Descartes is credited.

Phrenology

- Gall (1758-1828) introduced the idea that the brain was comprised of separate organs, each localized and responsible for a basic psychological trait.
- These traits controlled complex mental faculties, such as Cautiousness, Combativeness and Agreeableness, and simpler functions, such as Memory, Calculation Ability and Color Perception.

- Phrenology correlated the mental faculties described by philosophers with the development of specific brain areas. The development of these brain areas, called cerebral organs, resulted in skull prominences.
- These bumps could be analyzed and a Phrenology practitioner could determine the subject's personality and intelligence from analysis of the skull, called cranioscopy.
- Followers of phrenology categorized individuals on the basis of skull, and brain size.
- Men were believed to have larger "social regions" with more "pride, energy, and self-reliance", as compared to female skulls which were thought to possess more inhabitivness that is love of home, a lack of firmness and self-esteem.
- However research has shown that there is no relationship between the bumps on the skull and the underlying brain tissue, nor is there a relationship between the size of an area of brain and the size of the function that it supports.
- Although he was almost completely incorrect, Gall's Phrenology represents the beginning of the strong modern day localisationist doctrine.

19TH CENTURY

- **Localisation** Broca (1824-1880) described most famous case, "Tan", and a patient who suffered a stroke of the left hemisphere who could only utter the phrase "Tan".
- The patient could accurately comprehend language. Broca then used this case and a number of others to show that the expression of language was localized to the left frontal lobe.
- If you look carefully at the brain, you can detect a soft, fluid filled area in the frontal lobe.
- This represents the empty space, or infarction that is caused by the drop in blood supply to that brain area (stroke).

- The third convolution of the inferior posterior frontal lobe has since become known as “Broca’s area”, and patients with damage to Broca’s area are referred to as having Broca’s aphasia.
- Several years after Broca presented his cases of frontal lobe lesions, Wernicke (1848-1904) presented cases in which patients had lesions of the superior posterior part of the left hemisphere and had trouble comprehending language.
- This resulted in the idea that component processes of language were localized.
- On the basis of Wernicke’s observations, the modern doctrine of component process localization and disconnection syndromes began.
- This doctrine states that complex mental functions, such as language, represent the combined processing of a number of subcomponent processes represented in widely different areas of the brain.
- A mental faculty like “Combativeness” described by the Phrenologists was not discreetly localized in the brain. Such faculties, if they have validity at all, are the result of a number of primary cognitive operations.

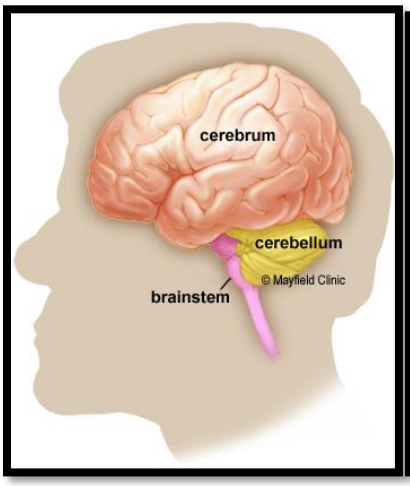
Basic Anatomy of the Brain

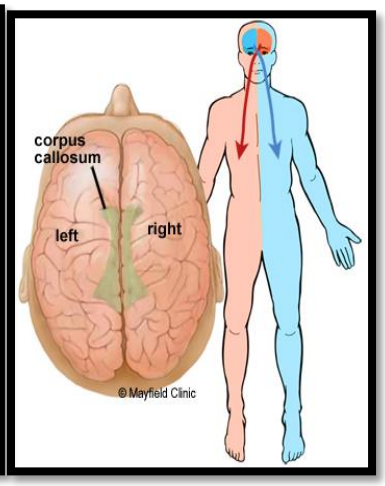
The brain is composed of the cerebrum, cerebellum, and brainstem.

Cerebrum: is the largest part of the brain and is composed of right and left hemispheres. It performs higher functions like interpreting touch, vision and hearing, as well as speech, reasoning, emotions, learning, and fine control of movement.

Cerebellum: is located under the cerebrum. Its function is to coordinate muscle movements, maintain posture, and balance.

Brainstem: acts as a relay center connecting the cerebrum and cerebellum to the spinal cord. It performs many automatic functions such as breathing, heart rate, body temperature, wake and sleep cycles, digestion, sneezing, coughing, vomiting, and swallowing.





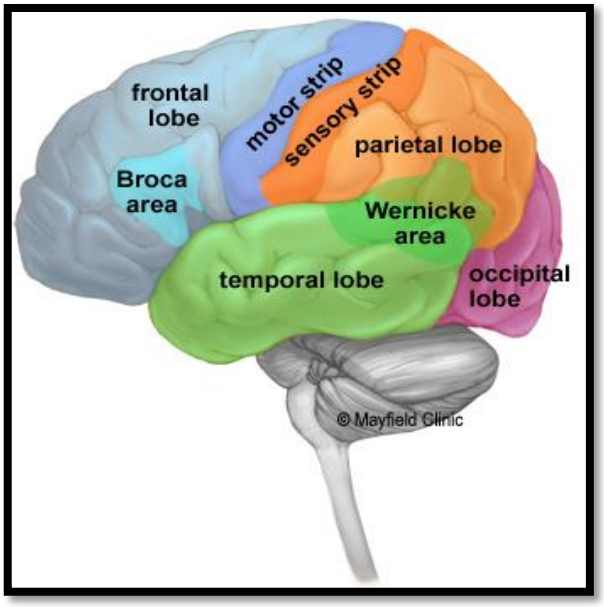
Right brain – left brain

The cerebrum is divided into two halves: the right and left hemispheres .They are joined by a bundle of fibers called the corpus callosum that transmits messages from one side to the other. Each hemisphere controls the opposite side of the body. If a stroke occurs on the right side of the brain, your left arm or leg may be weak or paralyzed.

Not all functions of the hemispheres are shared. In general, the left hemisphere controls speech, comprehension, arithmetic, and writing. The right hemisphere controls creativity, spatial ability, artistic, and musical skills. The left hemisphere is dominant in hand use and language in about 92% of people.

LOBES OF THE BRAIN The cerebral hemispheres have distinct fissures, which divide the brain into lobes. Each hemisphere has 4 lobes: frontal, temporal, parietal, and occipital. Each lobe may be divided, once again, into areas that serve very specific functions. It's important to understand that each lobe of the brain does not function alone. There are very complex relationships between the lobes of the brain and between the right and left hemispheres.

Frontal lobe



- Personality, behavior, emotions
- Judgment, planning, problem solving
- Speech: speaking and writing (Broca's area)
- Body movement (motor strip)
- Intelligence, concentration, self-awareness

Parietal lobe

- Interprets language, words
- Sense of touch, pain, temperature (sensory strip)
- Interprets signals from vision, hearing, motor, sensory and memory
- Spatial and visual perception

Occipital lobe

- Interprets vision (color, light, movement)

Temporal lobe

- Understanding language (Wernicke's area)
- Memory
- Hearing
- Sequencing and organization

Meninges: The meninges are the layers that surround the brain and spinal cord and provide protection. There are three layers of meninges

Dura mater: This is the thick outmost layer located directly under the skull and vertebral column

The arachnoid mater: This is the thin layer of web like connective tissue. Under this layer is cerebrospinal fluid that helps cushion the brain and spinal cord.

Pia mater: This layer contains veins and arteries and is found directly a top of the brain and spinal cord.

Language

- In general, the left hemisphere of the brain is responsible for language and speech and is called the "dominant" hemisphere.
- The right hemisphere plays a large part in interpreting visual information and spatial processing.
- In about one third of people who are left-handed, speech function may be located on the right side of the brain.
- Left-handed people may need special testing to determine if their speech center is on the left or right side prior to any surgery in that area.
- Aphasia is a disturbance of language affecting speech production, comprehension, reading or writing, due to brain injury – most commonly from stroke or trauma. The type of aphasia depends on the brain area damaged.

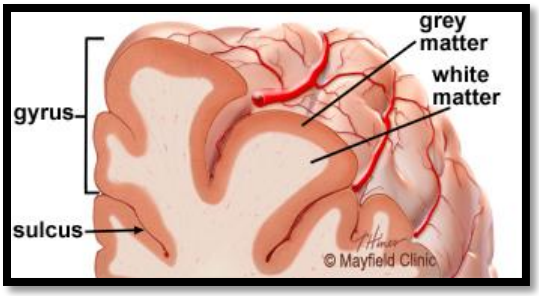
Broca's area: lies in the left frontal lobe. If this area is damaged, one may have difficulty moving the tongue or facial muscles to produce the sounds of speech. The person can still read and understand spoken language but has difficulty in speaking and writing (i.e. forming letters and words, doesn't write within lines) – called Broca's aphasia.

Wernicke's area: lies in the left temporal lobe. Damage to this area causes Wernicke's aphasia. The individual may speak in long sentences that have no meaning, add unnecessary words, and even create new words. They can make speech sounds, however they have difficulty understanding speech and are therefore unaware of their mistakes.

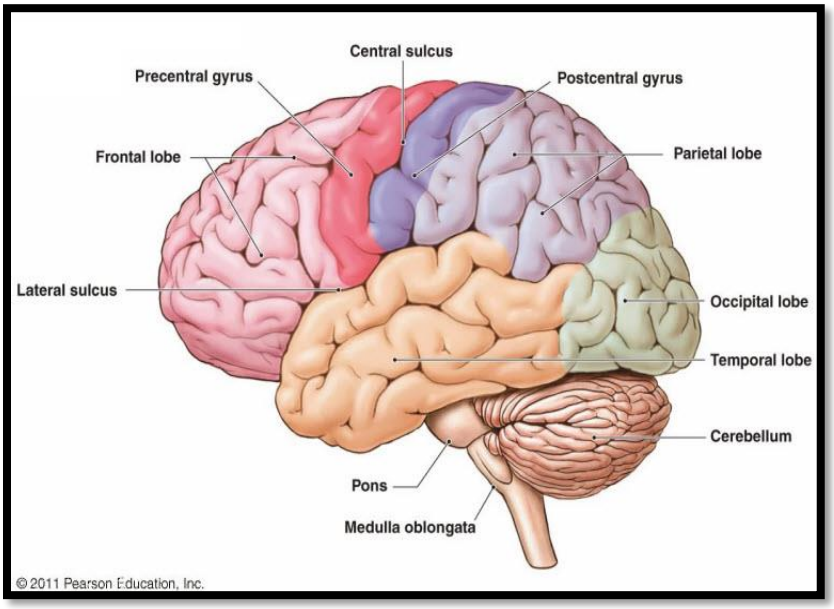
Cortex

The surface of the cerebrum is called the cortex. It has a folded appearance with hills and valleys. The cortex contains 16 billion neurons (the cerebellum has 70 billion = 86 billion total) that are arranged in specific layers. The nerve cell bodies color the cortex grey-brown giving it its name – gray matter.

Beneath the cortex are long nerve fibers (axons) that connect brain areas to each other — called white matter.



The folding of the cortex increases the brain's surface area allowing more neurons to fit inside the skull and enabling higher functions. Each fold is called a gyrus, and each groove between folds is called a sulcus. There are names for the folds and grooves that help define specific brain regions.



Hypothalamus: is located in the floor of the third ventricle and is the master control of the autonomic system. It plays a role in controlling behaviors such as hunger, thirst, sleep, and sexual response. It also regulates body temperature, blood pressure, emotions, and secretion of hormones.

Pituitary gland: lies in a small pocket of bone at the skull base called the sella turcica. The pituitary gland is connected to the hypothalamus of the brain by the pituitary stalk. Known as the "master gland," it controls other endocrine

glands in the body. It secretes hormones that control sexual development, promote bone and muscle growth, and respond to stress.

Pineal gland: is located behind the third ventricle. It helps regulate the body's internal clock and circadian rhythms by secreting melatonin. It has some role in sexual development.

Thalamus: serves as a relay station for almost all information that comes and goes to the cortex. It plays a role in pain sensation, attention, alertness and memory.

Basal ganglia: includes the caudate, putamen and globus pallidus. These nuclei work with the cerebellum to coordinate fine motions, such as fingertip movements.

Limbic system: is the center of our emotions, learning, and memory. Included in this system are the cingulate gyri, hypothalamus, amygdala (emotional reactions) and hippocampus (memory).

