

Parietal & Occipital Lobe Syndromes: Neuropsychological Approach

Mustafa Nadeem Kirmani¹, Mukesh Kumar Garg², Preeti Sharma³

ABSTRACT

Neuropsychology is the scientific study of the relationship between brain and behavior. It bridges the disciplines of neurology and cognitive psychology and seeks to describe and explain how cognitions, emotions and behavior are mediated by different processes in brain. In clinical settings, different neurological and psychiatric disorders effect psychological functioning of the patients in terms of information processing, sensory-perceptual processes, attention, execution and other order brain functions.

Neuropsychological functioning can be assessed by various sets of neuropsychological batteries available in India. It helps to understand the patients' neuropsychological deficits and strengths too. The neuropsychological functioning helps in formulating cognitive retraining and holistic management of brain related and psychiatric disorders. The term syndrome entails the group and cluster of symptoms associated with any clinical condition. This paper will briefly focus on the anatomy, functions and various syndromes associated with parietal and occipital lobes and their corresponding neuropsychological issues.

Keywords: *Syndromes, Parietal and Occipital Lobes, Neuropsychology*

Neuropsychology is the scientific study of the relationship between brain and behavior. It bridges the disciplines of neurology and cognitive psychology and seeks to describe and explain how cognitions, emotions and behavior are mediated by different processes in brain. Joseph Gall, a German anatomist and physiologist, initiated the notion of phrenology which attempts to study human personality by studying the size and shape of human skull. It paved the way to the study the relationship of brain to different behavioral aspects. His study of phrenology, though, appeared pseudoscience, later helped establish psychology as a science (Davies, 1955). Gall's work helped in paving the study of brain lateralization- localization process.

¹ Licensed Clinical Psychologist trained at NIMHANS, Bangalore

² Consultant Neurosurgeon, Ananta Institute of Medical Sciences, Udaipur

³ Counselor, Academy of Well-being, Udaipur & Research Scholar, Pacific University, Udaipur

*Responding Author

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The brain is splitted into the left and right hemispheres by a bundle of tissues known as corpus callosum. The largest part of the human brain is the cerebral cortex. The very back part of the brain contains the cerebellum (little brain), which is attached to the hindbrain. The Cerebellum has been implicated in the planning and execution of movement and recent work in neuroscience has shown that cerebellum is also involved in cognitive functions (Schmahmann,1997). Midbrain consists of parts known as put amen, substantial nigra, and glob us pallid us. Mid brain is implicated in Parkinson disease and schizophrenia. Forebrain is the largest part of the brain and is broadly involved in intellectual and higher cognitive functions. Each hemi-sphere is divided into four lobes namely, frontal, parietal, occipital and temporal. This paper will focus on the brief anatomy, function and syndromes associated with parietal and occipital lobes.

Neuropsychological Batteries in India

The term battery refers to a group of tests which assesses any specific domains of behavior. In India, the most common neuropsychological batteries used by professional's psychologists are as follows.

1. *NIMHANS Neuropsychology Battery- New Battery* : NIMHANS Neuropsychology Battery was developed by Rao, Subbakrishna, & Gopukumar in 2004. It was developed at National Institute of Mental Health & Neurosciences, Bangalore in 2004. It is a comprehensive neuropsychological assessment which is being carried out by a trained clinical psychologist or a clinical neuropsychologist.
2. *AIIMS Comprehensive Neuropsychology Battery*: This was developed by Gupta, Khandelwal and Tandon in 2000. It has 160 items to evaluate various neuropsychological funtions.
3. *PGI Battery of Brain Dysfunction (PGI-BBD)*: It was developed by Pershad and Verma in 1990. It has five subtests which evaluate brain dysfunction. Immediate, recent, remote and recognition memory are assessed. It also evaluate attention and concentration, verbal intelligence, information, digit span and arithmetical skills are also measured.
4. *NIMHANS Neuropsychology Battery- Old Battery*: It was developed by Mukundan in 1996 by compiling various tests related to brain function. The battery assess lobe functions with subtests including ideational fluency, kinetic melody, attention, scanning Bender Gestalt Test,, visual memory and learning. It uses idiomatic approach for clinical assessment.
5. *Neuropsychological and Achievement Battery for Children*: This battery assesses neuropsychological abilities, intellectual and cognitive abilities, achievement and learning. It was developed by Preeti Singh and Masroor Jahan in 2006.
6. *NIMHANS Neuropsychological Battery for Children* This battery was developed by Bhoomika Kar and Shobini Rao in 2004 for assessing neuropsychological functions of children with clinical behavioral, emotional and cognitive issues. It can be used with children with the age range of 5 to 15 years.

