UNIT 1 INTRODUCTION, DEFINITION AND DESCRIPTION OF NEUROPSYCHOLOGY

Structure

1.0 INTRODUCTION

This unit deals with neuropsychology, its definition and descriptions. It starts with introduction to neuropsychology, followed by historical perspectives of neuropsychology, clinical neuropsychology, what it is and a description of theme, followed by a description of the central nervous system and its functioning. Then we move on to definitions of neuropsychology and its concepts. Then we differentiate it from other related disciplines, followed by the functions of neuropsychologists. Then we deal with the domains of neuropsychological functioning and the reasons for referrals to neuropsychologists for neuropsychological examination. Then we describe what the reports contain based on the neuropsychological examination, what are the applications of neuropsychological examination and the various limitations to neuropsychological test applications. Then we move on to neuropsychological test selection and the problems one faces in assessing executive functions and how to overcome the same.

1.1 OBJECTIVES

After completing this unit, you will be able to:

- Define neuropsychology;
- Conceptualise neuropsychology;
- Describe the various aspects related to neuropsychology;
- Explain historically how neuropsychology came about;
- Describe the central nervous system and its functioning;
- Explain the functions of neuropsychologists;
- Elucidate the major domains of neuropsychological functioning;
- Describe when a person is to be referred to neuropsychologist for testing; and
- Analyse the application of neuropsychology examination to different areas.

1.2 INTRODUCTION TO NEUROPSYCHOLOGY

A field that combines neurology and psychology and studies the relationship between brain and behaviour is called the field of neuropsychology. The behavioural neurobiology, neuropsychology, neurology and psychology are all combined together to study how brain functions and in what ways the various systems and organs work together to produce different types of behaviours. It studies the cognitive processes and tries to understand which part of the brain is associated with which type of cognitive processes etc. It aims to understand how the structure and function of the brain relates to specific psychological processes.

Neuropsychology is a structured, objective, and scientific discipline which delves into the brain and tries to associate various behaviours of the individuals to the changes that come about in the brain. The ultimate aim is to understand the *individual* mind and brain.

The methods that neuropsychology uses to study many of these aspects include both experimental and objective scientific methods. 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).

Most persons may have come across people who are very old having tremors in their hands and unable to have proper motor coordination, and many would have also come across persons having tics and speech problems and quite a few would have come across persons lying in coma for days on in the hospital bed. All these conditions are related to neurological pathology. In other words these are related to certain neurological problems or brain related dysfunctions. At the same time

there are also many behavioural aspects related to these dysfunctions. Many behaviours can be traced to certain areas of the brain and if those areas of the brain are attended to, then probably the person's behaviour could also be changed. However whether they will become normal or not depends on a large number of factors. All that one could state is that there would be a change and that too more towards the positive direction.

Thus one may state that Neuropsychology is the study of brain behaviour relationships. It makes assessment, understands the problem and suggests modifications to certain aspects, like for instance memory areas. Neuropsychology seeks to understand how the brain, through structure and neural networks, produces and controls behaviours and mental processes, including emotions, personality, thinking, learning and remembering, problem solving, and consciousness. The field is also concerned with how behaviour may influence the brain and related physiological processes, as in the emerging field of psycho neuro immunology (the study that seeks to understand the complex interactions between brain and immune systems, and the implications for physical health).

Neuropsychology is that branch of psychology which deals with the relationship between the nervous system, especially the brain, and the cerebral or mental functions such as language, memory, and perception. Neuropsychology as a science is concerned with the integration of psychological observations on behaviour with neurological observations on the central nervous system (CNS), including the brain.

Neuropsychology seeks to gain knowledge about brain and behaviour relationships through the study of both healthy and damaged brain systems. It seeks to identify the underlying biological causes of behaviours, from creative genius to mental illness, that account for intellectual processes and personality.

1.2.1 Historical Perspective of Neuropsychology

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 localised 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 analysed and a Phrenology practitioner could determine the subject's personality and intelligence from analysis of the skull, called cranioscopy.

Followers of phrenology categorised 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", 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 localised 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 localised. On the basis of Wernicke's observations, the modern doctrine of component process localisation 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 localised in the brain. Such faculties, if they have validity at all, are the result of a number of primary cognitive operations.