Common Neurological Disorders

STROKE

Strokes, which affect more than 795,000 Americans each year, occur when you experience damage to the brain as a result of arteries leading to and within the brain becoming impaired. It's usually difficult to anticipate a stroke, but signs that you may be having a stroke include sudden:

- Blurred vision
- Confusion, trouble speaking, or understanding
- Dizziness or loss of balance
- Numbness or weakness of the face, arm, or leg—especially on one side of the body
- Severe headache

When we see people who have experienced a stroke, our priority is to help them prevent a second stroke. We often do this through medication, which can include blood thinners or drugs to treat any underlying heart problems, but it depends on your particular situation. You can lower your stroke risk by

exercising 30 minutes a day, five days a week, and by following a healthy diet that prioritizes fruits and vegetables and limits processed food.
These lifestyle modifications can help you control key stroke risk factors, such as:

- Diabetes
- Heart disease
- Heavy alcohol use
- High blood pressure
- High cholesterol
- Obesity and lack of exercise
- Smoking

SEIZURES

Seizures are changes in the brain's electrical activity and affect about one in 100 Americans. Signs and symptoms of a seizure can vary depending on the severity of your seizure, but the most common include:

- Cognitive or emotional symptoms, such as fear, anxiety, or deja vu
- Loss of consciousness or awareness
- Temporary confusion
- Uncontrollable jerking movements of the arms and legs

After having a seizure, it's important to see your doctor. Early treatment and medication can control your seizures, and you will avoid long-term complications such as memory loss and brain damage. A seizure often is the result of epilepsy, but can also happen due to:

- Alcohol abuse or withdrawal
- Head trauma that causes an area of bleeding in the brain
- High fever
- Lack of sleep
- Low blood sodium
- Medications, such as antidepressants or pain relievers

PARKINSON'S DISEASE

Parkinson's disease is a progressive nervous system disorder that affects your movement. Generally, it begins affecting people around age 60, and symptoms gradually get worse over time. Common symptoms include:

Constipation: This can occur at any time during Parkinson's disease, sometimes even decades before you experience motor symptoms

Muscle stiffness: This can occur throughout your body; in some cases, it can be difficult to swing your arms while you walk

Reduced smell: Most people with Parkinson's disease have some loss of their sense of smell

Stiff face: Especially in the early stages of Parkinson's disease, your face may begin showing little or no expression

Speech changes: Your speech can become soft or slurred

Tremor: Usually starts in your hands or fingers

Your doctor will diagnose Parkinson's disease during a visit in which you discuss your symptoms and undergo a physical examination. In many cases, you can alleviate symptoms and manage Parkinson's disease effectively through medication.

DEMENTIA

Dementia is an umbrella diagnosis that describes a group of diseases, including Alzheimer's, that may cause your brain to fail. Dementia, which becomes increasingly more likely as you age, leads to continuous loss of brain tissue, which can affect:

- Behavior
- Emotions
- Memory
- Perceptions
- Thinking

If you feel as though you may be experiencing symptoms of dementia, see your doctor. Some medications and therapies can help you manage symptoms.

Moreover, your doctor can connect you with support groups to help you manage life with dementia.

MULTIPLE SCLEROSIS

- A disease in which the immune system eats away at the protective covering of nerves.
- In MS, resulting nerve damage disrupts communication between the brain and the body.
- Multiple sclerosis causes many different symptoms, including vision loss, pain, fatigue and impaired coordination.
- The symptoms, severity and duration can vary from person to person. Some people may be symptom free for most of their lives, while others can have severe, chronic symptoms that never go away.
- Physiotherapy and medication that suppress the immune system can help with symptoms, and slow disease progression.

Huntington's disease

An inherited condition in which nerve cells in the brain break down over time. It typically starts in a person's 30s or 40s. Usually, Huntington's disease results in progressive movement, thinking (cognitive) and psychiatric symptoms. No cure exists, but drugs, physiotherapy and talk therapy can help manage some symptoms.

Cerebral palsy

A congenital disorder of movement, muscle tone or posture. Cerebral palsy is due to abnormal brain development, often before birth. Symptoms include exaggerated reflexes, floppy or rigid limbs and involuntary motions. These appear by early childhood. Long-term treatment includes physical and other therapies, drugs and sometimes surgery.

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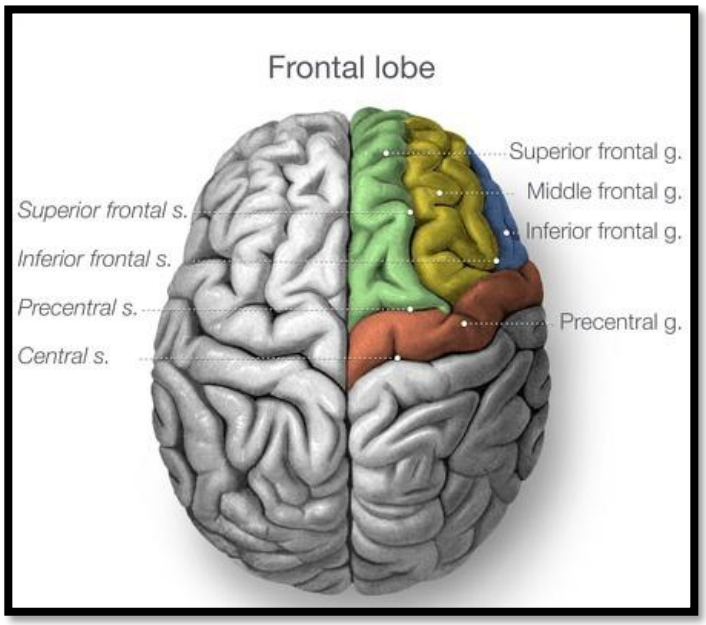
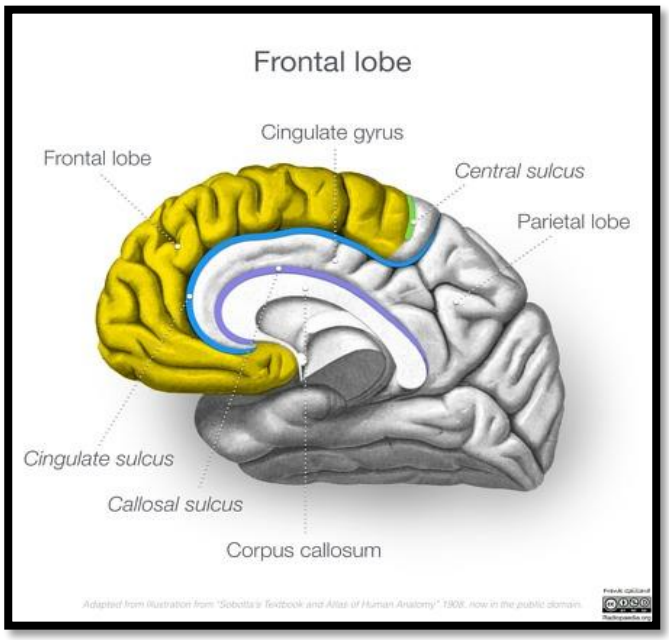
UNIT II

FRONTAL LOBE AND TEMPORAL LOBE

Frontal Lobe: Anatomy and Functional Organization - Frontal Lobe Syndrome: Disturbances of motor function, Loss of divergent thinking, Environmental control of behavior, Poor temporal memory - The Frontal Lobe and Personality. **Temporal Lobe:** Anatomical Features - Functional Organization- Complex Partial Seizures - Electrical Stimulation - Temporal Lesions and Cognitive Change.

FRONTAL LOBE: ANATOMY AND FUNCTIONAL ORGANIZATION





Anatomy: The frontal lobe into three distinct regions, each containing a number of vital structures. Those include:

The frontal lobe is roughly pyramidal in shape, with three cortical surfaces:

1. lateral surface (largest)
2. medial (interhemispheric) surface
3. inferior surface

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***Lateral* surface**

The lateral surface is curved, conforming to the inner surface of the frontal and parietal bones. It is divided into four gyri, which in reality are more 'regions' than true gyri, in that each is convoluted and divided by smaller incomplete sulci, which in turn are separated from each other by three main sulci [4].

- gyri
    1. superior frontal gyrus
    2. middle frontal gyrus
    3. inferior frontal gyrus
    4. precentral gyrus
- sulci
    1. superior frontal sulcus
    2. inferior frontal sulcus
    3. precentral sulcus

Although each gyrus and sulcus are discussed individually, a brief overview is presented here.

1. **superior frontal gyrus**
    - most medial and superior part of the frontal lobe
    - extends from the frontal pole anteriorly to the precentral sulcus posteriorly (separating it from the precentral gyrus)
    - laterally it is separated from the middle frontal gyrus by the superior frontal sulcus
2. **middle frontal gyrus**
    - runs parallel to the superior frontal gyrus, from frontal pole to precentral sulcus

- superomedially it is separated from the superior frontal gyrus by the superior frontal sulcus
- it is separated from the inferior frontal gyrus by the inferior frontal sulcus

3. **inferior frontal gyrus**
    - runs parallel to the middle frontal gyrus, from the lateral border of the orbital gyri anteroinferiorly
    - superiorly it is separated from the middle frontal gyrus by the inferior frontal sulcus
    - contains Broca's area
4. **precentral gyrus**
    - anteriorly it is separated from the posterior parts of the superior, middle and inferior frontal gyri by the precentral sulcus
    - posteriorly it is separated from the parietal lobe by the central sulcus
    - contains the primary motor

Medial frontal lobe: This region contains the cingulate gyrus, which is a part of the limbic system. It also contains the superior frontal gyrus, which research suggests plays a role in self-awareness

- **medial frontal gyrus**
    - anterior to the ascending branch of the cingulate sulcus
- **paracentral lobule**
    - posterior to the Para central sulcus (the ascending branch of the cingulate sulcus)
    - anterior to the marginal branch of the cingulate sulcus

inferior surface: The inferior surface of the frontal lobe is the smallest cortical surface of the lobe, located anterior to the stem of the Sylvain fissure.

Polar region: This region is home to the front marginal gyrus, as well as the transverse frontopolar gyri.

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The orbital frontal lobe contains a number of structures, including the anterior orbital gyrus, medial orbital gyrus, posterior orbital gyrus, and gyrus rectus. The orbital gyri is connected to the vagus nerve, an important part of the limbic system that coordinates and controls emotional and automatic reactions.

Functions: The frontal lobe plays a role in many higher level functions of your brain. This can include

The frontal lobe plays a key role in future planning, including self-management and decision-making.

People with frontal lobe damage may find it difficult to gather information, remember previous experiences, and make decisions based on this input.

Some of the many other functions the frontal lobe plays in daily functions include:

- **Speech and language production:** Broca's area, a region in the frontal lobe, helps put thoughts into words. Damage to this area can lead to difficulty with fluent speech.
- **Some motor skills:** The frontal lobe houses the primary motor cortex, which helps control voluntary movements, including walking and running.
- **Comparing objects:** The frontal lobe helps people categorize and classify objects and distinguish one item from another.
- **Forming memories:** Virtually every brain region plays a role in memory, so the frontal lobe is not unique. However, research suggests it plays a key role in forming long-term memories.
- **Understanding and reacting to the feelings of others:** The frontal lobe is vital for empathy.

- **Forming personality:** The complex interplay of impulse control, memory, and other tasks helps form an individual's key characteristics. Damage to the frontal lobe can impact an individual's personality.
- **Reward-seeking behavior and motivation:** Many of the brain's dopamine-sensitive neurons are in the frontal lobe. Dopamine is a brain chemical that helps support feelings of reward and motivation.
- **Managing attention, including selective attention:** When the frontal lobe cannot properly manage attention, conditions such as attention deficit hyperactivity disorder (ADHD), may develop. Voluntary movements (which are movements you control) of the opposite side of your body

- sequencing of complex or multistep movements, such as getting dressed or making a cup of tea
- speech and language production in the dominant frontal lobe (opposite your dominant hand)
- attention and concentration
- working memory, which involves processing recently acquired information
- reasoning and judgment
- organization and planning
- problem-solving
- regulation of emotions and mood, including reading the emotions of others
- personality expression
- motivation, including evaluating rewards, pleasure, and happiness
- impulse control
- controlling social behaviors
- Motor cortex: voluntary movement
- Premotor cortex: storage of motor programs, sensorimotor integration, facilitation of controlled, smooth movements

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- Prefrontal cortex: ability to concentrate; inhibition of reflexive behaviours; personality & emotional traits; abstract thinking. Working memory, executive functions including the ability to plan & implement (& monitor/evaluate) a series of goal-directed actions.
- Broca's Area: Motor control of speech
- Supplementary Motor Cortex: Intentional preparation for movement, procedural memory
- Frontal Eye Fields: Control of voluntary scanning movements of the eye

FRONTAL LOBE SYNDROME: DISTURBANCES OF MOTOR FUNCTION, LOSS OF DIVERGENT THINKING ENVIRONMENTAL CONTROL OF BEHAVIOUR

Frontal lobe syndrome (FLS) reflects damage to the prefrontal regions of the frontal lobe. It is characterised by deterioration in behaviour and personality in a previously normal individual.