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Some of the commonly used neuropsychological tests are Digit Vigilance Test to assess sustained attention, Digit Symbol Substitution Test to assess visual motor coordination, response & mental speed. It also gives an idea of information processing speed, Token Test to evaluate verbal comprehension, Animal Fluency Test to assess verbal fluency, Stroop Test to assess response inhibition, Wisconsin Card Sorting Test to assess abstract reasoning and set shifting, N Back Verbal 1 and 2 measures working memory, and Tower of London measures planning skills and self-monitoring and self-correction.

Parietal Lobe: Anatomy and Functions

The parietal lobes lie posterior to the central and above the Sylvian fissure posteriorly it is divided from the occipital lobe by the imaginary extension of the parieto occipital sulcus on the lateral surface. It is divided into the post central gyrus, the superior parietal lobule, the inferior parietal lobule, the supramarginal gyrus and the angular gyrus.

The post central gyrus mediates somatosensory sensation bodily sensation is represented as a homunculus. A larger cortical surface is devoted to extremities and the lips. The areas adjoining the post central gyrus form the somatosensory association cortex. Lesions cause abnormal sensations like numbness. Tingling body image disturbances such as extinction, obscuration or displacement of touch sensation may be present. The displacement can be proximal or distal. It can also be felt outside the body, i.e., exosomesthesia or on the contralateral side (alloesthesia). Touch on two adjacent places may be perceived as one. Two point discrimination is lost when the distance between the two points is perceptible to the normal individual, but not to the parietal lobe patient, body image disturbances may be unilateral or bilateral. Unilateral disturbances are caused by lesions in the contralateral parietal lobe. Bilateral disturbances are caused by lesions in the dominant or left parietal lobe. Lesions of the somatosensory cortex and the adjoining association areas can further cause metamorphopsias. These are distortions of body sensations such as feeling of lightness, heaviness, levitation and elongation.

The posterior parietal lobes are adjacent to the occipital lobes. Processing of the visual stimulus continues in the parietal lobe. The parieto occipital areas are involved in the processing of figure ground relationships. Perception of form, texture, absolute and relative size and distance as well as in the location of objects in visual space. These visuo spatial relations are important for the perception of the total form in a visual stimulus or for the perceptual gestalt. Lesions of the parieto occipital areas cause disturbances of form perception. The perceptual analysis of visual forms in terms of their shape, size, texture or distance is disturbed. Thus perceptual gestalt is also affected. These disturbances are associated with lesions in the non dominant or right parietal lobes.

Syndromes of Posterior Lobes

Constructional Apraxia

Construction of two dimensional or three dimensional forms are disturbed in parietal lobe lesion, again more often when the lesions are in the non-dominant parietal lobe. Constructional apraxia for two dimensional figures is present when the patient is unable to copy simple geometrical figures. Distortion rotation micrographia (the drawing is reduced in size) and macrographia (the drawing is enlarged in size) may be present. Constructional apraxia for three dimensional figures are present when the patient is unable to construct three dimensional forms. The placement of either blocks or sticks even in the simple form of a square may not be possible. In the next stage, if forms are constructed they may be rotated. The form may also be constructed on the design itself, qualifying for the closing in phenomenon, the patient may or may not benefit from cues. Usually constructional apraxia is associated with lesions of the right parietal lobe. If the patient substantially benefits from cues, it can be lateralized to the left parietal lobe. It can be assessed through complex figure and block design tests.