1.2.2 Clinical Neuropsychology

Clinical neuropsychology seeks such understanding, particularly, in the case of how damaged or diseased brain structures alter behaviours and interfere with mental and cognitive functions.

To understand fully the functions of neuropsychology it is imperative to have an idea of the structure and functions of the brain and the nervous system.

1.2.3 Central Nervous System (CNS)

The central nervous system is that part of the nervous system that consists of the brain and spinal cord. It is one of the two major divisions of the nervous system. The other is the peripheral nervous system (PNS) which is outside the brain and spinal cord.

The peripheral nervous system (PNS) connects the central nervous system (CNS) to sensory organs such as the eye and ear, other organs of the body, muscles, blood vessels and glands. The peripheral nerves include the 12 cranial nerves, the spinal nerves and roots, and what are called the autonomic nerves that are concerned specifically with the regulation of the heart muscle, the muscles in blood vessel walls, and glands.

We can consider the brain as a central computer that controls all bodily functions. The nervous system can be likened to a network that relays messages back and forth from the brain to different parts of the body. It does this via the spinal cord. The spinal cord runs through the back and has threadlike nerves which branch out to every organ and body part. These transmit all messages to the body from the brain and vice versa.

Imagine yourself touching a hot iron, immediately you wince and pull your hand back.

What happened, let us see. The moment you touched the hot iron, the nerves in your skin sent a message of pain to the brain. The brain immediately sends back a message asking the muscles in your hands to pull back. All this happens in a split second before you even realise what is going on.

Though so much of work is accomplished the human brain is only 3 pounds in weight. It has many folds and grooves which can store a large amount of information received by the brain. This brain is protected by the bones of the skull. The brain is made up of 3 parts, namely forebrain, midbrain and the hindbrain.

The forebrain is the largest and contains the cerebrum that is the area with folds and grooves and a certain other structures beneath it.

The spinal cord, on the other hand, is a long bundle of nerve tissue about 18 inches long and ¾ inch thick. It extends from the lower part of the brain down through spine. Along the way, various nerves branch out to the entire body. These are called the peripheral nervous system.

Both the brain and the spinal cord are protected by bone: the brain by the bones of the skull, and the spinal cord by a set of ring-shaped bones called vertebrae. They're both cushioned by layers of membranes called meninges as well as a special fluid called cerebrospinal fluid. This fluid helps protect the nerve tissue, keep it healthy, and remove waste products.

The brain is made up of three main sections: the forebrain, the midbrain, and the hindbrain.

The cerebrum contains all information about us, that is our intelligence, memory, personality, emotion, speech, and ability to feel and move.

The cerebrum also contains four lobes, that is frontal, parietal, temporal and occipital lobes. The cerebrum is also divided into two halves, the right and the left hemispheres. These hemispheres are connected by a band of nerve fibres, called as corpus collosum. This helps in the two hemispheres communicating with each other.

It must be kept in mind that the two hemispheres have different functions to perform, that is while the left hemisphere is considered to be logical, analytical and objective, the right side is considered to be more intuitive, creative and subjective. For example, when you are doing maths, you are using your left hemisphere, and when you listen to music you are using the right hemisphere.

Until now we were discussing the inner parts of the cerebrum. Now let us see what its outer parts are like. The outer layer of the cerebrum is called the cortex.

You know we have five senses, vision, hearing, touch, taste and smell. Information collected by these 5 senses are sent by the spinal cord to the cortex. Cortex is also known as the gray matter. The information then is directed to other parts of the nervous system for further processing. For example in the case of touching the hot iron, not only the hand is withdrawn, but the information is sent to the memory to make sure that you don't do it again.

The messages received from the sensory organs like eyes, nose, tongue, skin and ears are carried to the cortex by the thalamus which is in the inner part of the forebrain.

Another organ within the forebrain is called the hypothalamus which controls the pulse, thirst, appetite and sleep which are automatic processes. It also controls the pituitary gland associated with growth of the body, metabolism etc.

The *midbrain* is located underneath the middle of the forebrain, acts as a master coordinator for all the messages going in and out of the brain to the spinal cord.

The *hindbrain* sits underneath the back end of the cerebrum, and it consists of the cerebellum, pons, and medulla.

