

# NEUROPSYCHOLOGICAL TESTING: HOW IT CAN BENEFIT CLINICAL NEUROSCIENCE IN SINGAPORE

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## ABSTRACT

*Neuropsychological testing is a relatively new field in the area of clinical neuroscience. It has proven to be an effective and essential aid in the diagnostic process of brain-injured patients, especially in lesions of the cerebral cortex. More advanced countries have incorporated neuropsychological assessments in their standard neurological examinations of the brain damaged. Clinical neuropsychology is only beginning to be used in Singapore. Research using neuropsychological methods have also shown to be useful in providing a greater understanding of the brain-behaviour relationship in humans. Problems confronting the use of neuropsychological testing in Singapore are identified and the possible solutions discussed.*

*Keywords : Neuropsychological testing, Luria, Halstead-Reitan, qualitative versus quantitative testing, benefits of neuropsychological examination, Singapore.*

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## INTRODUCTION

As with many of the other disciplines, neuropsychology is an end-product of a marriage of two disciplines with longer and richer histories - neurology and psychology. In its broadest sense, neuropsychology encompasses the multifarious field of the study of behaviour as it relates to the nervous system. Interests among researchers as well as clinicians in this area range from the study of responses of sensory neurons to electrical stimulation in molluscs<sup>(1)</sup> to the postoperative observation of gross behavioural changes in human patients following commissurotomy<sup>(2)</sup>. Clinical neuropsychology is an applied scientific discipline subsumed under the wider field of neuropsychology wherein the observation of overt behavioural responses in humans with brain dysfunctions allows the scientist to detect or infer brain pathology from behavioural deficits, excesses and/or inappropriatenesses. It is this clinical aspect of neuropsychology that is the topic of discussion in the present article.

## APPROACHES TO CLINICAL NEUROPSYCHOLOGY

The short but intense development of the field has produced two approaches to neuropsychological testing.

The first approach largely grew out of the ingenuity and influence of Alexander R. Luria, a psychologist from the Soviet Union. Luria's form of neuropsychological testing is based on the notion that cerebral activity comprises of three basic functional units<sup>(3)</sup>:

a) Unit I for maintaining and regulating cortical tone. Normal and organized mental activity of an organism requires a optimal level of cortical tone. This is essential if the organism is to effectively receive, analyze, and carry out information received from within the organism as well as from the environment. The state of cortical activity is controlled by (and influences) the brainstem and thalamic structures.

b) Unit II is responsible for the receiving, analysing, and storing of information. Incoming stimuli must be processed before the organism can appropriately react and respond. The neural regions involved in this unit are the occipital, temporal, and parietal areas of the cortex. The functions of each area

can be further divided into the primary, secondary, tertiary zones according to their modal-specificity.

c) Unit III is involved with the programming, regulation, and verification of activity. After the organism receives, encodes, and stores the information, a plan or program must be initiated for the response. The behavioural response must be regulated so that it conforms to the original program, and the response must then be continually verified in order to correct any mistakes made along the way. Structures involved with this functional unit are located in the portions anterior of the central fissure.

As neural activity is based on the interaction of all three functional systems, any damage to the brain produces a panoply of signs and symptoms related to the units. These collectively form a functional syndrome which may or may not be directly related to the circumscribed lesion. An analysis of the syndrome must, therefore, identify the affected functional systems and, hence, the specific neural zones that contribute to each functional unit. From this, a more reliable estimate of the location of the lesion can be made.

To this extent, neuropsychological examination must necessarily involve the scrutiny of the examinee's behavioural response to each test. Not only is the mistake or correctness of the response important but the way the response was obtained and given by the patient is equally essential in providing information about the extent of damage to the functional units. In other words, a qualitative approach is taken towards the assessment of a patient.

Luria's testing methods can be broadly categorized into three stages:

### a. The Preliminary Conversation

This portion of the investigation aims to gather general information about the level of the patient's mental activity and consciousness. It also allows the examiner to observe behavioural responses that would allow him/her to form hypotheses about the nature of the disturbances and location of the lesion(s). This will set the stage for further testing of the initial hypotheses formed. The information collected will include the patient's general state of consciousness, the present and premorbid levels of mental functioning, his/her attitude towards the illness, situation and surroundings, and the principal complaints (generalized, episodic, progressing) about the problem.

### b. Individualized Investigation

The objective of this stage is to collect data by testing the patient's motor functions, acoustico-motor organization, cutaneous and kinesthetic functions, visual and speech functions, reading and writing skills, mnemonic and intellectual processes.