Aetiology

- Head injury.
- Cerebrovascular event.
- Infection.
- Neoplasm.
- Degenerative disorders - eg, Pick's disease, a type of dementia with histopathological findings of Pick's bodies and selective involvement of the frontal and temporal lobes.

Many instances of the disorder have a genetic cause.

Motor Function

The back of the frontal lobe is called the motor strip. This region controls and directs deliberate body movements. The left side of the motor strip controls the right side of the body. The right side of the motor strip controls the left side of the body.

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Loss of Divergent thinking:

- The frontal lobe controls high-level thinking and problem solving. It also helps you pay attention.
- Some functions are controlled primarily by the left frontal lobe. Others are controlled primarily by the right frontal lobe.
- Everyone's frontal lobe has a dominant side. In most people, it is on the left, but it can also be on the right.

The dominant side of the frontal lobe is involved in a number of functions, including:

- Language and speech
- Rational and logical thinking, or the ability to make sense of things
- Quantitative thinking, or thinking that has to do with numbers and statistics
- Analytical reasoning, or the ability to make decisions after considering facts

Environmental control of behavior: The frontal lobe is responsible for decision making and self-control. It also helps regulate emotions. This is the part of the brain that manages your interactions with other people. The frontal lobe regulates your behavior and helps you know what is socially acceptable and what is not.

Poor Temporal memory:

- Difficulty in understanding spoken words (Receptive Aphasia)
- Disturbance with selective attention to what we see and hear
- Difficulty with identification and categorisation of objects
- Difficulty learning and retaining new information
- Impaired factual and long-term memory
- Persistent talking
- Difficulty in recognising faces (Prosopagnosia)
- Increased or decreased interest in sexual behaviour

- Emotional disturbance (e.g. Aggressive behaviour)

Characteristic features are:

- **Decreased lack of spontaneous activity -** the patient feels no desire to do anything and is unable to plan activities, but may have periods of restlessness.
- **Loss of attention** - the patient displays a lack of interest and is easily distracted.
- M**emory is normal but the patient cannot be bothered to rememb**er.
- Loss of abstract thought - eg, cannot understand proverbs.
- **Perseveration** - a tendency to continue with one form of behaviour when a situation requires it to change.
- **Change of affect** - depending on the nature of the damage to the brain, the patient either becomes apathetic and 'flat' or becomes over-exuberant and childish or uninhibited with possibly inappropriate sexual behaviour.
- **head injury** (It has been found that in traumatic brain injury contusions

THE FRONTAL LOBE AND PERSONALITY: Depending on what part or parts of a person's brain are injured, the individual may experience significant behavioral and emotional changes.

The frontal lobe, for example, helps govern personality and impulsivity. If damaged, there might be no "braking mechanism" for self-control. A person may find he cannot control his anger or aggression. He may also make inappropriate comments to friends or strangers not realizing they are off color. Or the opposite might happen — someone's personality may become muted or seemingly emotionless. This is called "flat affect."

TEMPORAL LOBE: ANATOMICAL FEATURES

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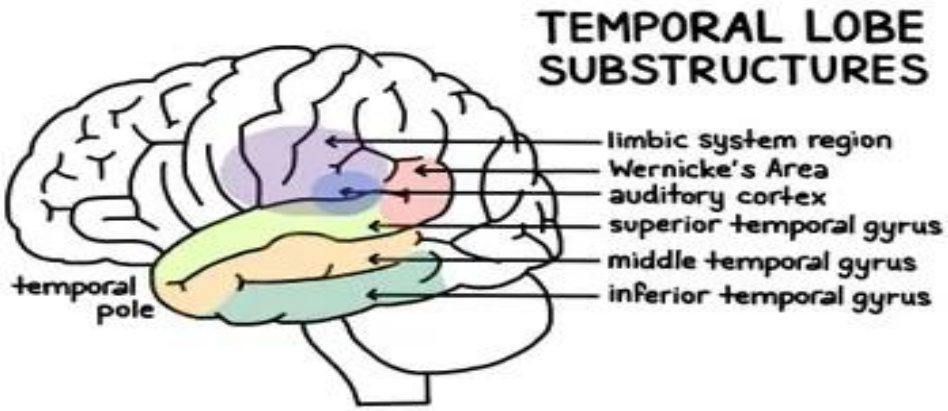

The temporal lobe sits at the bottom **middle portion of the brain**, just behind the **temples within the skull,** which is also where it gets its name. It also sits above the **brain stem and cerebellum.** The frontal and parietal lobes are above the temporal lobe. The occipital lobe sits just behind it. The temporal lobe is the **second largest lobe,** after the larger frontal lobe, accounting **22**% of the total neocortical volume .

Some of the most important structures in the temporal lobe include:

Limbic lobe: This brain region actually intersects with several lobes, but **interacts directly with the temporal lobe** to influence the limbic system, including **automatic emotional reactions such as the fight-or-flight** response and the limbic system. The limbic lobe is home to key **memory, learning, and attention processing structure**s such as the amygdala and hippocampus. This brain region also manages a number of automatic, unconscious bodily functions, as well as unconscious emotional states, such as sexual arousal and appetite.

Wernicke's area: This brain region is associated with the understanding and **processing of speech**. **Wernicke area**, region of the brain that contains motor neurons involved in the **comprehension of speech. T**his area was first described in **1874 by German neurologist Carl Wernicke**. The Wernicke area is **located in the posterior third of the upper temporal convolutio**n of the left hemisphere of the brain.

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Inferior temporal cortex is responsible for visual object recognition and receives processed visual information.

The superior temporal gyrus contain is responsible for **processing sounds**. It includes Wernicke's area, which is the major area involved in the comprehension of language. The superior temporal gyrus contains the **primary auditory cortex, w**hich is responsible for processing sounds

The medial temporal lobe (MTL) The middle temporal gyrus is bounded dorsally by the superior temporal sulcus and superior temporal gyrus and ventrally by the inferior temporal sulcus and inferior temporal gyrus. function consists of distinct processes such as encoding, consolidation and retrieval.

The **inferior temporal gyrus** is bounded above by the inferior temporal sulcus and below by the lateral occipitotemporal sulcus (which sits on the inferior surface of the temporal lobe). Its anterior and posterior limits are defined similar to the middle temporal gyrus

The temporal pole is a paralimbic region involved in high level semantic representation and socio-emotional processing.

FUNCTIONAL ORGANIZATION

the temporal lobe plays a key role in **auditory processing**. This role includes **perceiving sounds, assigning meaning to those sounds, and remembering sounds.** Much of the auditory work of the temporal lobe is processed through the superior **temporal gyrus, a temporal lobe structure that receives sound input directly from the ear. S**ome of its other functions include:

- The **formation of visual memories, including long-term memories**. In conjunction with the amygdala and hippocampus, two structures of the limbic system, the temporal lobe is vital for the formation of conscious memories.
- **Interpreting the meaning of visual stimuli,** including recognizing objects. It's not enough to just see an object. For **vision to be useful, you must also understand**

what it is you are seeing. The ventral part of the temporal lobe aids in the assignment of meaning to the sights you take in every day. Without the ventral lobe, you would not be able to recognize faces or read body language.

- **Production of speech.** The temporal lobe aids in the production of speech. Dysfunction in this brain area can lead to difficulties speaking, even when other structures are intact or you can consciously think about what you want to say.
- **Recognition of language.** The auditory cortex in the temporal lobe is key for **hearing and understanding speech**, but a range of other structures in the temporal lobe help you u**nderstand and give meaning to language.** Without the temporal lobe, you could not name objects, remember verbal exchanges, or recognize language.
- **Controlling unconscious and apparently automatic reaction**s, such as appetite, thirst, hunger.
- **Helping the body maintain homeostasis.** Note that this important role is shared by many regions in the brain.

COMPLEX PARTIAL SEIZURES

A complex partial seizure is a type of seizure that **arises in one lobe of the** brain, rather than the whole brain. The seizure affects **people's awareness a**nd may cause them to **lose consciousness.**

Complex partial seizures are now more commonly referred to as **focal onset impaired awareness seizures** or focal impaired awareness seizures.

Anybody can have a complex partial seizure, although people who have experienced **head injuries, strokes, or tumors in the brain** are more at risk.

Common symptoms of complex partial seizures include:

Aura

Seizures are often preceded by an aura, known as a simple partial seizure. Auras usually last just a few seconds.

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Motor: A simple focal seizure with motor symptoms will affect muscle activity, causing **jerking movements of a foot, the face, an arm or another part of the body.**

Sensory: A simple focal seizure may cause sensory symptoms affecting the senses, such as: **hearing problems, hallucinations and olfactory or other distortions.**

Autonomic: A simple focal seizure with **autonomic symptoms affects the part of the brain responsible for involuntary functions**. These seizures may cause changes in blood pressure, heart rhythm, or bowel or bladder function.

Psychic: Some simple focal seizures **strike parts of the brain that trigger emotions or memories of previous experiences, causing feelings of fear, anxiety,** or déjà vu (the illusory feeling that something has been experienced before).

Impaired consciousness

People who have a **complex partial seizure are not usually aware of their surroundings while it happens.**

They w**ill not respond to others or their environment,** and they do not typically remember what occurs during the episode. They may stare blankly into space, appear to be daydreaming, or wake from sleep suddenly.

In some cases, **the person will "freeze**," which is called a focal impaired awareness behavior arrest seizure.

Automatisms

In addition to an **aura and impaired consciousness,** many people also carry out **repetitive movements, called automatisms.** Examples of automatisms include:

Verbal:

- crying
- laughing

- moaning
- repetitive speech
- screaming

Oral:

chewing

lip smacking

swallowing

Manual*:*

- head rolling
- patting
- picking at things
- removing clothing
- walking
- coordinated movements, such as cycling of the legs or a swimming motion

Symptoms usually last from 30 seconds to 3 minutes.

Causes and triggers

Complex partial seizures are usually caused by epilepsy, although they can be experienced by anyone. Other conditions that may cause seizures include:

- anxiety
- autism
- brain infection
- depression
- extreme stress
- head injury
- psychological distress or trauma

- stroke
- tumor

Frequently, the cause of seizures is unknown.

The following are some of **the possible treatment** options:

- antiepileptic drugs (AEDs)
- tiagabine hydrochloride (Gabitril), a new AED that shows promise in clinical trialsTrusted Source
- stimulation of the vagus nerve
- responsive neurostimulation
- surgery
- dietary changes

ELECTRICAL STIMULATION : electrical stimulation applied to the human medial temporal lobe (MTL) typically disrupts performance on memory tasks,

- Adjustable, reversible therapies are needed for patients with pharmacoresistant epilepsy.
- Electrical stimulation of the hippocampus has been proposed as a possible treatment for mesial temporal lobe epilepsy (MTLE).
- Four patients with refractory MTLE whose risk to memory contraindicated temporal lobe resection underwent implantation of a chronic stimulating depth electrode along the axis of the left hippocampus.
- The authors used continuous, subthreshold electrical stimulation (90 microsec, 190 Hz) and a double bdouble-blindle cross-over, randomized controlled design, consisting of three treatment pairs, each containing two 1-month treatment periods.
- During each treatment pair the stimulator was randomly turned ON 1 month and OFF 1 month.
- Outcomes were assessed at monthly intervals in a double blind manner, using standardized instruments and accounting for a washout period.

- The authors compared outcomes between ON, OFF, and baseline periods.
- Hippocampal stimulation produced a median reduction in seizures of 15%. All but one patient's seizures improved; however, the results did not reach significance.
- Effects seemed to carry over into the OFF period, and an implantation effect cannot be ruled out.
- The authors found no significant differences in other outcomes. There were no adverse effects.
- One patient has been treated for 4 years and continues to experience substantial long-term seizure improvement.
- The authors demonstrate important beneficial trends, some long-term benefits, and absence of adverse effects of hippocampal electrical stimulation in mesial temporal lobe epilepsy.
- However, the effect sizes observed were smaller than those reported in no n-randomized, unblinded studies.