The cerebellum is also called as the "little brain" because it looks like a small version of the cerebrum. The cerebellum is responsible for balance, movement, and coordination.

The pons and the medulla, along with the midbrain, are often called the brainstem. The brainstem takes in, sends out, and coordinates all of the brain's messages. It also controls many of the body's automatic functions, like breathing, heart rate, blood pressure, swallowing, digestion, and blinking.

1.2.4 Functioning of the Nervous System

The basic functioning of the nervous system depends a lot on tiny cells called neurons. The brain has billions of them, and they have many specialised jobs. For example, sensory neurons take information from the eyes, ears, nose, tongue, and skin to the brain. Motor neurons carry messages away from the brain and back to the rest of the body.

The nervous system is the System of specialised cells (neurons, or nerve cells) which conduct stimuli from a sensory receptor through a network to the site. A neuron consists of many of the impulse-conducting cells that constitute the brain, spinal column, and nerves. It consists of a nucleated cell body with one or more dendrites and a single axon.

It is also called as the *nerve cell*. (e.g., a gland or muscle) where the response occurs. The cranial nerves handle head and neck sensory and motor activities, except the vagus nerve, which conducts signals to visceral organs. Each spinal nerve is attached to the spinal cord by a sensory and a motor root.

All neurons, however, relay information to each other through a complex electrochemical process, making connections that affect the way we think, learn, move, and behave.

At birth, the nervous system contains all the neurons you will ever have, but many of them are not connected to each other. As you grow and learn, messages travel from one neuron to another over and over, creating connections, or pathways, in the brain.

To take an example, when you learnt to drive the cycle it was so difficult and took time but once you leant you do not have to think to cycle, but cycling comes automatically to you. That means a pathway has been established.

In young children, the brain is highly adaptable; in fact, when one part of a young child's brain is injured, another part can often learn to take over some of the lost function. But as we age, the brain has to work harder to make new neural pathways, making it more difficult to master new tasks or change established behaviour patterns. That's why many scientists believe it's important to keep challenging your brain to learn new things and make new connections. It helps keep the brain active over the course of a lifetime.

Memory is another complex function of the brain. The things we have learned, seen are first processed in the cortex, and then, if we sense that this information is important enough to remember permanently, it is passed inward to other regions of the brain (such as the hippocampus and amygdala) for long-term storage and retrieval. As these messages travel through the brain, they too create pathways that serve as the basis of our memory.

Different parts of the cerebrum are responsible for moving different body parts. The left side of the brain controls the movements of the right side of the body, and the right side of the brain controls the movements of the left side of the body. When you press the accelerator with your right foot, for example, it's the left side of your brain that sends the message allowing you to do it.

A part of the peripheral nervous system called the autonomic nervous system is responsible for controlling many of the body processes we almost never need to think about, like breathing, digestion, sweating, and shivering. The autonomic nervous system has two parts: the sympathetic and the parasympathetic nervous systems.

The sympathetic nervous system prepares the body for sudden stress, like if you see a robbery taking place. When something frightening happens, the sympathetic

nervous system makes the heart beat faster so that it sends blood more quickly to the different body parts that might need it. It also causes the adrenal glands at the top of the kidneys to release adrenaline, a hormone that helps give extra power to the muscles for a quick getaway. This process is known as the body's "fight or flight" response.

The parasympathetic nervous system does the exact opposite: It prepares the body for rest. It also helps the digestive tract move along so our bodies can efficiently take in nutrients from the food we eat.

Because the brain controls just about everything, when something goes wrong with it, it is often serious and can affect many different parts of the body. Inherited diseases, brain disorders associated with mental illness, and head injuries can all affect the way the brain works and upset the daily activities of the rest of the body.

Problems that can affect the brain include brain tumours, cerebral palsy, epilepsy meningitis and encephalitis, migraine headaches, and mental illnesses. Another important problem is head injury which may be caused by many factors including accidents.

Self Assessment Questions

1) Define Neuropsychology and state its characteristic features.

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2) Trace the history of neuropsychology.

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3) What is clinical neuropsychology? Discuss

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4) Describe the Central nervous system and elucidate its functions.

