

Clinical Neuropsychology: issues and applications

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ABSTRACT

Neuropsychology is the speciality of clinical psychology, which deals with the study of brain behavior relationship. Clinical neuropsychology uses the principles and procedures of neuropsychology in clinical setting to understand brain related problems or clinical conditions, to intervene into them, to manage them, and to rehabilitate persons suffering from such conditions. Neuropsychological assessment is very important aspect of clinical neuropsychology, which attempts to generate structural as well as functional descriptions of the clients' present status in order to manage the problem more effectively from biopsychosocial perspective. The behavioral neurology approach, single test approach, neuropsychological battery approach, and qualitative or individual-centered normative approach of neuropsychological assessment have successively developed over the time; each of them have their own merits and limitations. The discipline of clinical neuropsychology has been proved to be an effective concomitant of neurology, neurosurgery, and psychiatry all over the world and its application in present day's neuromedicine has been accepted with respect. The present article discusses various applications of clinical neuropsychology along with major challenges of the subject in detail.

Keywords: Clinical neuropsychology; neuropsychological assessment; behavioral neurology; neuropsychological test; clinical psychology.

There has been enormous development in the field of neurodiagnostics. Various neurophysiological, structural, and neuropsychological tools have been operating in the field of mental health. Attempts to understand neurobiological parameters of psychiatric disorders have become very popular in the last 2-3 decades. This is more due to the advancement in the field of neurological and neurophysiological assessment too; neuropsychology has emerged as an important field trying to explain the brain-behavior correlates of functional mental disorders. This is also due to failure of single neurological instrument to pick up indices of brain dysfunction in all patients in a particular population. Some patients may show normal CT scan but abnormal blood flow while others may show vice versa. Some of them show disorder on both the measures while some of them may not show any disorder on both the measures (Golden & Carpenter, 1983).

Neuropsychology is the study of normal and pathological relationships between brain and behavior. Neuropsychology does not lie within the confines of neurology and psychiatry, but between neurology and psychology, or more correctly between the field of the neurosciences and that of the behavioral sciences or as defined by Williams (1972) "It is all about talking the study of the neuron as close to psychology as is scientifically possible." Neuropsychological assessment is a term that has replaced the older terms like, "testing for brain damage" or "testing for organicity". Ralph Reitan has defined neuropsychological test as a test that is sensitive to the condition of the brain. If the performance on a test changes with a change in the brain function, then the test is a neuropsychological test. But more recently, a new term or we can say, a new branch has emerged for neuropsychological assessment, known as clinical neuropsychology, which rests on two foundations: neurology and psychometrics.

IMPORTANCE OF NEUROPSYCHO-LOGICAL EVALUATION

Neuropsychological assessment may be undertaken for any one of several purposes. These are diagnosis, management, prognosis patient care rehabilitation and ultimately for research purposes. The identification of organic conditions was neuropsychology's first major concern (Wechsler 1994; Teuber 1948; Yates 1954) With increasing sophistication in the use of their tools and interpretation of their findings, neuropsychologists also became increasingly adept at localizing and identifying certain kind of brain lesions (Reitan, 1955, McFie, 1960; Smith, 1962) Nowadays neuropsychological assessment procedures are among the most sensitive methods available for detecting the presence of cerebral pathology. Psychometric tests validated to detect cerebral pathology or dysfunction are superior to the EEG and neurological examination (Filskov & Goldstein, 1974; Goldstein, Deysach, & Kleinnecht, 1973) and are specially useful in the cases where the lesion is either too small to be visually detected (e.g. early stages of dementia) or where the encephalopathy has a metabolic basis. Of course, current developments in neurodiagnostic technology have greatly reduced recourse to neuropsychology for diagnostic assistance. Yet a number of areas still remain in which neuropsychological assessment makes important diagnostic contributions (Fuld, 1978; Gainotli *et al.*, 1981; Golper and Binder, 1981).