TEMPORAL LESIONS AND COGNITIVE CHANGE

There are many possible causes of temporal lobe lesions. The most common causes include:

- A stroke. A stroke usually affects other parts of the brain but may occur in the temporal lobe.
- Brain tumours may also affect the temporal lobe of the brain.
- A serious head injury or a surgical operation to remove a brain tumour may may also cause damage to the temporal lobe.
- Progressive worsening of language can be part of a type of dementia called frontotemporal dementia.
- The temporal lobe can be affected by an infection of the brain (encephalitis), especially encephalitis due to herpes simplex virus.
- Other conditions affecting the brain, such as multiple sclerosis, can also affect the temporal lobes of the brain.

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The symptoms caused by temporal lobe lesions are usually much less obvious than when other parts of the brain are affected. For example, many strokes will cause muscle weakness (paralysis), often affecting one side of the body. However, the symptoms caused by a stroke affecting the temporal lobe will be much less obvious.

A lesion in the temporal lobe may cause various symptoms which may not be noticed by other people. These symptoms may include forgetfulness, problems with speech and language (especially understanding what is being said by others) and problems with vision. Temporal lobe lesions may also cause fits (seizures).

Other symptoms may include problems with hearing, identifying objects, learning new information and being unable to identify emotions in others. Temporal lobe lesions may also cause problems with memory and changes in your personality.

The symptoms will depend on the underlying cause of the temporal lobe lesion. A stroke will usually cause a sudden onset of symptoms but a brain tumour will often cause a slow onset and progression of symptoms. The symptoms will also depend on whether only the temporal lobe is affected or whether other parts of the brain are also affected by the underlying condition.

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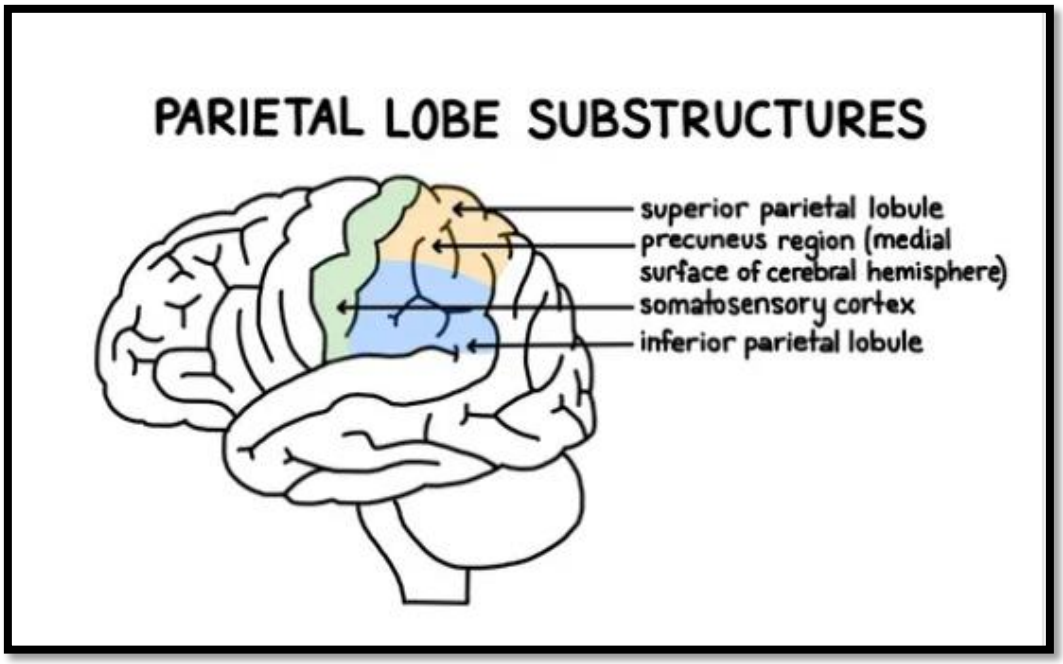
UNIT III

PARIETAL LOBE

Anatomical Features - **Sensory** and Perceptual Disturbances - Disorders of Spatial Orientation -Constructional Apraxia - Spatial Alexia and Acalculia -Unilateral Spatial Neglect **Disorders of Body Schema –Gerstm**ann's Syndrome.

ANATOMICAL FEATURES



- The parietal lobe is one of the major lobes in the brain, roughly located at the **upper back area** in the skull.
- The parietal lobe accounts for only 19% of the total neocortical volume
- The **parieto-occipito** sulcus separates it from the frontal lobe, while the lateral sulcus
- It processes **sensory information** it receives from the **outside world, mainly relating to touch, taste, and temperature.**
- Damage to the parietal lobe may lead to **dysfunction in the senses.** There are also some health conditions associated with parietal lobe damage.

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- The parietal lobe occupies about one quarter of each hemisphere and is involved in two primary functions: 1) **sensation and perception** and 2) the **integration and interpretation of sensory information**, primarily with the **visual field.**

The following are some key areas of the parietal lobe:

- **Postcentral gyrus:** This region is the brain's primary somatosensory cortex, and maps sensory information onto
- **Posterior parietal cortex:** This region is thought to play a vital role in **coordinating movement and spatial reasoning. I**t also plays a role in **attention, particularly attention driven by new stimuli,** such as when an animal jumps into the road while you are driving.
- **Superior parietal lobule:** This region helps you determine your own **orientation in space, a**s well as the **orientation of other objects.** It also receives significant input from the hand, suggesting that it helps **coordinate fine motor skills** and sensory input from the hands.
- **Inferior parietal lobule:** this region aids in assessing **facial expressions for emotional content.** Some research suggests it plays a role in other functions, including **language processing, basic mathematical** operations, and even body image.

Somatosensory cortex

- The somatosensory cortex in the front part of the parietal lobe resides in two areas: the **postcentral gyrus and the posterior paracentral** lobule.
- It helps process and interpret touch sensations and helps discriminate between them.
- For example, it helps with telling the difference between something that is cold and something that is painful.

Angular gyrus

- The angular gyrus is a small, **triangular area in** the parietal lobe.
- It helps the brain associate **symbols and meaning a**nd assists with **word recognition**.
- This gives the brain the **ability to assign meaning and name objec**ts in the environment.
- This helps a person understand written words and mathematical equations. Damage to the **angular gyrus, on the dominant sid**e, can cause **Gerstmann's syndrom**e. Gerstmann's syndrome is characterized by:
  - an inability to write
  - an inability to perform arithmetic
  - difficulty recognizing which finger is which
  - trouble differentiating the right from the left side of the body

Function

In general, the parietal lobe is a major interpreter of the sensory world around the body. In fact, the parietal lobe is a primary sensory area, which means that it is the starting point of sensory processing within the brain.

The following are some of the main functions of the parietal lobe:

Sensory processing

The parietal lobe deals with many sensations, including:

- touch
- pressure
- pain
- heat
- cold
- tension

These are the somatic senses, meaning that they come from the body. The information from these senses helps a person form physical sensations taken from the world around them.

- In order to carry out this function, the parietal lobe receives **sensory information from all over the body.**
- The parietal lobe also plays a role in a person's **ability to judge size, shape, and distance**.
- This includes those in written and **spoken language, mathematical problems, and codes and puzzles.**
- Hearing and **visual perception,** as well as memory, are also part of the parietal lobe's functions.

Navigation and control

- The parietal lobe also plays a role in functions such as **navigation and controlling the body**, as well as understanding spatial orientation and direction.
- A person's dominant hand will often determine which **side of the parietal lobe is more active.**
- A person who is **right-handed** may have a **more active left hemispher**e parietal lobe.
- The **left lobe tends** to deal more with **numbers, letters, and symbols**. The **right hemisphere** may be more active in people with a dominant left hand.

SENSORY AND PERCEPTUAL DISTURBANCES

- Damage to the **right side of the brain or the parietal a**nd occipital lobes of the brain can cause **sensory and perceptual problems.**
- These areas of the brain process the **input from our sense**s.
- They can cause over or under **sensitivity to sensory information,** including sight, sound, and touch.

Our sensory and perceptual systems include:

- auditory (sound)
- visual (colour, shape, size, depth and distance)
- tactile (touch relating to pain, pressure and temperature)

- olfactory (smells)
- gustatory (taste).

Types of Sensory perceptual disturbance:

- **Sensory modulating disorder:** This type usually involves over or undersensitivity to sensory information.
- **Sensory-based motor disorder:** This type affects balance, movement, and coordination.
- **Sensory discrimination disorders:** These affect how the brain interprets subtle differences in sensory inputs, such as different textures.

Symptoms:

Children who find sensory input overwhelming may show signs that include:

- being overwhelmed by people or places
- startling easily
- difficulty with bright lights
- avoiding contact with others
- reacting strongly to smells, sounds, or textures

Those who are under sensitive to sensory input may:

- frequently touch objects and play roughly
- have a high pain tolerance
- fidget or move regularly
- be clumsy and uncoordinated

Treatment: There is no medication or cure for sensory processing disorders. However, doctors can help a person manage the symptoms through therapy.

sensory integration therapy Sensory integration therapy can make a real difference by helping individuals to manage their sensitivities and cravings.

Visuospatial skills

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While problems can occur with our sensory systems, visuospatial problems are often more noticeable. Possible issues include:

- drawing objects
- recognising objects (agnosia)
- telling left from right
- mathematics (discalculia)
- analysing and remembering visual information
- manipulating or constructing objects
- awareness of the body in space (e.g. climbing stairs)
- perception of the environment (e.g. following directions).

DISORDERS OF SPATIAL ORIENTATION

- Topographical disorientation is the **inability to orient oneself in one's surroundings,** sometimes as a result of focal brain damage.
- This disability may result from **the inability to make use of selective spatial information (e.g., environmental landmarks)** or to orient by means of specific cognitive strategies such as the ability to form a mental representation of the environment, also known as a cognitive map.

Developmental

- Developmental topographical disorientation (DTD) refers to the inability to **orient from childhood despite** the absence of any apparent brain damage, neurological condition or general cognitive defects.
- Individuals affected by DTD are unable to generate a mental representation of the **environment** (i.e. a cognitive map) and therefore unable to make use of it while **orienting** (a process that usually people go through while orienting).

Egocentric

- Egocentric disorientation is marked by the **inability to represent the location of objects with respect to self.**

- This is usually **due to lesions in the posterior parietal lobe.**
- Patients experience **no difficulty recognizing or naming people or objects.**
- They are unable to accurately reach for **visual objects and are unable to state the relationship between objects and oneself** (above, below, left, right, nearer or farther).

Heading

- Heading disorientation is marked by the **inability to represent direction of orientation with respect to external environment.**
- This is usually due to lesions in the **posterior cingulate.**
- Patients are able to determine their location using landmarks, but are unable to determine which direction to proceed from those landmarks in order to reach their destination.
- They are also **impaired in map drawing tasks a**nd are unable to describe routes between familiar locations. landmarks. Symptoms of topographical disorientation disappeared in all three patients after two months.

Anterograde amnesia

- Anterograde disorientation is marked by the **inability to orient in new environments.**
- This is usually due to lesions in the parahippocampus.
- Patients were able to navigate through and draw maps of environments learned at least 6 months before the damage.
- . The finding indicates that the medial temporal lobe is not needed for the retrieval of spatial maps learned prior to injury.
- The hippocampus and other surrounding structures are essential for the formation of long-term declarative memories, including spatial memories.

Topographagnosia

- Landmark agnosia, also known as topographical agnosia and topographagnosia, is marked by the **inability to recognize salient environmental stimuli such as landmarks.**

- This is usually due to **lesions in the lingual gyrus**.
- Patients are able to **draw detailed maps and visualize places** familiar to them before the illness.
- They can distinguish between classes of buildings, such as house or skyscraper, but are unable to identify specific buildings, such as their own house or famous landmarks.

Diagnosis

- Topographical disorientation is usually diagnosed with the use of a comprehensive **battery of neuropsychological tests combined with a variety of orientation** tasks performed by the participants in both virtual and real surroundings.
- Performance on certain tests can identify underlying neurological disorders and verify the **disorientation as a selective impairment**.
- **Brain imaging is** used to determine regions of brain damage, if any. Navigational skills can be assessed by tests pertaining to memory, visual-perceptual abilities, object recognition, mental rotation, imagery abilities, and spatial abilities.

Treatment

- Treatment for topographical disorientation has been achieved through a case by case basis. Prognosis is largely dependent on the **organic cause**. Neuropsychological assessment followed by an assessment of unaffected cognitive abilities can be employed in therapy. Treatment for **recovering navigational skills requires strengthening** unaffected navigational strategies to bypass any defective ones.

CONSTRUCTIONAL APRAXIA

- Constructional apraxia is characterized by an **inability or difficulty to build, assemble, or draw object**s.
- Apraxia is a **neurological disorder** in which people are **unable to perform tasks or movements** even though they understand the task, are willing to complete it, and have the **physical ability to perform the movements.**

- Constructional apraxia may be caused by lesions in the **parietal lobe following stroke o**r it may serve as an indicator for Alzheimer's disease.