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1.3 DEFINITION AND CONCEPT OF NEUROPSYCHOLOGY

Neuropsychology, as mentioned earlier is the study of (and the assessment, understanding, and modification of) brain-behaviour relationships. Neuropsychology seeks to understand how the brain, through structure and neural networks, produces and controls behaviour and mental processes, including emotions, personality, thinking, learning and remembering, problem solving, and consciousness. The field is also concerned with how behaviour may influence the brain and related physiological processes, as in the emerging field of psychoneuroimmunology (the study that seeks to understand the complex interactions between brain and immune systems, and the implications for physical health).

The neuropsychologist uses objective tools, such as the neuropsychological tests to find out the association between biological and behavioural aspects together. Through the use of tests, the clinical neuropsychologist is able to differentiate whether or not a behavioural abnormality is more likely caused by a biological abnormality in the brain or by an emotional or learned process.

1.4 NEUROPSYCHOLOGY AND OTHER DISCIPLINES

If we presume that the brain is the starting point for why and how we process *all* mental information and not just cognitive, but interpersonal communications, self-concept, emotional reactivity, personality, learned responses, etc., then in some aspect, all psychology is *neuro*psychology. Neurolinguistics, for example, is the study of how language shapes our self concepts and our interpersonal communications.

Neurodevelopmental psychology is the study of how behavioural and mental characteristics change with nervous system growth. Even psychological concepts of dreaming (and dream content), level of attention, and conscious experience are subserved by brain processes.

Neuropsychology is the basic scientific discipline that studies the structure and function of the brain related to specific psychological processes and overt behaviours. The term neuropsychology has been applied to lesion studies in humans and animals.

It has also been applied to efforts to record electrical activity from individual cells (or groups of cells) in higher primates (including some studies of human patients).

Neuropsychology is scientific in its approach.

- It is closely related to cognitive psychology in that it also considers the mind as information processing system
- It is closely related to cognitive science.
- It is considered eclectic
- It overlaps with some areas of neuroscience

- It is also closely associated to philosophy of mind
- It ofcourse is associated closely with neurology
- Psychiatry draws a lot from neurology
- By using artificial neural networks it is considered close to computer science also.

Neuropsychology seeks to gain knowledge about brain and behaviour relationships through the study of both healthy and damaged brain systems. It seeks to identify the underlying biological causes of behaviours, from creative genius to mental illness, that account for intellectual processes and personality. *Clinical* neuropsychology seeks such understanding, particularly, in the case of how damaged or diseased brain structures alter behaviours and interfere with mental and cognitive functions.

Cognitive Neuropsychology aims to promote the investigation of human cognition that is based on neuropsychological methods including brain pathology, recording, stimulation or imaging. The research can involve brain lesioned or neurologically intact adults, children or non human animals as long as it makes an explicit contribution to our understanding of normal human cognitive processes and representations. Cognition is understood broadly to include the domains of perception, attention, planning, language, thinking, memory and action.

1.5 FUNCTIONS OF NEUROPSYCHOLOGISTS

Neuropsychologists are not medical doctors, but doctors of psychology whose field of study is concentrated on the brain and its functions. Neuropsychological testing is designed to determine the brain's capacity with respect to short and long term memory, abstract reasoning, attention, concentration, executive functioning, motor skills and other cognitive and psychological factors. By comparing the pattern of these results, against the patients pre-morbid capabilities, and correlating these results with the nature of the trauma suffered by the patient, neuropsychologists can, to a reasonable degree of certainty, opine that individuals without an acute diagnosis of brain injury, have permanent deficits as a result of brain trauma.

Neuropsychologists use batteries of tests to triangulate the brain's functioning and through that triangulation, determine whether the brain is functioning as it should. Just like tapping a knee to check the reflexes is an objective test of how the nervous system operates, neuropsychological tests are an objective measure of how the brain is functioning.

If a neuropsychologist is using what is called a "fixed battery" they will be using one of two such batteries, the Halstead-Reitan or the Luria-Nebraska battery. The advantage of using such batteries is that decades of study and thousands of test results have created an accurate profile of the pattern of deficits which correlate to specific types of brain injury.

The Halstead-Reitan Battery consists of the Category Test, Tactual Performance Test, Seashore Rhythm Tests, Speech Sounds Perception Tests, Finger Tapping Test, and Trail Making. Neuropsychologists often administer Full Scale IQ, Verbal IQ, and Performance IQ.

