

## Neuropsychological Assessment

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### Abstract

Neuropsychological assessment is perhaps the most important domain in neuropsychology. It allows for an in-depth and comprehensive evaluation of various cognitive domains, development of strategies for remediation and methods of management of neurobehavioral disorders. There has been constant advancement in the tools, techniques, and area under study. Purpose of this article is to discuss issues related to neuropsychological assessment approaches, tools, methodologies etc in this context, outlining the development of tests, role of computer, and limitations. This paper examines the major body of empirical research on neuropsychological assessment. It also provides recommendation for future research.

**Keywords:** Neuropsychological Assessment; Approaches; Reliability Validity.

### Introduction

The discipline of neuropsychology, the applied science concerned with the behavioral expression of brain dysfunction, came from the parent disciplines of Psychology and Neurology. Neuropsychological assessment is a performance-based method to assess cognitive functioning. This method is used to examine the cognitive consequences of brain damage, brain disease, and severe mental illness [1]. The importance of these tests depends on the fact that they often identify abnormality in the absence of positive findings from sophisticated diagnostic techniques like CT or MRI.

#### *Approaches to Neuropsychological Assessment*

There are three common modes of assessments in neuropsychology. They are 1) behavioral neurology, 2) neuropsychological battery approach and 3)

individual centered normative approach [2,3]. The behavioral neurology approach is quantitative, individualized and non-structured. Often it seems time consuming and comparison or generation of main data is often difficult. The battery approach is a structured approach to quantify cognitive functions that can be subjected to both cross sectional and longitudinal comparisons and offers the possibility of generating mass data e.g. Halstead-Reitan Battery (HRB)[4]. The individual centered normative approach is a path between the other two approaches. In clinical neuropsychology these data is often needed on a large number of subjects and frequent comparisons is impracticable in most situations. However, the battery approach is modified to suit the requirements of the disease condition under study. This led to the division such as fixed and flexible approaches in the field of neuropsychological assessment. Fixed or standard batteries have been advocated by many neuropsychologists. Halstead Reitan Neuropsychological Test Battery [4]

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Cambridge Neuropsychological Test Automated Battery (CANTAB) [5] and Luria Nebraska neuropsychological Battery (LNNB) [6] are few known fixed batteries. However, in view of the limitations of these tests, some neuropsychologists are attracted towards flexible batteries [7,8].

#### *Goals of Neuropsychological Assessment*

Goals of any neuropsychological assessment include 1) detection of neuropsychological impairment, 2) monitoring changes and 3) identification of specific disabilities. Ascertaining a clinical diagnosis for a sub threshold level of impairment may be difficult without the help of a detailed neuropsychological assessment. Sometimes neuropsychological assessments are very fruitful in making a differential diagnosis. Once a baseline data obtained which will serve two purposes such as keeping it as a baseline data and the observations obtained from the assessment can be disseminated to the caregiver regarding the strength and weakness of the index patient.

#### *Developments in Neuropsychological Tests*

Though the older tests are in practice widely, an understanding regarding the newer tests and instruments is unavoidable. Here we provide a brief description regarding the newer tests or about revisions that has been made to the older one.

*Intelligence:* The status of Wechsler Adult Intelligence Test (WAIS-III) and its other versions (such as WPPSI-III, WISC-IV) are considered as gold standard measure for intelligence [9-11]. But a comprehensive assessment of intelligence only with the help of WAIS-III has been criticized [12-14], and led to the development of six factor model from the WAIS-III and WMS-III, which includes verbal, perceptual, processing speed, working memory, auditory memory, and visual memory constructs [14]. In order to tackle the time constrains the use of shorter forms of IQ tests such as Wechsler Abbreviated Scale of Intelligence (WASI) are in use [15,16]. Test of Nonverbal Intelligence (TONY) [17] is considered as a substitute for Raven's Progressive Matrices [18]. As the construct of intelligence is difficult to assess in children under the age of two years, Bayley Scale of Infant Development (BSID) is often used to understand the development of children. BSID was revised (BSID-II) by adding new items and dropping old one [19].