Signs and symptoms

Left hemisphere damage

Patients with damage to their left hemisphere tend to preserve items, **oversimplify drawing features and omit details when drawing from memor**y. In addition, left hemisphere patients are less likely to systematically arrange the **parts of their drawing.**

Right hemisphere damage

- Patients with damage to their right hemisphere have **trouble correctly replicating spatial relationships of complex figures.**
- As a result, right hemisphere patients tend to produce asymmetric or **distorted drawings characterized by hemispatial neglect,** the omission of elements from one side of the model.

Alzheimer's disease

- Alzheimer's disease patients with constructional apraxia have unique symptoms.
- Their **drawings contain fewer angles, spatial alterations, a lack of perspective and simplifications**, which are uncharacteristic of left hemisphere or right hemisphere patients.
- Constructional disabilities are present early on in the disease and get progressively worse over time; however even patients with advanced Alzheimer's disease may be able to do some constructional tasks.
- As Alzheimer's disease progresses, the **patient's ability to copy objects becomes increasingly impaired** and they may **lose the ability to draw** correctly a simple figures due to a motor loss in routine memories.

Causes

- Both perceptual and motor functioning.

- It has been **linked to parietal lesions in the left and right hem**isphere, stroke and Alzheimer's disease.
- Constructional apraxia is common **after right parietal stro**ke and it continues after **visuospatial symptoms** have subsided. Patients with **posterior and parietal lobe lesions ten**d to have the most **severe** symptoms.
- Free drawing is a commonly used test in which the patient is asked to **draw a named object.**
- It can be an effective tool in measuring the **patient's ability to maintain** spatial relations, **organize the drawing, and draw complete shapes.** The complexity of the task should be noted as such tasks often require lexical-semantic abilities as well as imagery abilities.

Treatment

Motor imagery has been explored as a **potential therapy f**or constructional apraxia patients. Motor imagery is a process by which a specific action is mimicked in the working memory without a corresponding motor output. Since constructional apraxia is a visuospatial problem not a motor problem, **rehabilitation-treatment** based on motor imagery has not proven to be an effective in patients with right hemisphere stroke or hemispatial neglect.

SPATIAL ALEXIA AND ACALCULIA

Spatial Alexia

- disorder of **reading based on difficulty perceiving location** (place holding) of letters or words or maintaining the **correct sequence** of lines of print
- generally seen in context of **right hemisphere dysfunction**
- Alexia is an acquired disorder **resulting in the inability to read or comprehend written language.**

- Patients with alexia have difficulty performing activities of daily living such as reading the **newest best-selling novel, reading texts messages or letters from their loved ones, or even reading signs** and following written directions.

Alexia Diagnosis and Treatment

- At Wake Forest Baptist Health, our **speech-language pathologists** will meet with you, take your medical history, and perform a comprehensive **language evaluation**.
- The evaluation will include a **formal assessment of your reading fluency** and **reading comprehension.**
- The information gathered during the evaluation will be used to establish a treatment plan that is right for you. Our speech-language pathologists work closely with each patient, customizing therapeutic tasks to help improve specific reading skills and functional communication

Spatial Acalculia

- Spatial acalculia represents a disorder of spatial organization where the rules for setting written digits in their proper order and position are not followed;
- spatial neglect and number inversions are frequently found in this disorder.

Types of Acalculia

- **Aphasic acalculia**. The **calculation defects s**tem from linguistic alterations. The inability to understand and codify **numerical language stems from t**he inability to operate the language.
- **Alexic acalculia**. This is primarily linked to **difficulty reading and recognizing numeric symbols.** Patients are simply unable to understand things by reading them.
- **Agraphic acalculia**. Agraphia is the **inability to communicate and express yourself through writing**.

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- **Frontal acalculia.** This is perhaps the most common type of acalculia and it's somewhat rel**ated to attention-deficit disorders.** Patients with this type of acalculia tend to systematically **repeat the same mistakes.** It stems from the inability to identify mistakes. Patients with this problem also have **difficulty finding solutions.**
- **Semantic acalculia.** Patients with this type of acalculia have a hard time managing **concepts of relationships between things.** One clear example would be the **inability to associate math problems with the necessary steps you h**ave to take to solve them.
- **Spatial acalculia**. This particular condition results from an injury to the right hemisphere. **Problems with arithmetic are also associated with spatial processing problems.**

Symptoms of dyscalculia in pre-school aged children:

- Difficulties learning how to count.
- Problems associated with the comprehension of numbers

Inability to classify and measure:

It is difficult to associate a number with a real life situation, for example connecting the number "2" to the possibility of having 2 candies, 2 books, 2 plates, etc.

- **Problems recognizing symbols** associated with numbers
  , for example, inability to associate "4" to the concept "four".

Written errors

of numbers when they're written or copied.

- **Incorrect symbols:** *for example, confusing 9 with 6, or 3 with 8.*
- Reverse number while writing:
  Write the numbers upside down.

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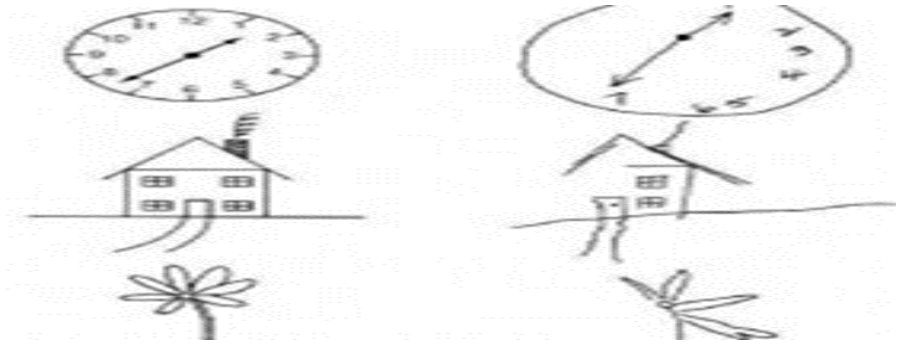
- **Sound errors:**
  Confuse numbers that sound similar, like “two” and “three”
- Symptoms when ordering or sequencing numbers:
  Repeat a number two or more times.

Symptoms relative to sequencing:

Another characteristic of dyscalculia happens when we ask a child to start counting from 4, for example. The child is not able to start from this number, and instead must say the complete sequence by writing it or saying the previous numbers to him or herself. They have a hard time classifying objects

by shape and size.

UNILATERAL SPATIAL NEGLECT DISORDERS OF BODY SCHEMA



Unilateral Spatial Neglect Syndrome

- Unilateral spatial neglect (USN) is the inability to pay attention to people and things on the side that is affected by the stroke.
- unilateral spatial neglect syndrome is a **neurological disorder**
- patients will present a **lack of attentio**n and **response to objects,** individuals and other stimuli that originate on the side that is contralateral to that of the injury.
- It is even possible to see patients that **do not recognize their own extremities (arms or legs)**

- The fact that an **injury is located in both parietal lobes i**s extremely important because they are the c**entral area for attentional control**, spatial perception and personal navigation in the outside world.

Types of Spatial Neglect

There are several types of spatial neglect and we will review the best-known ones in the next section.

Attentional or sensory spatial neglect: this type of spatial neglect refers to an **awareness deficit of any stimuli plac**ed

- This **lack of attention c**an occur with different types of stimuli: visual, auditive, tactile; located in **space or on the patient's body**.

Spatial Neglect: patients who suffer from this type of **neglect "forget" to complete the part of a task that corresponds t**o the opposite side of where the injury took place. For example, a patient affected by this type of spatial neglect would only **eat half of the food served on a plate.**

Personal Neglect: patients do **not recognize that their extremiti**es, specially those located on the opposite side of where the injury took place, belong to them.

Intentional or Motor Neglect: patients do not respond to stimuli, ***although they are aware of them*** and have no motor impairments in the affected body part.

Problems Associated with Spatial Neglect

unilateral spatial neglect or spatial neglect syndrome tends to affect considerably an **individual's level of functionality**. Patients affected by spatial neglect will see **how performing the activities of daily living, both basic and instrumental (or advanced), becomes affected, showing difficulties in t**heir performance or even not being able to do them at all. A few examples of the problems patients can encounter are:

Personal Hygiene: combing, shaving or putting make-up on one side of the face. The same thing happens with brushing one's teeth.

Bathing: using soap or drying one side of the body.

Getting Dressed: having difficulties placing a garment with respect to one's body or wearing a garment in only one side of the body.

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Eating: scooping food from one half of a dish and not finding those elements that are on the affected side.

Using Public Transport: having problems to understand a bus or train timetable and difficulties orienting oneself or getting down at the desired stop.

Rehabilitation after Spatial Neglect

In general, the majority of the rehabilitation tasks or activities used for spatial neglect are compensatory techniques or tasks that force patients to pay attention to the affected side. Below we will see some examples of the activities that are normally used:

- Instructions for visual scanning.
- Visual scanning exercises like, for example, cancellation and selection tasks.
- Train trunk rotation to facilitate visual scanning.
- Mirror Therapy.
- Reminding patients to pay attention to the affected side.
- Viewing videos with moving objects to train eye tracking.
- Virtual Reality.

Unilateral Spatial Neglect - Testing

- Spatial and exploratory tasks (eg. pattern
- crossing, line bisection)
- Copying tasks
- Drawing from memory even of objects with will known symmetrical configuration
- **Object centered neglect** - neglect left side of the figure although then reproduce the right side of a figure that is further to the left
- Reading
- Multiple-choice tasks Description of a scene

Furthermore, treatment will be more effective if several techniques are used and clinicians alternate among them for their application.

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GERSTMANN'S SYNDROME

Gerstmann's syndrome is a condition arising as a result of disease of the **dominant parietal lobe at the angular gyrus**. Possibly both **superior and inferior lobes** need to be affected. However, in Gerstmann's syndrome in particular, the result is characterised by four components:

- Agraphia or dysgraphia
- Acalculia or dyscalculia
- Finger agnosia
- Left-right disorientation

Gerstmann's syndrome, symptoms

There is loss or absence of four sensory abilities:

- Loss of the ability to express thoughts in writing (agraphia, dysgraphia).
- Inability to perform simple arithmetical calculations (acalculia).
- Inability to recognise or indicate one's own or another's fingers (finger agnosia).
- Inability to distinguish between right and left.

The speech area is in the dominant hemisphere that is on the left in over **95% of right-handed peop**le. It is also on the **left in 75% of left-handed** people; however, in the **other 25% it appears to be bilateral.**

In addition to the four primary symptoms, many children also have constructional apraxia, an **inability to copy simple drawings**. Frequently, there is also impairment in **reading (dyslexia).**

Eliciting features of Gerstmann's syndrome

Agraphia:

- Illegible or very poor writing.
- Inconsistencies in forming letters.

- Mixture of upper- and lower-case letters or print and cursory writing.
- Irregular letter sizes and shapes.
- Unfinished letters.
- They struggle to use writing for communication.

Acalculia: this is tested by asking the patient to do serial subtraction of 7 from 100. This means 100, 93, 86, 79, 72, etc. It must be interpreted in the light of the educational level of the patient, including the age of a child. An easier test may be applicable, especially for children.

Finger agnosia: finger agnosia is **difficulty in distinguishing** fingers on the hand. It is tested by requests like, "**Touch my index finger** with your index finger" and "Touch your nose with your little finger".

Left-right disorientation: this is confusion of the right and left limbs and indicates a lesion in the dominant parietal lobe. It is tested by requests like, "Show me your left hand", **"Touch your right foot" and "Touch your left ear with your right hand".** A positive test is the **inability to obey these commands** in the presence of otherwise normal sensory and motor function.

Differential diagnosis

In adults, differential diagnosis is that of cerebrovascular events and dementia. In children, it is global brain damage and general learning disability.

Investigations

MRI scan will usually show a lesion of the angular gyrus in the left parietal lobe.

Associated diseases

As well as occurring in strokes, head injuries and developmental disorders, the syndrome has been associated with:

- Cerebral atrophy

- Alcoholism
- Carbon monoxide poisoning
- Lead poisoning
- Anaphylactic shock
- Systemic lupus erythematosis

Gerstmann's syndrome treatment and management

There is no cure for Gerstmann's syndrome. Treatment is supportive:

Dysgraphia and apraxia can be helped by occupational and speech therapy. Calculators and word processors can also help school children cope with their disabilities.

There has been a recognition of the association between finger recognition and numerical ability and there has been promising work done where improving finger gnosis through training exercises has led to improvements in the mathematical skills of young children.