Neuropsychological tests can be employed to efficiently monitor the magnitude of any one of a variety of functional impairments over time and thus can be used to quantify disease severity and/ or progression with respect to its sequelae. Moreover, the test scores can be utilized to document the extent of reversibility of cerebral impairment occurring as a consequence of medical treatment. They aid in predicting the rate and nature of improvement or a downhill course (Ivnik, 1978; Brooks and Aughton, 1978; Levin *et al.*, 1982; Meier *et al.*, 1982). And finally Neuropsychological test scores are predictive, to some degree, of social and vocational adjustment (Heaton *et al.*, 1978 Heaton & Pendleton, 1931.)

Behavioral description for patient care, treatment, and planning is now probably the most common reason for undertaking neuropsychological assessment. Rehabilitation programs counseling require detailed behavioral description upon which treatment goals and goals and procedures can be rationally based (Diller & Grodan, 1981) Besides this neuropsychological assessment also plays an integral research role in the clinical neurosciences in evaluating treatment, providing behavioral criteria for refining diagnostic and treatment classifications and explicating the behavioral dimensions of neurological disorders. The assessment tools and data of neuropsychology have contributed significantly to the scientific understanding of human behavior and functional organization of the nervous system.

VALIDITY OF NEUROPSYCHOLOGICAL EVALUATION

It's clear now, that in clinical neuropsychology we are using different psychological tests and batteries to evaluate brain functioning and to fulfill the above mentioned requirements. But the total efficiency of the findings of neuropsychological evaluation depends upon the test or battery used for it and to say neuropsychological evaluation as a sound measurement, tests or batteries used must meet the criteria of validity, reliability and practicability.

Among these, validity is the most critical criterion and indicates the degree to which an instrument measures what it is supposed to measure and how well it does so. Fundamentally, all procedures for determining test validity are concerned with the relationships between performance on the test and other independently observable facts about the behavior characteristic under consideration. The specific procedures employed for investigating these relationships are generally classified under four categories, designated as content validity, predictive validity, concurrent or criterion-related validity and construct validity or criterion-related validity.

Content validity involves essentially the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured. Predictive validity indicates the effectiveness of a test in predicting future outcome. For this purpose, test scores are checked against a direct measure of the subject's subsequent performance, technically known as the criterion. While, the relation between test scores and indices of criterion status obtained at approximately the same time is known as concurrent validity or criterion-related validity. The construct validity of a test is the extent to which the test may be said to measure a "theoretical construct" or trait, and it requires the gradual accumulation of information from a variety of sources. So, to say a neuropsychological evaluation as valid, it should fulfill the above mentioned criteria of validity, or in short, the neuropsychological test or battery should have following qualities;

- It should cover a representative sample of the specialized skill and knowledge:
- The test performance should reasonably be free from the influence of irrelevant variables.
- The test should help in diagnosing the existing status.
- And, it should predict the future outcome.

APPROACHES TO NEUROPSYCHOLOGICAL EVALUATION

Three approaches are usually followed worldwide for carrying out neuropsychological evaluation, these are;

- Single tests
- Test batteries
- Qualitative syndrome analysis

Single Test Approach (STA)

STA was previously based on the assumption that brain is a unitary organ and impairment of the brain will have a unitary type of behavioral effect. But now, we know that lesion in different areas of brain may cause different type of behavioral impairments. So single tests are used either to evaluate specific functions or in combination with other evaluative procedure as per requirements, which is known as "flexible" or "adjunctive" approach.

Single tests can again be classified according to the specific abilities of brain such as intellectual functioning, reasoning, concept formation, problem solving, orientation, attention, vigilance, language, memory, perceptuomotor abilities, auditory and somato-sensory perception, psychomotor functions etc.

Intellectual function

The Wechsler Adult Intelligence Scale, which was revised in 1981 as the WAIS-R (both verbal and performance) and Wechsler Intelligence Scale for Children-Revised (WISC-R) are the most widely used tests for assessment of cognitive impairment associated with cerebral disease, they have the advantage of standardization in large normative populations and yield highly reliable results when the findings of different examiners are compared.