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The tests used in this stage are highly individualized and adjusted according to the patient's defect and premorbid level. The difficulty level of the tests such as the rate of presentation, tempo of the investigation, range of the scope of the tasks, etc are adjusted accordingly to challenge the patient's ability to use whatever neural functions remaining intact to perform the tasks. Only then, according to Luria, can the undamaged cortical analyzers be detected and identified. These tests can usually be conducted in a testing room or at the patient's bedside without laboratory equipment usually taking no more than an hour. However, to further investigate the physiological causes of the pathology, Luria advocates the use of special neurophysiological methods such as electromyography, electroencephalography, plethysmography, etc.

### c) Comparative Analysis of Results

The information collected from the previous stage is analysed to identify the fundamental defect of the pathology, describe the nature of the defect, and to define the underlying pathophysiological factors. This would help to ascertain how the various behavioural responses and activity are affected. [For a detailed account of Luria's methods, see *Higher Cortical Functions in Man*, 1980<sup>(4)</sup>].

Critics argue that Luria's method is often open to subjective interpretation of the observations made by the examiner. Some of the responses may be unique and idiosyncratic to the patient and this could be misinterpreted as abnormal behaviour.

In addition, reliability and validity of the test observations are called into question because of the lack of statistical comparisons with standardized data.

Contemporaneous with the Luria's development of clinical neuropsychology, psychologists in the United States were also formulating neuropsychological tests to detect brain dysfunction<sup>(5)</sup>. This second (and psychometrical) approach to neuropsychological testing was an accretion in the statistical and quantitative methods that the Americans had towards psychology as a whole. It is based on the fact that overt behavioural responses can be categorized according to some principle. These "principles" are in turn based on knowledge of the functions of various cortical regions. Thus, an individual's behaviour is evaluated and placed in a functional category after which it is rated on a numerical scale within the category.

Psychometric tests are designed to test the mental competence according to the functional categories. The numerical scores provide a statistical indication of the deviance of the patient's behaviour from the norm and according to the pattern of the deviant scores, a picture of the pathology of mental dysfunction and its corresponding lesion areas can be constructed.

An entire series of psychometric tests have been designed for neuropsychological investigation. Obviously, it would be beyond the scope of this article to mention all the different tests. However, Ward Halstead and Ralph Reiten have condensed some tests into a compendium called the Halstead-Reiten Battery which have been used widely in clinical neuropsychology<sup>(6)</sup>. Some of the tests include: Halstead Category Test where the patient's ability to form concepts is examined; Tactual Performance Test to investigate tactile form discrimination, manual dexterity and coordination, visuo-spatial functions; Rhythm Test to test for attention and auditory functions; Speech Sounds Perception Test for sound perception; Finger Tapping Test to measure motor speed; Time Sense Test for memory; Critical Flicker Frequency Test for visual reaction; Halstead-Wepman Aphasia Screening Test (self-explanatory); and Trail Making Test visuo-motor coordination. [For a detailed description of psychometric tests used for clinical neuropsychology, see *Neuropsychological Assessment*, Lezak, 1983<sup>(7)</sup>].

Problems with quantitative method of psychometric testing include the loss of information from direct observation of the patient. How the patient responds to a particular task and the quality of the mistake or how a patient overcomes a deficit to accomplish a task may provide valuable information about the patient's condition. Psychometric testing usually does not allow for such scrutiny of the patient's behaviour.

In addition the tests, may be so "finely" factorized that resultant scores do not provide meaningful information for a comprehensive assessment of the damaged structures and functions. Many of the tests have been designed to test for specific dysfunctions so that a slightly different behavioural aberration might not be detected by the test.

Furthermore, because psychometric tests are specific and inflexible, separate and numerous tests must be used to detect and localize various forms of cerebral dysfunction. Such quantitative evaluation is unwieldy and usually requires several hours of testing (sometimes spread over a few days). This poses problems concerning the efficiency and cost of the entire procedure not to mention heavily taxing the patient's physical and mental endurance.

Finally, the summed or averaged scores resulting from the different tests may be too overinclusive as to render them impossible for the investigator to tell what functions they represent, that is, their ability to distinguish behavioural skills, altered or intact, becomes diminished.

The distinction between the two approaches of Russian and American neuropsychology is one of methodology. While the former advocated close, intense observation and qualitative evaluation of behavioural responses presented by individuals under examination, the latter emphasizes on the performance of the individual on a battery of tests statistically selected through factor analysis to identify abnormal behaviour and, subsequently, predict areas of cortical damage.

This schism between the qualitative and quantitative approaches has attracted considerable debate concerning their validity, reliability, and efficacy in relation to the diagnostic value in brain-damaged individuals<sup>(7)</sup>. The relative merits and criticisms of these two schools of persuasion in clinical neuropsychology, and specifically as they relate to usage in the Singapore context, will be discussed in a later section.

## THE ROLE OF NEUROPSYCHOLOGY

Whatever the approach, clinical neuropsychology forms an important source of information for neuroscientists investigating persons with cerebral abnormality. The information obtained can be used for diagnostic, rehabilitative, and research purposes<sup>(7)</sup>.