*Executive Functioning:* Executive functioning is composed to four functions 1) volition; 2) planning;

3) purposive action and 4) effective performance [8]. The WCST is one of the unavoidable tests in the assessment of executive functioning. Recently a modified abbreviated form of administration by giving only first set of 64 cards, known as WCST-64, has been validated [20,21] Due to some practical problems in terms of test cards and patient factors Nelson modified the card sorting test (Modified Card Sorting Test) [22]. Though it is a time saving the test it is not comparable to WCST [23,24].

Another important test is Cambridge Neuropsychological Test Automated Battery (CANTAB). It assesses the subject's visual memory, visual attention, working memory, and planning. The test consists of one screening test and 12 principal tests [25] The test suffers from methodological issues such as inadequate norms and its effects on certain variables such as age, IQ and gender [26,27]. Eclipse 6 is the latest version of Cambridge Cognition's leading cognitive testing platform for academic research, used to assess cognitive functioning over 30 CNS disorders such as Alzheimer's disease, Parkinson's disease, ADHD, schizophrenia and depression and cited in over 1200 peer-reviewed publications.

*Attention and Concentration:* Comprehensive Trail Making Test is used to measure attention, visual scanning and executive functions, developed primarily to address the shortcomings of original TMT as it was lacking proper norms and increased sensitivity to detection of separate cognitive components [28]. Another test Paced Auditory Serial Addition Test (PASAT) and its children versions (CHIPASAT) measures working memory, divided attention and information processing speed. Children's version is also available as computer software. Trail Making Test can also be used to measure attention speed and mental flexibility. An oral version of the TMT is recommended for people having problems in drawing [29,31].

*Memory:* California Verbal Learning Test (CVLT) is used to measure verbal learning and memory which was developed according to process model [32]. Its revised form CVLT assesses both recall and recognition of two word lists over immediate and delayed memory trials. It has got children's version too known as CVLT-C. The test Doors and People was developed to assess visual and verbal episodic memory, including both recall and recognition [34]. Rey Auditory Verbal Learning Test (RAVLT) also known as Auditory Verbal Learning Test (AVLT) is used to measure learning and memory. Recently it is translated to various foreign languages [35]. The revised form of Rivermead Behavioral Memory Test

was originally designed to detect impairment in every day memory functioning due to neurological impairment [36-38]. A lot of other tests also developed or modified from its older version like WMS-III, [14] and Ruff Light Trail Learning Test (RULIT) [39].

In conditions like mild cognitive impairment (MCI) Clinical Dementia Rating (CDR) [40] and Dementia Rating Scale (DRS) [41] can be administered. Among these tests the subjects with MCI may get a score of 3 on GDS and 0.5 on CDR [42]. Where as in conditions like traumatic brain injury (TBI) scales like Galvenston Orientation and Amnesia Test are considered to be the right to begin with after detailed case history. There is a dearth of indigenously developed neuropsychological test battery that is suitable for Indian older adults to assess cognitive function as well as decline, [43] and the need for developing and validating cognitive measures has been highlighted by several researchers [44]. NIMHANS Neuropsychological Battery for Elderly (NNB-E) has been developed and standardized on Indian population[45]. Hindi mental-status examination (HMSE) is a modified version of MMSE and is validated for Indian population [46].

#### *Use of Computers in Neuropsychological Assessment*

Computer assisted psychological examinations are increasingly applied in health care. A major advantage of use of computers in the assessment are it is less time consuming and potentially more cost effective, once it is standardized it assures reliability and validity. In addition to these it enables precise time, quality monitoring and analysis of results. Though in many cases, validity and reliability of many tests remains a matter of controversy and more researches are needed. The following are some of the tests that available as computer programs or software: The Auditory Verbal Learning Test, The Five Point Test, Trail Making Test (TMT), The Computer Assisted Stroop Test, Complex Figure, The Poreh Picture Naming Test, The Controlled Oral Word Association Test (COWA), The Cleveland Card Sorting Sorting tests, The QPSS Continuous Performance Test.

#### *Factors Affecting the Neuropsychological Assessment*

*Culture-* Ethnicity and cultural background are important factors in interpreting test performance. [47-48] Minority members may score lower on some tasks due to unfamiliarity with test-taking and dissimilarities in cultural experiences and expectations.