WAIS-R is also standardized in Indian population and widely used to assess cognitive functions. Bhatia Battery of Performance Intelligence Tests is another Indian approach to assess intellectual functioning. Raven's Progressive Matrices is used in variety of situations and considered to be very sensitive measure in neuropsychological evaluation.

Reasoning, concept-formation, and problem-solving

Generally Kelley's Reparatory Grid Test (Banister & Fransella, 1966) and Goldstien Scheerer's Object Sorting Test (Goldstein & Scheerer, 1941) are mostly used tests for these abilities. Besides this, the Wisconsin Card-Sorting Test is found to be an effective procedure for assessing abstract reasoning and flexibility in problem solving.

Memory and orientation

The Wechsler Memory Scale (Wechsler, 1945) is most widely used test for memory. PGI Memory Scale (Persad & Varma, 1975), which is standardized on Indian population is used mostly in India. Visuospatial material has generally been employed to test nonverbal memory using both recall and recognition procedures. Benton's Visual Retention Test (BVRT) and Memory for Designs Test (MFDT) are usually used for it. Quantitative analysis of orientation is made by using the schedule of questions, developed by Benton, Allen & Fogel (1983), known as Temporal Orientation Test.

Attention and vigilance

These are very important areas in neuropsychological test. Usually attention and information processing are evaluated by a number of widely employed clinical procedures and by parts of other tests. However, Continuous Performance Test (CPT), Cancellation Tests (letter, number, symbol, color) and Knox-Cube Imitation Test are few tests designed to test attention

Language functions

Boston Diagnostic Aphasia Battery and Multilingual Aphasia Examinations are the standard instruments to assess language functions.

Visuo-perceptive capacity

Generally Bender Gestalt Test, Hidden Figures Test, Constructional Praxis Test (Block Designing Test), & Facial Recognition test are used for it.

Auditory perception

Can be evaluated by Seashore's test.

Somato-sensory perception

Can be assessed by the Tactile Performance test.

Psychomotor Functions

Were generally assessed by Reaction Time Paradigm. Other measures of speed of movement that have been used clinically are Finger Tapping Test and Quickness in placing pegs in board.

Neuropsychological Test Batteries

Assess the major functional areas they do not simply screen for presence or absence of brain damage but also evaluate a number of functional areas that may be affected by brain damage. A comprehensive Neuropsychological Battery usually assesses attention, perceptual ability, language, abstraction, memory, intellectual process, and motor skills.

They also allow for independent use of either quantitative or qualitative measures or both for interpretation. Example for only quantitative measurement is Halstead -Reiten Battery developed by Halstead (1947) and modified by Reiten (1976). Example for integrated approach of both quantitative and qualitative measurement is Luria-Nebraska Neuropsychological Battery, developed by Golden, Hammeh & Purisch (1980, 1981).

There are some other neuropsychological batteries, which are not in so much of use. These are Michigan Neuropsychological Test Battery, developed by Smith (1980) and Contributions to Neuropsychological Assessment, by Benton et al. (1983).

Qualitative Syndrome Analysis

Christensen's (1975) translation of Luria's Neuropsychological Investigation is the best available example of the qualitative approach. It is a very flexible approach where hypotheses are formulated and tested. This is also called as Qualitative Syndrome Analysis.