Prognosis

Gerstmann's syndrome symptoms may lessen in adults over time. This is also thought to occur in children but it is more likely that they adapt to life with them. It has been suggested that early diagnosis and intensive treatment give a better outcome

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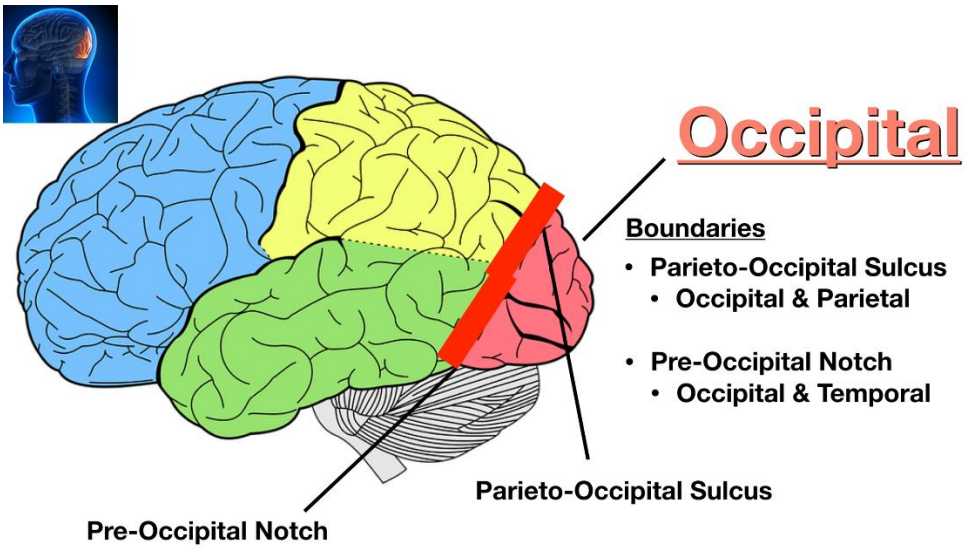
UNIT IV

OCCIPITAL LOBE AND HEMIPHERIC ASSYMETRY

Anatomical Features- cerebral Blindness -**Visual** Agnosia -Alexia without Agraphia –Visual **Hallucinations**. The Concept of Cerebral Dominance- **Unilateral** Lesion Studies - Hemispherectomy-Cerebral Commissurotomy.

ANATOMICAL FEATURES



The occipital lobe is the seat of most of the brain's visual cortex, allowing you to see and process stimuli from the external world and to assign meaning to and remember visual perceptions. Located just under the parietal lobe and above the temporal lobe, the occipital lobe is the brain's smallest lobe, but its functions are indispensable.

Brodmann area 17: Known as V1, this region is located in the occipital lobe's calcarine sulcus, and serves as the brain's primary visual cortex. It aids the brain to determine location, spatial information, and color data.

The ventral stream: Known sometimes as V2, this is a secondary visual cortex that helps the brain assign meaning to what it is seeing. Without V2, you would still be able to see, but would have no conscious awareness of or understanding of the sights your eyes took in.

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The dorsomedial stream: Neuroscientists don't yet have a strong understanding of this brain region, which connects to both V1 and V2, as well as other brain regions.

The lateral geniculate bodies: These structures take in optic information from retinal sensors in each eye, sending raw information to each visual cortex.

Lingula: this area receives information from the contralateral inferior retina to gather information about the field of vision.

Function

Although we know that the occipital lobe is dedicated to vision, this process is highly complex, and includes a number of separate functions. Those include:

- Mapping the visual world, which helps with both spatial reasoning and visual memory. Most vision involves some type of memory, since scanning the visual field requires you to recall that which you saw just a second ago.
- Determining color properties of the items in the visual field.
- Assessing distance, size, and depth.
- Identifying visual stimuli, particularly familiar faces and objects.
- Transmitting visual information to other brain regions so that those brain lobes can encode memories, assign meaning, craft appropriate motor and linguistic responses, and continually respond to information from the surrounding world.
- Receiving raw visual data from perceptual sensors in the eyes' retina.

Damage to the occipital lobe can include:

- Difficulty with locating objects in environment
- Difficulty with identifying colours (Colour Agnosia)
- Production of hallucinations
- Visual illusions - inaccurately seeing objects
- Word blindness - inability to recognise words
- Difficulty in recognizing drawn objects

- Inability to recognize the movement of an object (Movement Agnosia)
- Difficulties with reading and writing.

CEREBRAL BLINDNESS

- Cortical blindness is the total or partial loss of vision in a normal-appearing eye caused by damage to the brain's occipital cortex.
- Cortical blindness can be acquired or congenital, and may also be transient in certain instances.
- Acquired cortical blindness is most often caused by loss of blood flow to the occipital cortex from either unilateral or bilateral posterior cerebral artery blockage (ischemic stroke) and by cardiac surgery.
- In most cases, the complete loss of vision is not permanent and the patient may recover some of their vision (cortical visual impairment).
- Congenital cortical blindness is most often caused by perinatal ischemic stroke, encephalitis, and meningitis.
- Rarely, a patient with acquired cortical blindness may have little or no insight that they have lost vision, a phenomenon known as Anton–Babinski syndrome.

Symptoms

The most common symptoms of acquired and transient cortical blindness include:

- A complete loss of visual sensation and of vision
- Preservation/sparing of the abilities to perceive light and/or moving, but not static objects (Riddoch syndrome)
- A lack of visual fixation and tracking
- Denial of visual loss (Anton–Babinski syndrome)
- Visual hallucinations
- Macular sparing, in which vision in the fovea is spared from the blindness.

Causes

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The most common cause of cortical blindness is ischemia (oxygen deprivation) to the occipital lobes caused by blockage to one or both of the posterior cerebral arteries. However, other conditions have also been known to cause acquired and transient cortical blindness, including:

- Congenital abnormalities of the occipital lobe
- Head trauma to the occipital lobe of the brain
- Bilateral lesions of the primary visual cortex
- Infection
- Creutzfeldt–Jakob disease (CJD), in association with a rapid onset of dementia
- rarely Dissociative identity disorder (DID)
- Side effect of some anti-epilepsy drugs (AEDs)
- Hyperammonemia
- Eclampsia and, rarely, pre-eclampsia

The most common causes of congenital cortical blindness are:

- Traumatic brain injury (TBI) to the occipital lobe of the brain
- Congenital abnormalities of the occipital lobe
- Perinatal ischemia
- Encephalitis
- Meningitis

Diagnosis

- A patient with cortical blindness has no **vision but the response of** his/her **pupil to light is intac**t (as the reflex does not involve the cortex).
- Therefore, one diagnostic test for cortical blindness is to first objectively verify the optic nerves and the non-cortical functions of the eyes are functioning normally.
- This involves **confirming that patient can distinguish lig**ht/dark, and that his/her pupils **dilate and contract with light exposure.** Then, the patient is asked to describe

something he/she would be able to recognize with normal vision. For example, the patient would be asked the following:

"How many fingers am I holding up?"

"What does that sign (on a custodian's closet, a restroom door, an exit sign) say?"

"What kind of vending machine (with a vivid picture of a well-known brand name on it) is that?"

Outcome

- The prognosis of a patient with acquired cortical blindness depends largely on the original cause of the blindness.
- For instance, patients with bilateral occipital lesions have a much lower chance of recovering vision than patients who suffered a transient ischemic attack or women who experienced complications associated with eclampsia.
- In patients with acquired cortical blindness, a permanent complete loss of vision is rare.

VISUAL AGNOSIA: Visual agnosia is a neurological disorder. A person won't be able to recognize a familiar object using only sight even when they have otherwise normal vision. A person with visual agnosia may need to rely on other senses to recognize everyday items. People with visual agnosia may have no other problems with their eyesight or with their memory. But they likely have damage in certain parts of the cerebral cortex. These areas are responsible for processing specific aspects of vision.

Types of visual agnosia

- **Autotopagnosia** – Inability to recognize or name parts of their own body, such as fingers or toes
- **Prosopagnosia** – Inability to put a name to a familiar face, such as a relative, a neighbor or a celebrity
- **Simultanagnosia** – Inability to recognize a collection of objects, such as a set of tools, or a scene, such as a landscape

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- **Topographagnosia** – Inability to recognize familiar or famous places, such as the Grand Canyon or a friend's living room

What causes visual agnosia?

The brain damage that leads to visual agnosia may be caused by a number of issues, such as:

- Brain tumors
- Dementia, such as from Alzheimer's disease or Posterior Cortical Atrophy
- Developmental disorders
- Head injuries
- Infections
- Lack of oxygen (hypoxia)
- Stroke
- Exposure to toxins such as carbon monoxide or mercury

Visual agnosia diagnosis and treatment

A diagnosis of visual agnosia may require multiple consultations. These may be with an eye doctor, a neurologist and/or other healthcare professionals.

Th following steps may be a part of the process of diagnosing visual agnosia:

- Interviewing the patient about their history and challenges in daily life
- Showing the patient simple items like an apple, a cup or a phone and asking them to identify the objects by sight
- Doing thorough physical, eye and neurological exams and looking for problems with vision (such as visual acuity)
- Giving standardized tests to rule out problems with memory and cognition
- Ruling out other reasons for inability to identify objects (such as general dementia or anomia)

- Ordering brain imaging tests such as a CT (computed tomography) scan or MRI (magnetic resonance imaging)

ALEXIA WITHOUT AGRAPHIA

- Pure alexia, also known as agnosic alexia or alexia without agraphia or pure **word blindness**, is one form of alexia which makes up "the **peripheral dyslexia**" group.
- Individuals who have pure alexia have severe **reading problems while other language-related skills** such as naming, oral **repetition, auditory comprehension or writing a**re typically intact.
- Pure alexia is also known as: "alexia without agraphia", "**letter-by-letter dyslexia","spelling dyslexia**", or "word-form dyslexia". Another name for it is "Dejerine syndrome", after Joseph Jules Dejerine, who described it in 1892; however, when using this name, it should not be confused with medial medullary syndrome which shares the same eponym.

Classification

Pure alexia results from cerebral lesions in circumscribed brain regions and therefore belongs to the group of acquired reading disorders, alexia,as opposed to developmental dyslexia found in children who have difficulties in learning to read.

Symptoms and Signs

- There is loss of the ability to read in a literate person, but recognition of faces, places and objects is preserved.
- The patient is unable to read, but can still write.
- When the patient tries to read a word or a nonword aloud, the patient will usually resort to naming, not sounding out, the individual letters slowly
- After naming the individual letters correctly, the patient will then say the word aloud

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Physical examination

- Right sided congruous homonymous hemianopia is often present due to the left occipital cortex lesion.
- Right sided achromatopsia and color anomia have also been observed in patients with pure alexia.

Clinical diagnosis

- Diagnosis is based on the symptom of not being able to read, but the patient still maintains visual acuity and the ability to write
- Patients often have right homonymous hemianopia due to left occipital lobe involvement
- Neuropsychometric testing may also be used to diagnose alexia without agraphia
- It is a performance-based method to evaluate cognitive function and can be used to assess brain damage, brain disease, and mental illness

General treatment

- Many vision rehabilitation techniques can be tried in the treatment of pure alexia
- One technique includes improving letter-by-letter reading
- Oral re-reading is another technique that can be used
- Oral re-reading can lead to improved accuracy and reading rate
- Another technique involves increasing patients' ability to access entire words in their orthographic lexicon through implicit tasks

Prognosis

- So far there is no cure for alexia without agraphia
- There is not a treatment that has been shown to help patients read normally or near normally

- Since there is not a cure or treatment that significantly improves reading ability, strategies such as letter-by-letter reading, oral re-reading, and tactile-kinesthetic training are used to lead to some improvement.

VISUAL HALLUCINATIONS

Visual hallucinations are relatively uncommon, and can be due to a variety of 'organic' brain diseases, affecting a variety of regions of the brain. The use of the term organic here is by convention, and should not be taken to imply absence of brain dysfunction in psychiatric illness.