*Education-* Education has a marked effect on neuropsychological test performance. For example, the cutoff for "normal" performance on the Mini-Mental State Examination may vary by as much as eight points depending on the individual's educational level[49]. The clock-drawing test, widely used in clinical screening, is also affected by low education. Education-specific normative data are not available for most tests, and interpretation of test results in individuals with unusually high or low levels of education must be done with caution. It has an important influence on cognitive test performance[50,51] An effect of education on non-verbal tests has also been reported in children [52].

*Gender -* Gender has consistent but minor effects on neuropsychological assessment. Women tend to perform better on tests of verbal memory than men[53] and men evidence more decline than women on most neuropsychological tests in the course of normal aging [54] Gender effects are of modest magnitude compared with the influences of age and education on neuropsychological test performance [55].

*Age-* Aging affects several domains of neuropsychological function, including fluid intellectual abilities, complex attentional processes, some aspects of memory, psychomotor speed, accessing word knowledge, visuospatial skills, some forms of abstract reasoning, and complex problem-solving [56,57]. Age stratified norms exist for most widely used instruments, although patients in the extremes of old age (above age 75) are often underrepresented in the normative sample, making interpretation of test results in very old patients more difficult.

*Psychiatric disorders-* Neuropsychiatric disorders like anxiety, depression, psychosis, apathy, and irritability all have an impact on the patient's ability to cooperate with testing and may directly affect cognition. Anxiety and depression impair performance on effort-demanding tests and have less effect on tests of over-learned skills. Memory complaints are common manifestations of depressive disorders, and severe depression is commonly accompanied by psychomotor slowing, impaired attention, decreased cognitive flexibility, and poor retrieval memory [58].

*Substance abuse-* Chronic alcoholism is associated with deterioration in abstraction, visuospatial skills, and problem-solving abilities [59]. A history of excessive substance use must be sought and integrated the interpretation of neuropsychological test data. This is particularly important in the evaluation of patients with histories of head trauma because trauma is more common among those with

substance abuse [60].

*Flynn effect*- Performance on mental ability tests rising from one generation to the next is called "Flynn effect". The phenomenon has important implications for clinical utilization of IQ tests [61]. Flynn effect does apply to the Wechsler and Stanford-Binet tests, as well as tests such as the Otis Intermediate Test of Mental Ability and the California Test of Mental Maturity [62]. Not only does the Flynn effect causes published norms for Full Scale IQ to become progressively less appropriate over time, but it also causes different subtest norms to change at different rates. Clinical neuropsychologists who use old versions of IQ tests not only will overestimate IQ but also will risk misinterpreting indicators such as Verbal-Performance disparities and subtest profiles [61].

#### *Neuropsychological Methods Vs Other Methods of Assessment: A Co-relational View:*

Neuropsychology and neuroimaging both provide information about the relationship between brain structure and function, and thus attempts to understand if the neural basis of cognition should benefit from converging results obtained across the two methods. However, serious attempts to integrate the two methodologies face several challenges, such as differences in basic paradigm designs [63]. Many attempts have been made to evaluate the benefits that can be derived from in-depth comparisons of neuroimaging or functional neuroimaging and neuropsychology, or focusing on the strengths and weaknesses of the two methods [64]. Studies conducted with this type of interdisciplinary objective in mind are likely to be extremely valuable, because they should provide new constraints that motivate revisions and refinement to theoretical models of human cognition in neuropsychological assessment using event-related brain potentials [65].

*Electrophysiological Methods:* Two studies examined ERP responses to the computerized version of the Peabody Picture Vocabulary Test - Revised (PPVT-R) [66] in 10-year-old children [67] and young adults [68] and concluded that the results from the PPVT-R supported the use of ERPs in the assessment of receptive vocabulary levels. Historically, clinicians have utilized evoked potentials for evaluating sensory functions and neuropsychological testing for evaluating cognitive functions, however, the clinical implementation of it remains to be developed fully. Language functions have also been assessed using neuropsychological tests that are formatted for computer presentation with simultaneous ERP

recordings and significantly correlating the two measures [69].