Unfortunately, not much work has been done in India in this area. Most of the studies conducted in India were based on the

unitary assessment of a function, like, intelligence, memory or visuomotor coordination etc. An extensive review of Indian literature has been reported by Siddiqui and Prasad (1989) highlighting the tools frequently used to assess neuropsychological functioning in India. The intelligence tests (Bhatia Battery of Performance Intelligence Test, Weschler's Adult Intelligence Scale - Revised, Raven's Progressive Matrices, Binet-Kamath Test of Intelligence & Cattell's Culture Fair Test) have been reported to be most frequently used measures, followed by memory tests (PGI - Memory Scale and Wechsler's Memory Scale), visuomotor coordination test (Bender Gestalt Test & Nahor Benson Test), and visual retention test (Benton's Visual Retention Test). Now, recently in 1990 Pershad and Verma have developed a new neuropsychological battery, standardized on Indian population, known as P.G.I. Battery of Brain Dysfunction. It comprises PGI memory scale, Revised Bhatia's Short Battery of Performance Tests of Intelligence, Indian adaptation of WAIS-R (Verbal), Nahor-Benson Test, and Bender Gestalt Test. But reliability and validity of this battery is yet to be established.

APPLICATION OF NEUROPSYCHO-LOGICAL EVALUATION

Head Injury

A considerable intra- as well as interindividual variation characterizes the pattern of neuropsychological test performance following head injury. A patient may show mild motor deficit on the right hand in one task and on the left in another. Higher level problem solving, concept formation, new learning, and mental flexibility tend to be the most impaired area and the slowest to recover. The role of neuropsychological evaluation following head injury is to provide understanding of the presence and type of psychological deficits. It helps towards assuring a proper rate of return to normal pre-injury activities. And in the cases of head injury without complications, psychological examinations are required to contribute to the determination of deficit and with prognosis.

Intracranial Tumors

The behavioral expression of Intracranial Tumors, like Glioma, Meningioma, and Metastatic Tumors, depends on rapidity of growth, on location and on whether they are intracerebral or extracerebral. Primary intracerebral tumors produce focal signs specific to the hemisphere involved, such as verbal-performance splits, mild to moderate motor impairment, and tactile perceptual impairment. These deficits may indeed be quite focal and the uninvolved side of the brain may appear reasonably unimpaired. However, non-lateralized higher level cognitive functions as reflected by measures of memory, learning, attention, and mental flexibility, and tasks requiring hypothesis testing, planning and judgement and those requiring solution of unfamiliar problems often indicate significant impairment even when the IQ scores are at or above the average range. Extracerebral tumors may also produce relatively focal and lateralized deficits but verbal-performance discrepancy is less common.

Cerebrovascular Disorders

In cerebrovascular disorders dramatic physical symptoms and higher cognitive dysfunction are seen. Such patients may show excellent conversational ability and may perform in an apparently normal manner on routine tests of psychometric intelligence. The same patients, however, may show signs of loss of judgement, memory, abstractions, mental efficiency, and learning ability when sound neuropsychological measures are used.

While in Degenerative and Demyelinating Diseases, like Parkinson's disease, Huntington's Chorea, and Multiple Sclerosis, major deficits are found in motor area. However, no definite cognitive impairments are found in these diseases, but mental decline is associated and IQs of such patients are found similar to other brain damaged patients.

Alcoholism and Psychoactive Drug Abuse

In alcoholics, impairment in certain psychological abilities is found due to general neurological deficit among chronic alcoholics and additional specific nutritionally related neurological deficits in Korsakoff's syndrome patients. They show extreme deficit in new learning and generalized significant decline in current cognitive processing. Such patients may not show deficient motor skill and may earn average IQ levels. Deficits are seen particularly in abstraction, spatial and temporal organization, and concentration. Memory problems are more predominant in Korsakoff's syndrome patients in comparison to chronic alcoholics.

The pattern for Psychoactive Drug Abuses was found to be similar to the nonspecific generalized higher mental decline without serious sensory, motor or verbal deficit as reported for chronic alcoholism.

Epilepsy

It is not surprising that no specific pattern or type of psychological deficit is diagnostic of epilepsy. However, Klove and Matthews (1974) found that adults with epilepsy, regardless of etiology tend to perform in a manner somewhat inferior to that of matched non-brain damaged controls. Nevertheless many epileptics perform quite normally on psychological tests, and many more perform well in some areas while showing one or more circumscribed behavioral deficits.