The most commonly employed intelligence test is the Wechsler Adult Intelligence Scale-Revised (WAIS-R). The three summary IQ measures are derived from averaging individual subtest scores.

An Aphasia Screening Test, a Sensory-Perceptual Examination, are also typically administered, and many neuropsychologists will also administer the MMPI as well.

A normal IQ score, or even high test scores in specific areas, do not rule out brain injury. First, if a person has a 130 IQ before the injury and a 100 IQ after, this would clearly establish injury. More significantly, many profoundly brain injured survivors, maintain an average IQ near their pre-morbid levels. It is not their average scores that are significant, but the pattern of such scores. The IQ only measures certain brain functions, those primarily cognitive in nature. The neuropsychological examination is designed to evaluate a comprehensive cross section of brain function.

Self Assessment Questions

1) Define Neuropsychology.

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2) How would you conceptualise neuropsychology?

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3) How is neuropsychology related to other disciplines? Explain

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4) What are the functions of neuropsychologists? Elucidate.

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1.6 MAJOR DOMAINS OF NEUROPSYCHOLOGICAL FUNCTIONING

Neuropsychological examination is useful in measuring many categories of functioning, including the following:

- Intellectual functioning
- Academic achievement
- Language processing
- Visuospatial processing
- Attention/concentration
- Verbal learning and memory
- Visual learning and memory
- Executive functions
- Speed of processing
- Sensory-perceptual functions
- Motor speed and strength
- Motivation/symptom validity
- Personality assessment

1.6.1 Referrals to Neuropsychologists for Neuropsychological Examination

Neuropsychological testing provides diagnostic clarification and grading of clinical severity for patients with obvious or supposed cognitive deficits. Often these include patients with a history of any of the following problems:

- Head injury
- Failure to achieve developmental milestones
- Learning or attention deficits
- Exposure to drugs, alcohol, or maternal illness in utero
- Exposure to chemicals, toxins, or heavy metals
- Parkinson's disease
- Seizure disorders
- Substance abuse
- Strokes
- Dementia
- Psychiatric Disorders

1.6.2 Information Obtained From Neuropsychological Reports

Neuropsychological tests are a series of measures that identify cognitive impairment and functioning in individuals. They provide quantifiable data about the following aspects of cognition:

- Reasoning and problem solving ability
- Ability to understand and express language

- Working memory and attention
- Short-term and long-term memory
- Processing speed
- Visual-spatial organisation
- Visual-motor coordination
- Planning, synthesising, and organising abilities

1.6.3 Applications of Neuropsychological Examinations

This includes the following:

- Differential diagnosis of organic and functional pathologies
- Assessment for dementia versus pseudodementia.
- Determination of the presence of epilepsy versus somatoform disorder (that is, nonepileptic seizures or pseudoseizures)
- Determination of the presence of traumatic brain injury (TBI) versus malingering or
  - unconscious highlighting
- Guidance for rehabilitation programs and monitor patient progress
- Guidance for referring to specialists
- Providing of data to guide decisions about the patient's condition, such as the following:
  - Competency to manage legal and financial affairs
  - Capacity to participate in medical and legal decision making
  - Ability to live independently or with supervision
  - Ability to return to work and school affairs
  - Candidacy for transplants
- Providing data to guide the following assessments and procedures:
  - Evaluation of the cognitive effects of various medical disorders and associated interventions
  - Assessment of tests for diabetes mellitus, chronic obstructive pulmonary disease (COPD), hypertension, human immunodeficiency virus (HIV) infection, coronary artery bypass graft (CABG), and clinical drug trials
  - Assessment of CNS lesions and/or seizure disorders before and after surgical interventions, including corpus callosotomy, focal resection (e.g., topectomy, lobectomy), and multiple subpial transection
- Monitoring the effects of pharmacologic interventions
- Documentation of the cognitive effects of exposure to neurotoxins
- Documentation of the adverse effects of whole brain irradiation in children
- Issuance of Standard protocols for assessment of specific disorders, such as dementia (e.g. Alzhimer Disease)

In addition to the above, developmental disorders (e.g. specific learning disabilities) require detailed assessment of cognition, academic achievement,

and psychosocial adjustment for proper identification and neuropsychological tests help in these assessments. It acts as a guide to their management including academic placement in special education and resource classrooms.