*Neuroimaging Methods:* Neuropsychological testing and structural imaging with X-ray computed tomography (CT) or magnetic resonance imaging (MRI) in major depression shows evidence of slowing in motor and cognitive domains with additional prominent effects on mnemonic function most marked in the elderly [70]. Recently, functional neuroimaging techniques, such as PET [71], fMRI [72], and Magnetoencephalography (MEG) [73], have provided a more direct link between cerebral and cognitive aging [74]. Studies of cognitive recovery after acquired brain damage in adults using functional neuroimaging and neuropsychological tests found males performing better on block design and visual reproduction, and females performing better on the California Verbal Learning Test (CVLT). Across both sexes, block design scores correlated significantly with right hemisphere M100 location, with more anterior source locations associated with better performance. CVLT scores were negatively correlated with right hemisphere M100 source locations, suggesting that MEG-based measures of interhemispheric asymmetry may be related to specific neuropsychological test performance measures [75]. Comparative study of the neuropsychological and neuroimaging evaluations in children with dyslexia indicated significant correlation between the two measures [76]. In yet another study, neuropsychological test battery sensitive to fronto-striatal system dysfunction and CT scans were applied on patients with schizophrenia indicating structural frontal abnormalities in them [77].

#### *Methodological Considerations of Neuropsychological Assessment*

Low reliability not only limits the sensitivity of any individual test when it is used on its own for clinical diagnosis or as a research tool but also sets limits to the extent to which it can be expected to correlate with other measures and its sensitivity when it is repeatedly administered to detect changes in ability [78]. Many of tests in both Cambridge Neuropsychological Test Automated Battery (CANTAB) and the International Study of Post-Operative Cognitive Dysfunction (ISPOCD) batteries seem to have test/re-test correlations that are unacceptably low for use as research tools [78]. In a review of eight common neuropsychological instruments, most measures showed significant

practice effects [79]. The instruments were Trail Making Test, Stroop Color/Word Interference Test, Grooved Pegboard, California Computerized Assessment Package (CalCAP), Digit Span, Symbol Digit Modalities Test, Rey-Osterrieth Complex Figure Test (RCFT), Controlled Oral Word Association Test (COWAT). However, small effect sizes on some measures raises doubt on their clinical significance. The greatest effect sizes were found on the RCFT recall trials. Most other measures that had significant changes had effect sizes within the .20 to .32 range. The measures that failed to show significant practice effects, including the direct copy of the RCFT Copy trial, Word Reading trial of the Stroop, and the CalCAP Choice Reaction Time 1 trial. All of the measures that required some cognitive engagement such as memory, strategy, speeded processing, or divided attention showed some practice effects, while the relatively straightforward overlearned tasks did not. In sum, practice effects appeared to occur on motor, psychomotor, attention, processing speed, nonverbal memory, and executive functioning measures. Test-retest correlations were generally good in these instruments. In contrast to the above, another study [80] reported better reliability with Grooved Pegboard as their sample was somewhat more heterogeneous. It has been observed that sensitivity to diffuse neuropsychological changes and ease/speed of administration make the Rey Auditory Verbal Test a valuable tool in medical rehabilitation settings [81]. Cancellation task have traditionally been used to measure visuospatial neglect but recently, such tests have also been viewed as potential measures of executive function with good convergent validity for all three executive organization measures (mean inter-target distance, path intersection rate, and a quantification of overall path uniformity) [82]. The Brown Location Test (BLT) designed to specifically measure visual memory for location of identical objects (dots) has good internal and alternate form reliabilities [83]. Factor analysis of a brief test battery confirmed that BLT performance is generally independent of verbal memory and global intellectual abilities. BLT performance declined with age, but there was no association between performance and gender, education, or intellectual functioning. In view of the favorable psychometric properties observed during preliminary studies, additional normative and validation studies in healthy and patient populations are warranted.

In the future, neuropsychological assessment, neuroimaging and electrophysiological methods should be used in convergence in designing rehabilitation programs and in monitoring the effectiveness of such programs, assessing outcomes

and the success of rehabilitation treatments. New guidelines, Specific training are needed as in disability; ecological validity of tests; academic programs for students with disabilities; specific cognitive-behavioral interventions, government assistance programs for individuals with disabilities.

## Conclusion

Neuropsychology is one of those avenues where the contribution from the mental health professional is pivotal. Understanding and updating information is unavoidable to a psychologist to excel and this ability to adapt to changes in techniques, ideas, and patients served accomplishes its potential to be of service to humanity.

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