Schizophrenia

Studies from the 1960s onwards, as reviewed by Heaton et al. (1978), consistently showed that patients with schizophrenia

– whether acute or chronic – exhibited an organic pattern of deficits. Subsequent studies have not only shown that schizophrenics have pronounced global intellectual deficits, but have demonstrated difficulties in other areas of neuropsychological functions (Lawrie, 1999), particularly attention, executive function, and memory, and have tried to identify associations between these and clinical phenomena. Hang (1963) has indicated evidence of cortical atrophy in 61% of schizophrenic patients and Mirsky (1989) has reported abnormal EEG findings in schizophrenics. However in an attempt to provide a clinically useful as well as empirically defensible approach to understanding patients who are schizophrenic and those with an identifiable neurological disorder, Russel (1975) proposed the combined, sequential use of neuropsychological and personality assessment to more completely describe the behavior of these possibly different groups. He found that neuropsychological tests could separate brain damaged and schizophrenic patients from normal. The MMPI could identify those patients who were schizophrenic. Thus the combination seemed to provide a more complete assessment than utilization of one measure alone

Mood Disorder

In a few reports published to date researchers have consistently found patients with mood disorders to have performance deficits on neuropsychological measures. However, mood disorder patients have typically performed better than schizophrenics. Most deficits in the patients with mood disorder on tasks that reportedly measure non-dominant hemisphere functioning.

CONCEPTUAL AND METHODOLOGICAL ISSUES

Neuropsychological tests share the same standardization requirements as all psychological tests. But due to their special nature and purpose they have some specific conceptual and methodological issues to be considered with enough seriousness.

Criterion Used

Most often a test is said to be valid, when an independent criterion is used and the performance of the test is compared against this criterion (criterion-related or concurrent validity). So, to determine the concurrent validity of a neuropsychological evaluation, there should be an independent and reliable criterion. Because the correlation between a test and its criterion is generally reduced, if either the test or the criterion or both are unreliable.

Mostly for neuropsychological evaluations, the criterion used is the objective identification of some central nervous system lesion. In past, neurologists or neurosurgeons used to identify and diagnose brain lesions on the basis of clinical signs and symptoms. However, identification of lesion of the brain has been very difficult, as it can not be visualized directly except if the patient has undergone brain surgery or biopsy. In absence of these, in past, one had to rely on brain autopsy, which was also not very usable or reliable as numerous changes could have taken place between the time of the testing and time of examination of the brain.

Fortunately, the scene is not that much depressing currently. These days the development of advance neuroimaging techniques of identifying brain lesion has overcome the problem to a great extent. Highly sophisticated techniques like CT Scan, PET Scan (Position Emission Tomography) and NMR promises more definite criteria for neuropsychological hypotheses and assessment methods. A number of studies have reported good correlation between CT scan, regional cerebral blood flow, and neuropsychological test results.

Level of Inference

Second major issue is relationship between level of inference and criterion. There are two levels of inference are used in neuropsychological evaluation process. First level is the presence or absence of structural brain damage. For this usually same test is given to different groups and the discriminating power of the test is measured. Most often, a brain damaged and non-brain damaged group is selected on the basis of clinical diagnosis or some laboratory procedures and the performance is compared. However it was found in initial studies that many neuropsychological tests were performed at abnormal levels by patients with several functional psychiatric disorders. Though, many tests were criticized in this ground, now under the influence of newer biological approaches to psychopathology the whole issue has been reformulated. Various studies are now trying to find out the neuropsychological aspects of many of the functional psychiatric disorders, most well known example is that of chronic Schizophrenia.

At the second level of inference, the localization and lateralization of the brain lesion is approached. Various studies by Teuber (1948), Newcomb et al. (1969), and recently by Golden et al. (1983), attempted to relate both site of lesion and concomitant neurological deficits of performance on neuropsychological tests. However, it was observed that localization does not always operate independently with regard to determination of behavioral change, but interact with type of lesion or the specific process that produced the brain damage, acuteness or chronicity of lesion etc. Thus, overall the validity of neuropsychological tests in this level of interaction has been found to be limited. It is not so because of the test itself, but because of the limited knowledge with regard to brain-behavior relationship.

