FOR MY PARENTS

Mr & Mrs N.A. Naidu

A SPECIAL TRIBUTE

As a parent I have always taken a deep and abiding interest in my daughter's (Venodha) completion of her Masters' dissertation. I was particularly impressed by her zealous passion for her research and I am convinced that her painstaking efforts are the result of the overwhelming support and advice proffered by her supervisor and promoter Theo Lazarus.

At my first encounter with Theo Lazarus, I was struck by his humility, benevolence and compassion, and by the interest displayed when I discussed my intention to ensure the publication of my daughter's dissertation. He facilitated and co-ordinated the finalisation of the dissertation, giving much of his valuable time. He had to also sacrifice several of his own commitments, especially at a crucial stage when he was busy with his own doctoral thesis. I am most grateful for his kindness, willing assistance and warm interaction whenever I consulted him.

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In conclusion, I would like to pay tribute to my late daughter, Venodha. After her sad demise on the 22 June 1991, I was amazed at the methodical arrangement of her research material and the information collated for her masters' dissertation. The manner in which she had arranged her research document, her systematic filing and compilation in neat segments inspired me to fulfill her years of painstaking effort. I am convinced that her research would be useful to all those interested in this field of study. May her soul rest in peace.

N.A. NAIDU (father)

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THE INFLUENCE OF AGE, SEX, AND SOCIO-ECONOMIC STATUS ON THE PERFORMANCE OF NORMAL ADULTS ON THE LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY (LNNB)

BY

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CONTENTS

ABSTRACT

The study was planned to investigate issues relating to the Luria-Nebraska Neuropsychological Battery. The aims were to investigate the influence of age, sex and socio-economic status on performance on the Luria-Nebraska Neuropsychological Battery. A sample of forty males and forty females, stratified according to age (25-40 year olds and 50-60 year olds) and socio-economic status was selected. The results suggested that age formed a significant effect on the total and individual scale scores of the battery. There were no significant sex differences on the total score and most of the scale scores of the battery. Sex formed a significant variable on the performance on the intellectual processes and visual scales. A significant negative correlation was found between total and scale scores of the Luria-Nebraska Neuropsychological Battery and socio-economic status. The implications of these findings are discussed.

CHAPTER ONE

INTRODUCTION

Neuropsychological assessment involves the identification of behavioural changes that are contingent on neurological insult. This area of practice has become increasingly important in view of the widespread prevalence of neurological disorders due to disease or trauma-related conditions.

In an effort to reach some uniformity in the diagnostic outcome of neuropsychological assessment, several test instruments have been proposed. The Luria-Nebraska Neuropsychological Battery (LNNB) represents one of the most widely used batteries (Yudofsky and Hales, 1987). This test battery was based upon the neuropsychological diagnostic procedures used by the prominent Soviet neuropsychologist, A.R. Luria. In conformity with Luria's flexible and qualitatively oriented assessment approach, the items and materials presented in 'Luria's neuropsychological Investigation' were not intended to be administered in a routine standardized manner, nor was performance to be scored and quantified. Based upon the procedures and materials provided by Christensen, the Luria-South Dakota was developed by Golden and two associates, Purisch and Hammeke.

The Luria-Nebraska Neuropsychological Battery was developed as an attempt to provide such standardization and quantification to Luria's items. The major consideration prompting the development of standardized administration and quantitative scoring of Luria's items was the potential utility of a psychometric instrument with a sound underlying theoretical base. Such a test would differ from other major instruments which were developed relatively atheoretically. Performance patterns on such a test could be interpreted empirically through use of statistical comparisons, similar to other psychometric instruments. However, test performance could also be interpreted theoretically, in reference to Luria's concepts. This would permit insight into the reasons for performance deficits beyond the simple recognition of deficits through statistical methods.

The use of the Luria-Nebraska Neuropsychological Battery worldwide has gained momentum for the above-stated reasons. However, the deployment of the battery to cultural settings beyond that in which the test was standardized needs to be treated with caution. In South Africa, the test battery has been received with great enthusiasm despite some criticism relating to it's validity and reliability. The South African population is heterogenous in nature and only about ten per cent of the

population is represented by Whites. It is likely, therefore, that the norms may be more relevant for this subgroup than for Indians, Blacks or Coloureds.