Neuropsychological examination is however of limited value in the following areas and these are given below.

- In cases where the patient is severely compromised, as in the case of advanced dementia
- Where patient is suffering from serious brain injury (e.g., TBI, stroke, anoxia, infection),
- Where the patient has other serious medical complications or psychiatric disorders.

1.6.4 Technical Limitations and Issues in Neuropsychological Evaluation

Results of an NPE must be considered in the context of the patient's age, education, sex, and cultural background. These factors can affect test performance and limit the conclusions that can be drawn from the evaluation. In addition, issues such as reliability, validity, sensitivity, and specificity need to be considered.

- Large, population based norms are available for relatively fewer measures.
- Those measures that do boast such norms, such as major intellectual and academic instruments, are of limited usefulness within a neuropsychological test battery.
- Ideally, patients should be compared with population based norms, as well as with local norms and subgroup norms so as to examine strengths and weaknesses in the individual who is being tested.
- Significant gaps can be found in the normative data for all age, educational, and intellectual ranges.
- Also there are major deficiencies in the development of appropriate measures and norms for minority populations.

Self Assessment Questions

1) What are the major domains of neuropsychological functioning?

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2) When and whom we refer to neuropsychologists for examinations?

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3) Describe the information available in a neuropsychological report.

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4) Discuss the application of neuropsychological examination to different areas.

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5) What are the limitations to neuropsychological test examination?

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1.7 NEUROPSYCHOLOGICAL TEST SELECTION

1) **Reliability, Validity, Sensitivity and Specificity**

Generally, findings suggest that performance on tests of motor functioning, speed of cognitive processing, cognitive flexibility, complex attention, and memory are related positively to real-world success. The amount of variance accounted for by cognitive factors alone, however, is typically quite small. Exceptions occur when comparisons made between results of formal Neuropsychological examination and real world criteria are limited to very simple, very circumscribed, and very well defined functions.

Consequently, situational assessment is seen as a critical adjunct to neuropsychological assessment, especially at higher levels of cognitive functioning.

Neuropsychological tests, with very few exceptions, were not developed with an eye toward ecologic validity. They were developed as indicators of brain function or dysfunction and generally were validated against neurosurgical, neurologic, and neuroradiologic data. Nevertheless, many tests have proven to be good predictors of future behaviour and, therefore, have demonstrated ecologic validity.

A qualitative process approach may improve the ecologic validity of the neuropsychological test battery. For example, testing the limits with measures of memory and executive functioning allows the examiner to understand better what a person can do under relatively ideal circumstances. The test itself may have little demonstrable ecologic validity, but an accurate analysis and insightful interpretation of findings can be highly valid from an ecologic perspective.

2) **Sensitivity and Specificity**

Sensitivity refers to a test's ability to detect the slightest abnormalities in CNS function and is a reflection of the test's true positive rate, that is, its ability to identify persons with a disorder. Specificity refers to the ability to differentiate patients with a certain abnormality from those with other abnormalities or with no abnormality, as indicated by the true negative rate.

A score on any test can be a true positive, false positive, true negative, or false negative.

True positive means it rquires high sensitivity to dysfunction, allowing dysfunctions to be detected.

False positive means it indicates sensitivity to dysfunction, though lacks specificity to a particular dysfunction.

True negative refers to the high specificity, allowing negative to be distinguished from others.

False negative on the other hand refers to the lack of sensitivity, without regard to specificity of the test.

Therefore for any evaluation, it is important to understand the rates of each of the above aspects in the results.

The Stroop Test, for example, shows a relatively high level of specificity, with a high true negative rate (95.7%) and low false positive rate (4.3%). However, its sensitivity is questionable, as it has a relatively low true positive rate (30.8%) and high false negative rate (69.2%).

It must be kept in mind that each test has strengths and weaknesses in its ability to detect a minimal CNS dysfunction (sensitivity) while being able to indicate a specific CNS dysfunction (specificity).

Timed measures of cognitive and/or motor processing are generally sensitive to diffuse cerebral dysfunctions, although the specificity of these tests is generally poor to moderate.

Measures of cognitive and motor processing that are not timed are generally less sensitive to diffuse dysfunctions but are very useful in identifying specific brain lesions.