Concept of Validity

The problem of Predictive Validity deals with the course of illness, treatment and rehabilitation plan. In fact, there are very

less number of studies dealing with this issue. The practical problems generally encountered because it is not always possible to do a full neuropsychological assessment in various cases like closed head injury, confusional state etc. Thus, in absence of a comprehensive assessment the prognostic implication of the test becomes limited. Even though, some longitudinal studies have been done on normal elderly and on dementia patients, it is not yet possible to determine whether an individual suspected of having dementia will deteriorate or not? Of course, predictive validity of a test can not be explained solely on the basis of deficit. It is important to know the illness involved and its relation with the particular impairment and course of the illness.

Regarding Construct Validity, neuropsychology abounds with constructs like, short term memory, attention, visual-spatial skills, psychomotor speed, intellectual process etc. Sometimes we fail to recognize constructs as such, because they are so well established; but concepts like memory, intelligence and attention are in fact theoretical entities used to describe certain classes of observable behavior. Within neuropsychology, the process of construct validation generally begins with an attempt to find a measure that evaluates some concept. So, practically it is very difficult to judge the construct validity of neuropsychological tests.

Major Validation Studies

A major review of validation studies was accomplished by Klove (1974) and updated by Boll (1981). These reviews covered only Wechsler's scales and Halstead Reitan Battery, but there are several reviews of the work with Luria Nebraska Neuropsychological Battery (LNNB) as well.

Major basic research regarding localization of brain damage was conducted by Teuber (1959), in which attempts were made to relate both site of lesion and concomitant neurological defects to performance on an extensive series of neuropsychological procedures ranging from measures of basic sensory functions (Semmes, Teuber et al., 1960) to complex cognitive skills (Teuber & Weinstein, 1954). Similar work with brain wounded individuals was accomplished by Newcomb *et al.* (1969). The extensive work of Roger Sperry *et al.* (1969) with patients who had undergone cerebral commissurotomy also contributed greatly to validation of neuropsychological tests with regard to the matter of difference between the two hemispheres; particularly the functional asymmetries of cognitive differences. In general the concurrent validity studies have been quite satisfactory and many neuropsychological test procedures have been shown to be accurate indicators of many parameters of brain dysfunction. The highest hit rate reported so far about Halstead Reitan Battery in diagnosing brain damage is 98.8% obtained in a study by Wheeler, Bruke & Reitan (1963).

About LNNB's efficacy in diagnosing, Golden et al. (1978) reported a high hit rate, occasionally above 90%. Peurisch *et al.* (1981) have reported an overall hit rate of 88% and Sarvick and Golden (1984) reported 77%. With respect to discriminating validity of LNNB regarding localization & lateralization of lesion, McKay & Golden (1979), Lewis *et al.* (1979), and Golden *et al.* (1981) have reported hit rate of 84% for lateralization and 74% for localization.

For predictive validity, there is however some literature on recovery from stroke, much of which is attributable to the work of Meier *et al.* (1974). Among neuropsychological measures, Glasgow Coma Scale (Teasdale & Janett, 1974) has well-established predictive validity. Perhaps Paul Satz and his collaborators accomplished most extensive efforts towards the establishment of the Predictive Validity of neuropsychological tests in 1978 and 1980 predicting the reading achievement in kindergarten school children using Halstead-Reitan Battery.

At the other end of the age spectrum, there are currently several ongoing longitudinal studies comparing normal elderly individuals with dementia patients (Danziger, 1983; Wilson & Kaszniak, 1983). Ben-Yeshay et al. (1970) were able to show that battery of neuropsychological tests could successfully predict length of time in rehabilitation and functional outcome in patients with left hemiplegia. There have been several studies (reviewed by Parsons & Farr, 1981) concerned with predicting outcome of alcoholism treatment on the basis of neuropsychological test performance. In general, studies of predictive validity in neuropsychological assessment have not been as extensive as studies involving concurrent validity.