Holme's Syndrome

Disturbances in the perception of absolute distance from oneself to an object is known as absolute localization. The distance between two objects external to oneself is relative localization. Both these can be disturbed in right parietal lesions. These deficits are manifest when the patient is unable to grasp an object extended to him/her. The reaching movements are not accurate. It appears as if the patient has poor eyesight. Size constancy is lost. The patient perceives the bigger objects as nearer and the smaller objects as farther.

Agnosia

Lesions of the left angular gyrus or disconnection of this area from the occipital lobes results in an inability to recognize familiar objects through the visual modality. The patient is able to recognize the object through another modality such as touch. This deficit is termed as visual object agnosia. Understanding of a complex scene or a picture may be impaired as in *simultagnosia*. The patient is able to describe the picture in parts, but is unable to sum up the totality of a scene. Recognition of objects through touch is impaired in parietal lesions, known as tactile agnosia or *astereognosis*. Familiar objects placed in the hand are not recognized. The deficit may be unilateral wherein the lesion is in the contralateral parietal lobe. If it is bilateral, the lesion is in the left parietal lobe. Finger agnosia is another condition wherein the patient is unable to name or identify the fingers which are touched. The patient is unable to identify his/her own fingers and the fingers of the examiner. This is an inability to recognize body parts, is bilateral in nature and associated with left parietal lesions. *Anosognosia* is an inability to recognize a paralyzed limb as belonging to oneself. *Prosopagnosia*, the inability to recognize familiar faces visually is associated with right parietal lesions. The patient can recognize the same person through the clothes, vice or the silhouette. Recognition is absent when the face is seen. The patient may even be unable to recognize his own face in the mirror.

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Right parietal lesions are associated with disturbances of visual memory. The localization is to right parietal area when the memory disturbance is for simple visual forms. Memory of places or locations i.e., topographical memory is disturbed in right parietal lesions. The patient is unable to locate familiar places on a map. Independent of the memory deficit, patients with left parietal lesions get lost in familiar surroundings which are termed as *route finding difficulty*. It can occur even in their own homes, the patient is able to verbally recall the route but gets lost while traversing it. The deficit is hypothesized to arise from another parietal deficit which is left-right disorientation. Here the patient gets confused between the left and right sides. Identifying one's left or right side is difficult. The patients are confused when asked to identify the examiner's left or right side.

The left parietal lobe, in particular the angular gyrus is important for writing, reading and calculation, the semantic lexicon is situated here. Lesions cause damage to the lexicon following which comprehension of oral and written language is affected. This condition is the *apraxic aphasic alexia*. If the angular gyrus is disconnected from the visuo perceptual centers of the occipital lobe, only *alexia* is present. It is characterized by impaired reading. Disconnection for the left angular gyrus from the motor engrams situated in the inferior parietal lobule results in *agraphia*. Writing difficulty or *agraphia* may be part of visuo perceptual disorders when it is known as *spatial agraphia*. If the patient is unable to write because of inability to construct two dimensional figures, then it is known as *apraxic*. Difficulty in calculation or *acalculia* has two components, *spatial acalculia* is present when the patient is unable to place numbers properly and is associated with right parietal lesions, difficulty in arithmetic is associated with left parietal lesions. *Gerstman's syndrome* is associated with left parietal lesions, specifically of the angular gyrus. It consists of *acalculia*, *agraphia*, *finger agnosia* and left-right disorientation.