1.7.1 Problems in Assessing Executive Functions

One of the major drawbacks of the neuropsychological tests can be stated to be the lack of ecologic validity when assessing executive functioning.

As is known, the neuropsychological examination is generally conducted within calm and quiet testing rooms where the subject is clearly presented with the task to be completed, is informed of time restrictions, and is prompted to start and stop behaviours. Under these conditions, a subject may achieve a score that indicates no executive dysfunctions, although the individual may be particularly drained from the mental exertion.

Completing tasks in the real world, however, requires several executive functions that are not tested in traditional neuropsychological examination, including recognising that a task must be completed, starting the task, switching tasks, adapting to changes, and stopping a task.

However, changes in executive tests have dramatically increased the environmental validity of executive neuropsychological examination. These changes include a growing emphasis on subject self reporting of premorbid and postmorbid functioning, as well as premorbid and postmorbid reports from relatives and significant others in the subject's life. Oftentimes, the self report is not sufficient, for executive dysfunctions may be unknown to the subject, or else they may be ego syntonic.

A dramatic approach to overcoming the problem of ecologic validity appears in the Multiple Errands Test (MET). The test takes place in a shopping mall and requires the subject to conduct 3 tasks simultaneously, such as buying an item, meeting at a certain location at a certain time, and acquiring available information (such as a foreign currency exchange rate). This evaluation tests the subject's abilities in planning, task initiation, and task switching, and even requires the subject to interact with other individuals in an effective manner. The test has shown considerable sensitivity and specificity, and subjects with neurologic deficits have performed considerably worse than controls. A version of this test has also been created for the hospital setting.

1.8 LET US SUM UP

Neuropsychology is that branch of psychology which deals with the relationship between the nervous system, especially the brain, and the cerebral or mental functions such as language, memory, and perception.

The field emerged through the work of Paul Broca and Carl Wernicke , both of whom identified sites on the cerebral cortex involved in the production or comprehension of language.

The nervous system is the System of specialised cells (neurons, or nerve cells) which conduct stimuli from a sensory receptor through a network to the site. A neuron consists of any of the impulse-conducting cells that constitute the brain, spinal column, and nerves, consisting of a nucleated cell body with one or more dendrites and a single axon.

The field is also concerned with how behaviour may influence the brain and related physiological processes, as in the emerging field of psychoneuro-immunology (the study that seeks to understand the complex interactions between brain and immune systems, and the implications for physical health).

The neuropsychologist uses objective tools -neuropsychological tests to tie the biological and behavioural aspects together. Through the use of tests, the clinical neuropsychologist is able to differentiate whether or not a behavioural abnormality is more likely caused by a biological abnormality in the brain or by an emotional or learned process.

Cognitive Neuropsychology aims to promote the investigation of human cognition that is based on neuropsychological methods including brain pathology, recording, stimulation or imaging.

Neuropsychological examination is used to quantitatively measure the cognitive and behavioural capabilities of a patient. The data from neuropsychological tests can then be compared to normative data based on a number of different demographic criteria, including (but not limited to) age, race, gender, and socio-economic status. NPE can include testing of intelligence, attention, memory, and personality, as well as of problem solving, language, perceptual, motor, academic, and learning abilities.

1.9 UNIT END QUESTIONS

1) Discuss the functions of neuropsychologists.
2) Define Neuropsychology and bring out its characteristic features.
3) Discuss the important aspects related to the major domain of neuropsychological functioning
4) What are the important aspects to be kept in mind in applying neuropsychological battery to patients? (discuss the reliability, validity, specificity etc.).
5) What are the various problems encountered in testing executive functions with neuropsychological test?

1.10 SUGGESTED READINGS

John A.Kiernan (2008). 9th edition. *Barr's The Human Nervous System: An Anatomical Viewpoint,* Lippincott Williams Wilkins.

Kolb Bryan and Ian Q.Whishaw (2008). *Fundamental of Human Neuropsychology*. Worth publishers, NY

Todd E. Feinberg and Martha J.Farah (2003). (2nd edition). *Behavioural Neurology and Neuropsychology.* McGraw Hill Medical Publishing Division, New York.

Warren H Lewis (editor) (2000). (2oth edition) *Gray's Anatomy of the Human Body Anatomy of the Human Body* New York: Bartleby.com