Regarding construct validity of neuropsychological evaluations, there were always criticisms but in recent years, it has involved multidisciplinary efforts with cognitive psychology, experimental psychology of memory and learning, linguistics and sensory and perceptual process. For example, aphasia testing has been profoundly influenced by basic research in psycholinguistics (Blumstein, 1981), while memory testing has been correspondingly influenced by recent development in information processing theory and the experimental psychology of memory and learning (Butters & Cermak, 1980). LNNB received a lot of criticisms regarding its construct validity by Stanley and Home 1983; Delis & Kaplan, 1983; and Prasad & Verma, 1989. McKay *et al.* (1981) found that global WAIS IQ level could be approximately estimated using the LNNB clinical scale measures.

Neuropsychological Validation Studies: Criticism

Majority of the criticisms related to neuropsychological validation studies centers around methodological issues. Important ones among them are;

1. The criterion group is not properly defined in most of the studies, thus giving rise to false positive or false negative findings.
2. Many of the studies have not taken the sample of patients, which have difficulty in diagnosis, or with

unequivocal findings.

3. Some studies have reported six months follow up to suggest predictive validity, which may not be sufficient enough for predictive validity.
4. Role of other variables like age, sex, education etc. is not controlled in most of the studies.
5. In most of the studies neurological examination's or laboratory test findings are not stated.
6. Severity of pathology of the patient is not controlled.
7. Psychotropic drug levels are not described for any of the subjects.

FUTURE DIRECTION

Further work in the direction of validation must attempt to explain the underlying brain behavior correlates. As there are tremendous advancement taking place in the field of neurosciences, it is necessary that neuropsychological assessment procedures should be refined and modified to meet the existing demands. More researches should be conducted to correlate neuropsychological findings with various brain-imaging techniques. With the advancement in the knowledge of the different disease process, tests should be provided to a number of illness groups to find out a differential pattern of cognitive deficits in relation to diagnosis & cause of illness to be validated. Comprehensive test batteries should be used experimentally in a variety of alternate cultural settings. This field requires more longitudinal studies to find out predictive validity.

Technical advancement is another area in which clinical neuropsychology has to put lots of emphasis in future. Computer-based assessment is definitely going to be the ideal assessment procedure in the field of neuropsychology (Wilson & McMillan, 1992). There are advantages of computer-based assessment which are of particular consequence to the neuropsychologists, however clients with impaired communication, slow and difficult to comprehend responses, severe physical disabilities, and limited abilities to use the conventional forms of communication required in tests, will have many advantages. The major challenge in this area is, at present, the development of appropriate tests that can be administered as well as scored by the computers with adequate validity.

CONCLUSION

In conclusion, it can be said that the techniques of clinical neuropsychological have primarily provided the association between the anatomical structures and behavioral functions by generation of both the structural descriptions and the functional descriptions of the human brain. In this process, clinical neuropsychological has not just given add to the diagnostic techniques, but it has brought very strong methods for deciding medical and psychological intervention of the client who has suffered some form of damage to the nervous system, managing clients with neurological disorder, predicting improvement, and monitoring change in the clients. The behavioral neurology approach, single test approach, neuropsychological battery approach, and qualitative or individual-centered normative approach of neuropsychological assessment have successively developed over the time. Most of the neuropsychological assessment procedures have met validation requirement, though some of the problems are continued in the area of construct and predictive validity. It must be remembered that this is more because the state of knowledge we have in general about brain behavior relationships. Clinical neuropsychology, along with enhancing its applicability, has to face many challenges in the future related to computerization of assessment procedure, legal issues, problem-specific assessment, linking assessment with management and rehabilitation.

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