Clinical presentation

Visual hallucinations can take various forms and should be distinguished from visual distortions or pseudohallucinations. They can be divided into simple and complex forms:

- simple hallucinations
- typically due to irritation or stimulation of the primary visual cortex (e.g. tumours, epilepsy)
- brief, uniform and stereotyped
- flashes of light and colour or indistinct forms
- complex visual hallucinations
- disruption to the wider visual system
- complex visual percepts
- branching or tessellated patterns
- people and/or animals
- complex scenes often associated with sensory distortions

Aetiology

A number of conditions are known to be associated with visual hallucinations including:

- delirium including secondary to drugs such as cocaine, methamphetamine
- psychoses (schizophrenia, schizoaffective disorder)

- occipital lesions (e.g. tumours, vascular malformations, strokes, epileptogenic foci)
- Anton syndrome: may be seen after occipital infarcts
- migraine, posterior reversible encephalopathy syndrome (PRES)
- dementia
- Lewy body dementia: >20% experience visual hallucinations
- Parkinson disease dementia: 50% experience visual hallucinations
- Alzheimer disease
- sleep-related, especially in narcolepsy
- alcohol withdrawal i.e. delirium tremens
- genetic metabolic disorders

Treatment could be done with medications and counseling.

THE CONCEPT OF CEREBRAL DOMINANCE

DEFINITION

Cerebral dominance refers to the dominance of one cerebral hemisphere over the **other in the control of cerebral functions.** Cerebral dominance is the ability of **one cerebral hemisphere** (commonly referred to as the left or right side of the brain) to **predominately control specific tasks**. Accordingly, damage to a specific hemisphere can result in an impairment of certain identifiable functions. For example, trauma to the left hemisphere can impair functions associated with speech, reading, and writing. Trauma to the right hemisphere can result in a decreased ability to perform such tasks as judging distance, determining direction, and recognizing tones and similar artistic functions.

Cerebral dominance and handedness

Cerebral dominance is also related to handedness—whether a person has a strong preference for the use of their right or left hand. More than 90% of people are right-handed and in the vast majority of these individuals, the left hemisphere controls language-related functions.

In left-handed individuals, however, only about 75% have language functions predominantly controlled by the left hemisphere. The remainder of left-handed individuals have language

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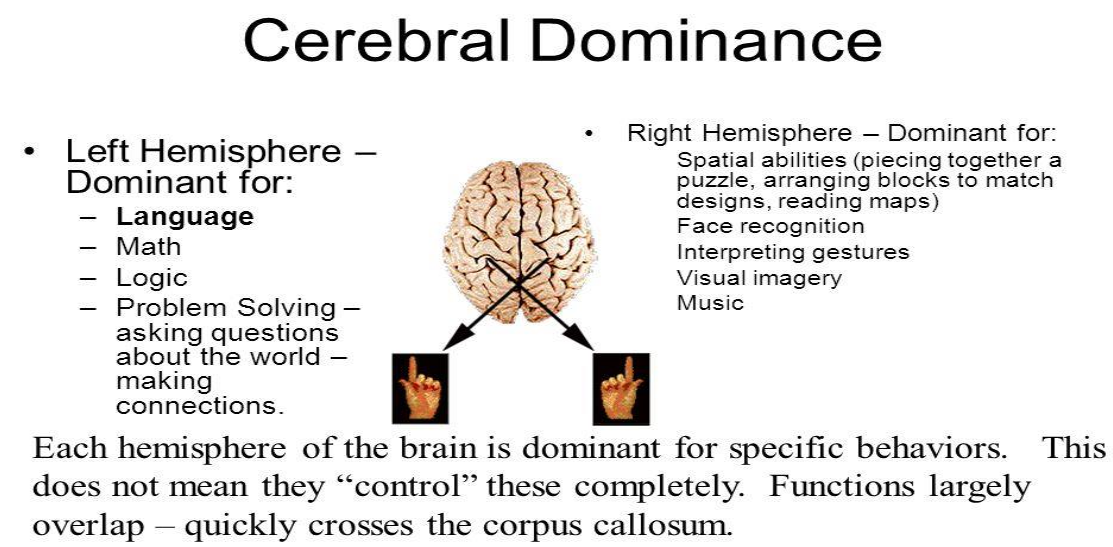
functions controlled by the right hemisphere, or do not have a dominant hemisphere with regard to language and spee



UNILATERAL

LESION STUDIES

a lesion on one side or lobe of an organ or part. For example, a unilateral cerebral lesion involves one cerebral hemisphere, left or right, with effects that may vary according to the dominance of the hemisphere and the function affected. The motor and sensory effects of the lesion are generally on the contralateral side—that is, on the side opposite to that of the lesion—unless the lesion occurs in the cerebellum.

HEMISPHERECTOMY

A hemispherectomy is where half of your child's brain is either totally or partly removed or disconnected from the rest of the brain. It is a rare surgical procedure done for epilepsy not responsive to medications. It is typically done in children and occasionally in adults. In these patients, the whole hemisphere is abnormal and responsible for causing seizures.

The "hemi" part of "hemispherectomy" means "half" and refers to the cerebral (brain) hemisphere – half of your brain.

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Hemispherectomy if they have these symptoms:

- Seizures (epilepsy), not controlled with medication.
- Weakness on one side of their body. Also, they can't use their hand as well and they might lose their peripheral vision.
- Abnormal finding on brain MRI that usually affects one side of the brain.
- Developmental delay because of seizures.

The symptoms listed above are associated with the following conditions and diseases:

- Malformations of cortical development.
- Perinatal infarction (stroke).
- Hemimegalencephaly.
- Sturge-Weber syndrome.
- Rasmussen's encephalitis.

Your child might have started having seizures and weakness early in life. Once your healthcare provider suspects drug-resistant epilepsy, you should be referred to a center that specializes in children with seizures

hemispherectomies

There are two types of hemispherectomies: anatomic and functional (disconnective).

- **Functional (disconnective):** The functional technique involves removing a smaller area of the brain and disconnecting the side from the rest of the brain. It has less risk for complications. Hemispherectomy is a term used when the tissue removed is small.
- **Anatomic**: Anatomic hemispherectomies are usually performed on children who have persistent seizures despite the "functional/ disconnective" hemispherectomy. This type of hemispherectomy is where the frontal, parietal, temporal, and occipital lobes of the brain are removed. This procedure has higher risk for complications – there can be extra blood loss and fluid buildup.

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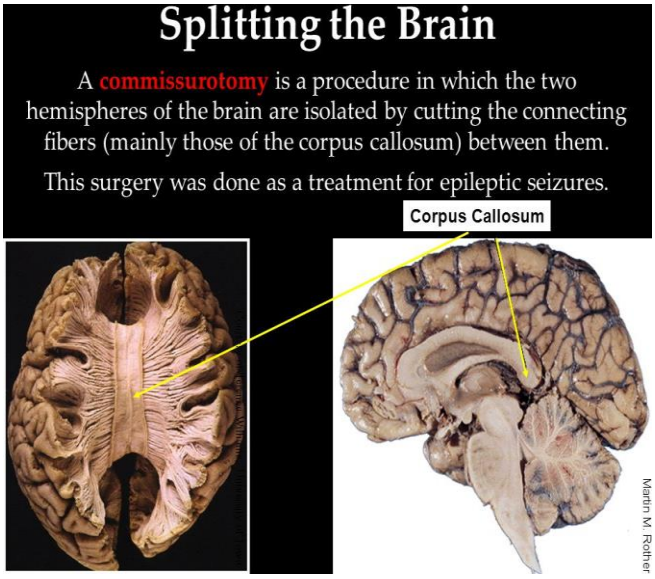
CEREBRAL COMMISSUROTOMY

Cerebral commissurotomy or the "split-brain" procedure may be a valuable adjunct to anticonvulsants for the control of seizures in people whose epilepsy cannot be relieved by anticonvulsants alone, and who are not candidate for the standard methods of surgery.



- split-brain surgery, may be performed in people with the **most extreme and uncontrollable forms of epilepsy**, when frequent seizures affect both sides of the brain.
- After the **right and left brain are separated,** each hemisphere will have its own separate perception, concepts, and impulses to act.
- Having two "**brains" in one body can create s**ome interesting dilemmas.
- When one split-brain patient dressed himself, he **sometimes pulled his pants up with one han**d (that side of his brain wanted to get dressed) and down with the other (this side did not).
- However, such conflicts are very rare. If a conflict arises, one hemisphere usually overrides the other.

Risks of a Corpus Callosotomy: Serious problems are uncommon with a corpus callosotomy, but there are risks, including:

- Risks associated with surgery, including infection, bleeding, and an allergic reaction to anesthesia
- Swelling in the brain
- Lack of awareness of one side of the body
- Loss of coordination

- Problems with speech, such as stuttering
- Increase in partial seizures (occurring on one side of the brain)
- Stroke

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NEUROPSYCHOLOGY

UNIT V:

ASSESSMENT

A .**Neuro Physiological Assessment**: Brain Imaging Techniques: CT scan- MRI -Methods to Study Functional Status: PET - Methods to Study Electrical Activities: EEG-BEAM

B. **Neuropsychological Assessment**: Bender Gestalt- Luria Nebraska Neuropsychological Battery- Halstead Reitan Battery- PGI Battery of Brain Dysfunction- Wechsler's Memory Scale- Memory for Design Test.

NEUROPHYSIOLOGICAL ASSESSMENT

Neurophysiological methods are **used to identify and to define the states of consciousness and unconsciousness** (as during sleep with different functional states of consciousness associated with distinct brain rhythms detectable with the EEG.

Neuroimaging falls into two broad categories:

1. **structural imaging** – deals with the structure of the brain and the diagnosis of large-scale intracranial disease—such as a tumor—as well as injury.
2. **functional imaging** – measures an aspect of brain function, often with a view to understanding the relationship between activity in certain brain areas and specific mental functions. It is primarily used as a research tool in cognitive neuroscience and neuropsychology.

Commonly used brain imaging techniques are:

- functional magnetic resonance imaging (fMRI)
- computerized tomography (CT)
- positron emission tomography (PET)
- electroencephalography (EEG) and magnetoencephalography (MEG)
- functional near-infrared spectroscopy (fNIRS)

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One of the benefits of brain imaging is how easily it can be performed. It doesn't require invasive steps and often simply involves laying down and being still while the scan takes place around you. These modern brain imaging techniques enable doctors to map out the regions and functions of your brain in a non-invasive way.

What is brain imaging used for

Brain imaging has many roles in health care and makes the jobs of diagnosticians easier. Some uses of brain imaging techniques include:

- identifying the effects of a stroke
- locating cysts and tumors
- finding swelling and bleeding

Types of imaging

fMRI

Functional magnetic resonance imaging (fMRI) can detect changes in blood flow and oxygen levels that result from your brain's activity. It uses the magnetic field of the scanner to affect the magnetic nuclei of hydrogen atoms, so they can be measured and converted into images.

MRIs display anatomic structure and fMRIs measure metabolic function.

fMRIs have many uses, such as:

- assessing brain activity
- finding brain abnormalities
- creating pre-surgical brain maps

CT

A computerized tomography (CT) scan is a series of X-ray images converted into cross-sectional images of your brain. These X-rays are combined to form cross-

sectional slices or even a 3-D model of your brain. The results of a CT scan can also provide more detail than a standard X-ray. A CT scan uses X-rays and computers to produce images of a cross-section of your body. It takes pictures that show very thin "slices" of your bones, muscles, organs and blood vessels so that healthcare providers can see your body in great detail.

Used For CT

Doctors order CT scans for a long list of reasons:

- CT scans can detect bone and joint problems, like complex bone fractures and tumors.
- If you have a condition like cancer, heart disease, emphysema, or liver masses, CT scans can spot it or help doctors see any changes.
- They show internal injuries and bleeding, such as those caused by a car accident.
- They can help locate a tumor, blood clot, excess fluid, or infection.
- Doctors use them to guide treatment plans and procedures, such as biopsies, surgeries, and radiation therapy.

PET

- A PET (positron emission tomography) scan is an imaging test that uses radioactive material to diagnose a variety of diseases.
- Doctors use it to find tumors, diagnose heart disease, brain disorders and other conditions.
- A PET scan provides a picture of the body working, not just a picture of its structure, like some other scans.
- A PET scan is able to see these tracers and observe how they move and accumulate in your brain.

- This allows doctors to see trouble spots where glucose isn't moving correctly.

Test is Performed

A PET scan uses a small amount of radioactive tracer. The tracer is given through a vein (IV). The needle is most often inserted on the inside of your elbow. The tracer travels through your blood and collects in organs and tissues. This helps the radiologist see certain areas more clearly. You will need to wait as the tracer is absorbed by your body. This takes about 1 hour.

PET scans can evaluate:

- seizures
- Alzheimer's
- tumors

Method to study electrical activity: Electrical activity is the **study of the electrical properties of biological cells, tissues and organs.** It includes measurements of change in **voltage or electric current on a far-ranging variety of scales from single ion channel p**roteins to entire organs like the heart

EEG

- **electroencephalography**, technique for recording and interpreting the electrical activity of the brain.
- The nerve cells of the brain generate electrical impulses that fluctuate rhythmically in distinct patterns.
- In 1929 German **scientist Hans Berger** published the results of the first study to employ an electroencephalograph, an instrument that measures and records these brain-wave patterns.