First, information obtained from neuropsychological examination conducted in concert with information from standard medical procedures such as neurological examinations, CT or PET scans, MRI, EEG recordings, etc, can offer valuable data that may be crucial for diagnostic purposes. There is evidence that neuropsychological techniques may be even more sensitive in detecting brain impairment than some of the current neurological procedures eg CT scans may not be able to detect morphological anomalies of the cortical areas in the early stages of certain disorders<sup>(8)</sup>. This is especially important if early detection of some cerebral lesions is essential for proper therapy/intervention programs to be proposed.

Attesting to the efficacy and sensitivity of neuropsychological procedures, Casson, Siegel, Sham, Campbell, Tarlau, and DiDomenico<sup>(9)</sup> examined 18 professional boxers for brain damage and found that 87% of them had "definite signs" of neural impairment. The boxers were put through a neurological investigation, EEG test, CT scan, and neuropsychological assessment. The neurological examina-

tion showed that five of the 18 subjects had abnormal signs; the EEG recordings (which were administered to only 13 of the boxers) revealed that only five had abnormal records; CT scans produced six cases of cerebral atrophy with the rest showing no signs of brain damage. The neuropsychological tests, however, picked up abnormal signs in all the 18 boxers. Even in four of the subjects where the neurological examination, CT scan, and EEG failed to detect neural abnormality, there were unmistakable signs of brain damage under neuropsychological examination. The researchers concluded that "neuropsychological testing is a highly sensitive and accurate means of detecting brain damage..."<sup>(9)</sup>.

Second, in terms of patient-care and rehabilitation, determination of the area of brain injury cannot adequately predict the subsequent behaviour of the patient. Whether the brain-injured individual has suffered cognitive deficits which would have serious implications on the life-style of the patient (such as the type of job he/she is capable of, the ability to manage personal finances, etc) or whether a remedial program is appropriate for the patient (this includes the ability of the patient to adhere to such a program) cannot be assessed from descriptions of areas of cortical insult alone. Rather, a careful analysis and description of the patient's behaviour vis-a-vis neural functioning can provide important insights into what the patient can or cannot do. Thus, rehabilitative action can be more constructive.

In addition, information gleaned from neuropsychological testing can also be used to evaluate the effects of surgical procedures, medical treatment, or other forms of therapy related to neurological functioning.

Finally, neuropsychological assessment is an indispensable tool in research in neuropsychology. Case studies of individual patients with cortical lesions often provide important clues to the functions of the different areas of the human cerebral cortex. Alternatively, groups of patients under similar diagnostic categories can be neuropsychologically tested to investigate the constellation of signs and symptoms which may help to further identify underlying syndromes previously overlooked in certain disorders. This is particularly useful in the medical model of differential diagnosis. In the local context, research in this area may provide insights to brain functions dependent upon, or at least affected by, cultural norms and mores. This is especially cogent in the areas of speech and language.

In summary, for any one individual with brain damage, a neuropsychologist can furnish information pertaining to the (1) establishment of cognitive/behavioural alterations stemming from the brain injury, (2) estimation of the relative extent of the insult, (3) estimation of the ability of the affected individual to assume the lifestyle he/she had prior to the accident and, more importantly, what the patient is capable or incapable of in the future, (4) suggestion of rehabilitative help, and (5) provision of information that could lead to avenues of research of brain functions.

#### NEUROPSYCHOLOGICAL TESTING IN SINGAPORE

While neuropsychology in the West and in the Soviet Union has been advancing at a tremendous pace, the subject has only begun to emerge in Singapore. In fact, psychology as a formal discipline was only introduced locally in 1986 in the National University of Singapore (NUS). Thus, at the present time it would be unrealistic, indeed ingenuous, to expect a wide base of psychologists trained in this specialty area to provide an efficacious service to the local community. Neither would it be prudent for anyone to assume that we are able to import the knowledge and techniques used so successfully in the more developed societies en masse and mechanically apply them in Singapore. An endeavour to adopt the use of neuropsychological

testing is not without its problems which I will attempt to identify and elucidate, and hopefully, suggest viable solutions for them.

The first and biggest problem neuropsychologists face in Singapore is, I believe, the multiracial and multilingual texture of the populace. The literacy rate in Singapore might pose of problem. For an individual who is illiterate the administration of many of the tests which are often written in the English language is, at best, very difficult and, at worst, downright impossible. The problem is compounded even further if the examiner does not speak the language of the patient and vice versa. Even if the subject is proficient in his/her native language, translated versions of the tests into Malay, Tamil, or Mandarin may not exist. Although not insurmountable, the task to adequately translate the neuropsychological tests for local usage is certainly not a small one either. Even then, problems in accuracy and congruency of the translations may threaten the reliability and validity of such tests.