Unilateral Spatial Neglect

An important sign of right parietal lesions is unilateral spatial neglect or hemi neglect or hemi inattention. Visual attention is not allocated voluntarily to one half of space. The patient is able to attend to it if the attention is drawn to this area verbally. Spontaneously attention is not allocated to the side contra lateral to the lesion. The neglect is usually present on the left half of space. The lesion is in the right parietal lobe. Visual attention is an important function mediated by the right parietal lobe. The right dorsal parietal lobe disengages attention in visual space, if this disengagement does not occur, attention is fixated to one area and other areas are neglected. The attention disengagement results in the patient neglecting all aspects of the contra lateral space. The patient does not see objects on the neglected side and bumps into them. Dressing of one half is neglected. Drawings omit the left half of the figure. Touch is not felt when it is in the left half of the body. Hemi-inattention can occur in right occipital and right frontal lesions also.

Pathology of Emotions

The right parietal lobe is hypothesized to mediate emotions. Normally the right frontal lobe inhibits the right parietal lobe. Lesion of the right frontal lobe removes this inhibitory influence.

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Excessive emotions result as in mania or affective disorders. Electroencephalographic (EEG) recordings show the right hemisphere to be more active than the left during emotional stimulation. Dysfunction of the right hemisphere is associated with affective disorders. Studies conducted on stroke patients have indicated that emotional processing is largely lateralized to the right hemisphere. Positive affect is mediated by the left hemisphere. Hence damage to the left hemisphere particularly the left frontal lobe is associated with depression. Negative affect is associated with the right hemisphere. Damage to the right hemisphere reduces the negative affective coloring of experience. The result is a disproportionate positive affect resulting in mania. Normal emotions are the outcome of a balanced processing between the two hemispheres.

Sensory Template

Polymodal association cortices of the cerebral cortex are present in the parietal lobes. It is connected to the frontal lobes and to the limbic system. Thus, it is hypothesized that the sensory template of the environment is constructed on a moment to moment basis by the parietal lobe. Its specialization for visuospatial attention spatial cognition as well as the polymodal association area enables it to scan the environment adequately and construct the sensory map. Thus while the frontal lobes are known as the executive centers of the brain the temporal lobes are known as the integrative centers of the brain the parietal lobes construct the sensory template of the world in a dynamic fashion.

Occipital lobe: Anatomy and Functions

The occipital cortex occupies the posterior part of the cerebral cortex. It lies above the cerebellum and is posterior to the parietal and temporal cortices. There are three Brodmann areas in this cortex. The most posterior of these is the area 17 which is also known as the striate cortex. The fibres of the optic tract coming from the eyes terminate here and give it the striate appearance to the naked eye. Area 17 is in the medial portion of the occipital cortex. It consists of simple cells which are sensitive to movement. These cells are also sensitive to specific location and orientation of lines. The cells fire when visual stimuli move. In addition some of these cells fire when the stimuli are in a specific location and orientation. Colour perception also occurs in this area. Area 18 is adjacent to 17 laterally and contains complex cells. Each complex cell receives input from several simple cells. The complex cells are sensitive to orientation. However they are not location specific. They fire across different locations if the orientation is maintained. Complex cells are predominantly present in area 18. Some of these cells receive converging input from both eyes, the remainder receive input only from one eye. The complex cells are probably involved in the earliest stages of actual form perception. Area 19 is adjacent to the area 18 laterally. It contains predominantly hyper complex cells which are sensitive to movement, position and orientation. They process angles, corners, and movements and analyze discontinuity. These cells process geometric forms and it is here that visual closure is present. Hyper complex cells together with neurons in the temporal lobe initiate the closure essential to perceive incomplete figures. The fovea is most densely represented in the primary visual cortex or the striate cortex. This area also receives input from non visual areas of the brain

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such as the brain stem nuclei, the pontine and mesencephalic reticular formation, the lateral amygdala and the lateral hypothalamus. These connections enable the processing of visual stimuli to be influenced by level of wakefulness and by emotional and motivational influences. The visual cortex is connected to the frontal regions. The association areas of the occipital cortex i.e., areas 18 and 19 are connected to the inferior temporal lobe and to the parietal lobe. These connections take the processing of visual information beyond the occipital cortex. Visual "stimuli become positioned in space and personally meaningful through these connections.