- The recording produced by such an instrument is called an electroencephalogram, commonly abbreviated EEG.
- Before the scan, clinicians will attach small electrodes to your scalp that are attached to wires.
- These electrodes detect electrical activity in your brain and send it to a computer where it creates a graph-like image.
- Each type of frequency appears on its own line and gives your doctor information about your brain activity.

EEG can detect issues such as:

- anxiety
- head injuries
- epilepsy
- sleep disruption

brain electrical activity mapping

- A non-invasive diagnostic technique used to detect certain kinds of epilepsy, head injuries, dyslexia, brain tumours, dementia and other brain diseases.
- This procedure utilises a computer to convert data from brain electrical potentials into coloured topographical maps of the brain, which are then automatically compared with those of an appropriate control group to indicate the degree of deviation from the norm.
  (1) localizes tumors in patients with normal or nondiagnostic EEGs, (2) adds additional information to that visible on computerized axial tomography, and (3) demonstrates electrophysiological abnormalities in patients with functional lesions but normal CT scans.
- A sensitivity to the functional component of a neurological lesion suggests that BEAM may provide complementary information to the anatomical definition provided by the CT scan.

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MEG

Magnetoencephalography (MEG) measures the magnetic field from neuron electrical activity. This type of scan can locate and identify malfunctioning neurons in your brain. Doctors use MEG to evaluate both spontaneous brain activity, as well as neuronal responses triggered by stimuli.

MEG allows doctors to assess areas such as:

- epilepsy sources
- motor areas
- sensory areas
- language and vision

B. NEUROPSYCHOLOGICAL ASSESSMENT: BENDER GESTALT- LURIA NEBRASKA NEUROPSYCHOLOGICAL BATTERY- HALSTEAD REITAN BATTERY- PGI BATTERY OF BRAIN DYSFUNCTION- WECHSLER'S MEMORY SCALE- MEMORY FOR DESIGN TEST

A neuropsychological assessment is a formal comprehensive evaluation of cognitive abilities (e.g. memory, problem-solving, visual-spatial skills, attention, processing speed) that is done to understand brain-behaviour relationships (i.e. how the brain works). It must be done by a licensed psychologist who is specially trained in neuropsychology.

BENDER GESTALT

The Bender Visual Motor Gestalt test (or Bender-Gestalt test) is a psychological assessment used to evaluate visual-motor functioning, visual-perceptual skills, neurological impairment, and emotional disturbances in children and adults ages three and older.

Purpose- The Bender Gestalt Test is used to evaluate visual maturity, visual motor integration skills, style of responding, reaction to frustration, ability to

correct mistakes, planning and organizational skills, and motivation. Copying figures requires fine motor skills, the ability to discriminate between visual stimuli, the capacity to integrate visual skills with motor skills, and the ability to shift attention from the original design to what is being drawn.

Description

The Bender Gestalt Test is an individually administered pencil and paper test used to make a diagnosis of brain injury. There are nine geometric figures drawn in black. These figures are presented to the examinee one at a time; then, the examinee is asked to copy the figure on a blank sheet of paper. Examinees are allowed to erase, but cannot use any mechanical aids (such as rulers). The popularity of this test among clinicians is most likely the short amount of time it takes to administer and score. The average amount of time to complete the test is five to ten minutes.

Results

A scoring system does not have to be used to interpret performance on the Bender Gestalt Test; however, there are several reliable and valid scoring systems available. Many of the available scoring systems focus on specific difficulties experienced by the test taker.

These difficulties may indicate poor visual-motor abilities that include:

Angular difficulty: This includes increasing, decreasing, distorting, or omitting an angle in a figure.

Bizarre doodling: This involves adding peculiar components to the drawing that have no relationship to the original Bender Gestalt figure.

Closure difficulty: This occurs when the examinee has difficulty closing open spaces on a figure, or connecting various parts of the figure. This results in a gap in the copied figure.

Cohesion: This involves drawing a part of a figure larger or smaller than shown on the original figure and out of proportion with the rest of the figure. This error may also include drawing a figure or part of a figure significantly out of proportion with other figures that have been drawn.

LURIA NEBRASKA NEUROPSYCHOLOGICAL BATTERY

The Luria-Nebraska Neuropsychological Battery, also known as LNNB or Luria-Nebraska Battery, is a standardized test battery used in the screening and evaluation of neuropsychologically impaired individuals.

Purpose-

- The LNNB was developed in an attempt to combine the qualitative techniques of some neuropsychological tests with the quantitative techniques of others.
- However, the scoring system that most clinicians use is primarily quantitative.
- The battery measures specific neuropsychological functioning in several areas including motor skills, language abilities, intellectual abilities, nonverbal auditory skills, and visual-spatial skills.
- The battery is used by clinicians as a screening tool to determine whether a significant brain injury is present or to learn more about known brain injuries.
- It is also used to determine what the patient is or is not able to do with regard to neuropsychological functioning.
- For example, the LNNB may be used to determine which intellectual or cognitive tasks a patient may or may not be able to complete.
- The battery can also be used to arrive at underlying causes of a patient's behavior.

- More specifically, information regarding the location and nature of the brain injury or dysfunction causing a patient's problems is collected.

Administration and scoring

The battery, written in 1981 by Charles Golden, is appropriate for people aged 13 and older and takes between 90 and 150 minutes to complete. For the adult version of this standardized test, used with ages 15 and above, there are 269 items that are scored from 0 to 2. On this continuum a score of 0 represents a normal non-damaged brain and a higher score near 2 depicts brain damage. None of these items measures exactly the same thing, although each of them may have alternative ways of measuring the same behavior

- reading
- writing
- arithmetic
- visual
- memory
- expressive language
- receptive language
- motor function
- rhythm
- tactile
- intellectual

HALSTEAD REITAN BATTERY

- This tests was developed by ward Halstead and his student Ralph Reitan in the early 1940.
- This tests helps to determine the location and specific brain lesions.
- observations of persons with cerebral lesions brain-damaged individuals had a wide range of deficits and that a single test would not be able adequately to identify and evaluate the severity of their deficits.
- Developed a series of 10 tests that ultimately formed the principal basis for his concept of biological intelligence.

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Purpose-Neuropsychological functioning refers to the ability of the nervous system and brain to process and interpret information received through the senses. The Halstead-Reitan evaluates a wide range of nervous system and brain functions, including visual, auditory, and tactual input; verbal communication; spatial and sequential perception; the ability to analyze information, form mental concepts, and make judgments; motor output; and attention, concentration, and memory.

Sub test: The 10 tests in HRB

Category Test

A series of 208 pictures consisting of geometric figures are presented, sorted in groups according to some underlying principle, which the test subject is asked to determine. For each picture, individuals are asked to decide which of four principles they believe is represented and to press a key that corresponds to the number of choice. If they chose correctly, a chime sounds. If they chose incorrectly, a buzzer sounds. The pictures are presented in seven subtests.

Tactual Performance Test

A form board containing 10 cutout shapes, and 10 wooden blocks matching those shapes are placed in front of a blindfolded individual. Individuals are then instructed to use only their dominant hand to place the blocks in their appropriate space on the form board. The same procedure is repeated using only the non-dominant hand,

Trail Making Test

This test consists of two parts. Part A is a page with 25 numbered circles randomly arranged. Individuals are instructed to draw lines between the circles in increasing sequential order until they reach the circle labeled “End.” Part B is a page with circles containing the letters A through L and 13 numbered circles

intermixed and randomly arranged. Individuals are instructed to connect the circles by drawing lines alternating between numbers and letters in sequential order, until they reach the circle labeled "End."

Finger Tapping Test

Individuals place their dominant hand palm down, fingers extended, with the index finger resting on a lever that is attached to a counting device. Individuals are instructed to tap their index finger as quickly as possible for ten seconds, keeping the hand and arm stationary. This trial is repeated five to 10 times, until the examiner has collected counts for five consecutive trials that are within five taps of each other.

Rhythm Test

Thirty pairs of tape-recorded, nonverbal sounds are presented. For each pair, individuals decide if the two sounds are the same or different, marking "S" or "D" respectively on their answer sheets. The pairs are grouped into three subtests.

Speech Sounds Perception Test

Sixty tape-recorded nonsense syllables containing the sound "ee" (for example, "meer" and "weem") are presented. After each syllable, individuals underline, from a set of four written syllables, the spelling that represents the syllable they heard.

Reitan-Indiana Aphasia Screening Test

Aphasia is the loss of ability to understand or use written or spoken language, due to brain damage or deterioration. In this test, individuals are presented with a variety of questions and tasks that would be easy for someone without impairment.

PGI BATTERY OF BRAIN DYSFUNCTION

- The P.G.I Battery of Brain Dysfunction was developed by D. Pershad and S. K. Verma.
- It is a sophisticated collection of various tests that are used to quantify cognitive dysfunction, impairment, decline, or deficits in clinical settings.
- The P.G.I Battery of Brain Dysfunction measures well-known cognitive functions of the brain behaviour such as intelligence (both performance and verbal), memory, perceptual acuity, and transference from one hemisphere to another.
- PGI Battery of Brain Dysfunction, 1990, Second edition 2007, By Dwarka Pershad and S.K.Verma.

This battery includes five tests :

- Bhatia's Short Scale,
- Verbal Adult Intelligence Scale,
- PGI Memory Scale,
- Bender Visual Motor Gestalt Test and,
- Nahor Benson Test of Perceptual Acuity.

Norms are developed for the 20 to 50 years age group; following a factorial sampling design of 2 X 3 X 5 [two levels of sex, three levels of education, and five levels of age]. It gives a global rating of cognitive dysfunction based on 19 test variables and estimates well accepted/validated psychological concepts of (a) intelligence, (b) memory, and (c) gestalt formation of perceptual acuity. It provides a profile of the current cognitive functioning of the subject.

INTERPRETATION AND DISCUSSION :

In P.G.I-Memory Scale (PGI-MS) the participant scored well for attention and concentration in forwarding digit span while scoring relatively lower for backward digit span could be due to any disturbance. Other tests were

performed well and the dysfunction rating score obtained was 0, which indicates that the patient can pay attention and concentrate, meaning no impact on attention from damage to areas like the prefrontal cortex because of the lesion is there.

- This assessment can be helpful in planning rehabilitation strategies accordingly and may also help the judiciary in taking decisions about the extent of decline for grant of compensation.
- PGI battery of memory dysfunction: Includes 10 subtests including forward and backward digit spans, one minute delayed recall of a word list, immediate recall of sentences, retention of similar word pairs, retention of dissimilar pairs, visual retention, visual recognition, recent memory, remote memory and mental balance test.

WECHSLER'S MEMORY SCALE

The Wechsler Memory Scale (WMS) measures various memory functions in people aged 16-90 and is the most commonly used memory scale for adults. The original WMS was first introduced in 1945 with the latest edition being the WMS-IV introduced in 2009. The WMS is frequently used along with the Wechsler Adult Intelligence Scale (WAIS). The WMS is used to determine memory function and can diagnose memory abnormalities as an effect of dementia or neurological disorders. Developed by David Wechsler the test assesses learning, memory, and working memory and is published by Harcourt Assessment

- Auditory Immediate
- Visual Immediate
- Immediate Memory
- Auditory Delayed
- Visual Delayed
- Auditory Reception Delayed

- General Memory
- Working Memory

MEMORY FOR DESIGN TEST

The Memory for designs test was designed by Graham and Kendall, in 1946. The test examines visual recall of an individual based on brain damage versus functional disorder versus normality. It is a popular test for the examination of brain damage in children and adults. The scoring system allows the accumulation of normative data (Graham & Kendall, 1947).

Administration of the test

The test is administered by presenting a series of fifteen geometric designs of increasing difficulty on individual cards. The cards are nine by twelve inch pieces of paper, with all designs drawn on the same piece of paper. Each design is presented to the individual alone, in a prearranged sequence. The subject is supposed to view the design for five seconds before it is removed from his view. The test's duration is about five to ten minutes (Erickson & Scott, 1977).

Development of the test

The memory test was intended to draw the line and distinguish between individuals who are organically impaired and those who are functionally impaired. The inability to reproduce geometric designs from immediate memory is related to organic impairment.

Scoring, scale norms and distribution

According to the criteria provided by Graham and Kendall (1960), each reproduction has a score of 0-3, whereby the highest score signifies the worst performance. There was no penalty due to incomplete or forgotten designs. This is because the variables did not distinguish brain damaged subjects from control subjects.