To circumvent the problem with illiterate patients, tests that rely exclusively on the subject's ability to read and write can, and should, be avoided. More often than not, such tests are confined to assessment for aphasia. Tasks used for testing for lesions in other cortical areas are not as dependent on the need for reading and writing skills on the part of the examinee. Thus, a majority of the tests can still be put to good use in Singapore hospitals. Even for testing of problems in language comprehension and production, there are other means of "getting" at the problem other than the use of paper and pencil. To this end, Luria's approach of neuropsychological investigation holds more promise for neuropsychology in Singapore. Luria's insistence on the interpretation of the quality of the response and the manner at which the answer was derived, rather than simply a correct or incorrect evaluation of the response, means that the examiner must scrutinize the behaviour of the patient asked to complete a task. It also means that the examiner is continuously forming hypotheses in an attempt to lateralize and localize cortical damage, and testing these hypotheses even as he/she is conducting the examination. This flexibility allows the neuropsychologist to narrow down the possible foci of lesion and thoroughly examine problem areas. This flexibility also allows the examiner the choice of tests to use, or in some cases to avoid, if the patient does not possess reading and writing knowledge. On the other hand, using the fixed battery of tests to collect a numerical representation of brain lesions as proposed by Reitan and his followers would not allow local examiners the flexibility to adapt to the needs of individual patients. These needs may be even less homogenized in a multiracial society in Singapore.

Second, the difficulty of using neuropsychological tests in Singapore may not always be with the examiner or the patient. Tests may be designed for a group of people who have a common and identifiable set of ideas and lifestyle, that is, these tests may be culturally biased so that poor performance by an individual unfamiliar with the culture of the group of which a test was written for would not necessarily imply any cognitive deficit, and hence, cortical dysfunction. For example, patients are often tested for explicit memory, or rather the loss of it, by asking them to name pictures of well-known American personalities of the past such as presidents, movie-stars, writers, etc. Such a test would be wholly inappropriate in the Singapore context. Even if the photographs were replaced with those that are distinctively more local in flavor, there arises the question of whether such information borne by the mass media (which is usually the main source of such information for the general public) is equally influential in the two cultures.

The tasks employed by Luria are seldom couched under cultural norms. In this regard, application of these tests in

Singapore would not be as problematic. Also, as Luria's techniques involve small and discrete tests of behavioural responses, translations of entire sets of tests, and the problems arising thereof, are avoided.

Third, as with many other psychological tests, neuropsychological assessments (notably Halstead-Reitan's battery of tests) are often based on how deviant the performance of brain-injured persons are compared to statistical distributions of scores of normal individuals on psychometric tests. However, such normative data of the local population is not available either because action to gather the data has not been initiated or the existing data collected by psychologists in the various mental health institutions have yet to be collated. Again, the adoption of normative data collected in other countries for use here would not be meaningful for reasons previously cited.

The problem of absence of standardized normative data on the different tests needs to be urgently rectified. The level of performance of the "average" person in this country on the different tests can only be determined through empirical research. Such research requires a significant amount of time and resource. Until and unless such data is gathered, psychometric testing for brain damage remains inaccurate and misleading. Luria's method of neuropsychological investigation is helpful in this area in that no time consuming collection and collation of standardized scores is needed for assessments to be performed.

Finally, the level of sophistication and competence of the local professionals in this area is of concern. Neuropsychology is without doubt a specialised and demanding area and, as such, it should be practised by professionals expertly trained in it. Presently, there is a scarcity of psychologists adequately trained in clinical neuropsychology in Singapore. There is certainly a need for qualified personnel to meet the demands necessary for a comprehensive and effective neuropsychological program in Singapore as well as for existing practitioners of clinical psychology who deal with brain-injured patients to develop and upgrade their knowledge and skills in detecting brain damage using neuropsychological techniques. The latter problem can be overcome through consultations with the Department of Social Work and Psychology at NUS.

It is also important for the medical community to be aware of the potential uses and benefits that neuropsychology offers.

Only when the neurologist or neurosurgeon realizes the significance of neuropsychological input in the diagnostic as well as prognostic evaluation of brain injury can neuropsychological testing be of any value in the area of clinical neuroscience. If he/she astutely incorporates and uses information provided by a neuropsychologist in handling brain-damage cases, then clinical neuroscience in Singapore will be all the better for it. For this purpose, the present article is intended as a rudimentary source of information for medical professionals.

Through co-operation and education, both the medical and psychological communities must work together more closely to provide Singapore with a more effective service in clinical neuroscience. At the same time, neuropsychologists in Singapore must strive to introduce and expand the service of neuropsychological testing here, and through research and clinical work, upgrade the quality of the service. Much work lies ahead.

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