Occipital Lobe Syndromes

Lesion in the occipital cortex is associated with various disorders of processing visual information. Large and bilateral lesions in the medial calcarine cortex or area 17 lead to cortical blindness. The patient is blind though the eye and retina are intact. As this area receives maximum input from the fovea patterned vision is lost. The patient is able to discriminate levels of brightness and can make out light from dark. Peripheral vision mediated at the thalamic geniculate level would be present. Consequently though the patient is unable to see they do not bump into large objects. This phenomenon is known as blind sight. Probably because of this the patient with cortical blindness denies the blindness. If confronted with their blindness they invent reasons and excuses for their disability. This is known as Anton syndrome. If the lesion is partial, the patient might have hemianopia wherein loss of vision is present in only half of the visual field. Smaller lesions in the occipital lobe lead to hallucinations. Lesions in the area 17 result in hallucinations of moving lights, flashes, sparks and tongues of flame and colours. Objects become exceedingly large which is known as macropsia or exceedingly small which is known as micropsia. Objects also may be elongated or blurred in their outline. Colors might run and objects might lose colour. Lesions in the visual association areas i.e., areas 18 and 19 can produce complex visual hallucinations. These are images of men and animals. Objects and geometrical figures are seen. Micropsia and macropsia can also occur. The objects move towards the patient or recede from the patient. Complex hallucinations are fully formed and are quite real. The patient may not believe that these are hallucinations and might react to them as if they are actually present. Agnosias are the other major disorders occurring in occipital lesions. Visual objects agnosia or the inability to recognise familiar objects through sight is associated with medial occipital lesions, the patient is able to recognize the object through another sensory modality such as touch. Lesions of the left occipital lobe or disconnection of the occipital lobe from the left angular gyrus results in this agnosia. Sometimes, the patient is able to recognise the objects when the object is placed in a familiar context. The patient may be able to draw, paint or trace the object without recognizing it. The object becomes stripped of its meaning. Optic ataxia is present when the object changes its appearance or disappears while the patient is looking at it. Inability to recognise colours or colour agnosia is another condition associated with inferior bilateral occipital lesions. The patient is unable to name, match and identify colour. *Prosopagnosia* or the inability to recognise familiar face by sight is associated with right occipital lesions. The patient recognizes a face as a face but is unable to place as to whom it belongs. He or she may also recognize the voice without recognizing the face. The lesions are in

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the right occipital and temporal regions. *Simultagnosia*, is an inability to perceive the totality of a figure or a scene. The patient is unable to see the totality of the scene and can describe only parts of it. It is associated with difficulties in visual scanning. The ability to scan and visually explore the environment is drastically reduced. It is a break down to perform visual serial step by step analysis. Visual attention is largely limited to the central visual field. The lesions are in the left hemisphere, or in the frontal eye fields. Bilateral superior occipital lesions can also cause this dysfunction. In some cases, the patients are unable to maintain fixation and focus on the parts of the object. This disorder is known as *Balint's syndrome*. It is a strange combination of three symptoms. Oculomotor apraxia: the inability to intentionally move your eyes towards an object. Optic ataxia, the inability to accurately reach for something you're looking at and Visual simultagnosia: the inability to take in the entirety of a picture. Instead, a person sees only parts of the whole as described in the preceding portion. For example, when shown a picture of a house, someone with simultagnosia could only see a window, a door, a wall, and so on, but not the entire house.

CONCLUSION

The current health paradigm recognizes the holistic approach to management. Neurological disorders often have issues which are associated with psychological impairments in the domains of attention, sensory-visual processes, higher brain and execution functioning like planning, decision making, problem solving etc. Clinical neuropsychology attempts to understand through neuropsychological evaluation and use cognitive retraining strategies to work and help improve these functions to improve the functioning and activities of daily living and quality of life of these patients. Besides, neurologists, neurosurgeons, psychiatrists, clinical psychologists and clinical neuropsychologists need to be a part of the treating team in the unit of neurology and neurosurgery for the holistic care of the patient. This paper is expected to highlight the importance of this in health care units in India and globally.

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