Within this context, the present study was planned on a sample of Indian adult subjects. The following aims were pursued.

i) To investigate the influence of age on performance of normal adults on the Luria-Nebraska Neuropsychological Battery.

ii) To investigate the influence of sex on the performance of normal adults on the Luria-Nebraska Neuropsychological Battery.

iii) To investigate the influence of socio-economic status on the performance of normal adults on the Luria-Nebraska Neuropsychological Battery.

The corresponding hypotheses are presented in order to fulfil these aims.

(i) There will be a significant difference between the performances of the 25-40 and the 50-60 year old normal adults on the Luria-Nebraska Neuropsychological Battery.

(ii) There will be a significant difference between the performances of females and males and on the Luria-Nebraska Neuropsychological Battery.

(iii) There will be a significant relationship between socio-economic status and performance on the Luria-Nebraska Neuropsychological Battery.

CHAPTER TWO

LURIA'S THEORY OF BRAIN ORGANIZATION

2. THEORIES OF BRAIN FUNCTIONING

Over the past three centuries, theories of the brain's role in the functioning of the individual have changed considerably. Since the brain was accepted as playing a vital role in the control of behaviour, theories regarding brain functioning have become more extensive and sophisticated. Research studies investigating the role of the brain in behaviour have broadly drawn on two major schools of thought, viz., one asserting that control could be localized in specific areas of the brain, and the other that the brain functions as a whole.

2.1 The Historical Development of the Theories of Brain Functioning

The first breakthrough in brain-related studies was made by the Egyptians and Babylonians. However, it was the early Greeks who initiated modern physiology, and in particular, Pythagoras, who identified the brain as the centre of human reasoning (Golden, 1983).

According to Golden and Vicente, (1983), Herophilius (± 300 B.C.) was the first to propose that cognitive faculties were localized in the ventricles. Subsequently, Erasistratus (310 - 250 B.C.) postulated the localization of function within the substance of the brain itself. Galen (130 - 200 A.D.) isolated imagination to the 'Forebrain' and sensation to the 'Hindbrain'.

Research in the nineteenth century was initiated by Gall who described the difference between grey and white matter of the brain, and concluded that human 'faculties' are located in particular and strictly localized areas of the brain. According to Filskov and Boll (1981), Dax (1836) asserted that the dominant hemisphere's designations are derived from its role as the location for speech centres.

But the first scientific investigation of the disturbance of mental functions occurred in 1861 when Paul Broca isolated the posterior third of the left inferior frontal gyrus as the centre for the motor images of words, and that a lesion of the region leads to a loss of expressive speech termed aphasia (Luria, 1973; Golden and Vicente, 1983).

A decade later Broca's discovery was followed by Carl Wernicke's (1873) claim that he had isolated a centre for understanding speech, that is, the posterior third of the left superior temporal gyrus. By the 1880's localization of brain func-

tions had advanced so much, that certain writers, e.g., Munk (1881), Hitzig (1874), and Ferrier (1874, 1876) claimed that they were able to draw functional maps of the cerebral cortex.

During the 1870's, the concept of narrow localization was challenged by the English neurologist, Hughlings-Jackson. He maintained that the complexity of mental processes approached from the level of their construction was important, rather than their localization in particular areas of the brain. Hughlings-Jackson felt that behaviour was the result of interactions among all the areas of the brain. Even the simplest movement requires the full co-operation of all the levels of the nervous system, from the peripheral nerves and the spinal cord to the cerebral hemispheres (Golden, 1983).

However, Luria (1973) opposed the narrowed localizationist view of function, claiming instead that mental processes are mediated by functional systems located in the brain. His proposals are elaborated in the next section.

2.2 Luria's Theory of the Functional Organization of the Brain

2.2.1 The Three Principle Functional Units

Luria (1973) postulated that human mental processes are complex functional systems and that they are not localized in narrow, specialized areas of the brain. He proposed that they take place through the participation of groups of concertedly-working brain structures, each of which makes its own particular contribution to the organization of this functional system.

Therefore, Luria suggested the first task should be to discover the basic functional units from which the human brain is composed, and the role played by each of these in complex forms of mental activity.

Basically, there are three principle functional units of the brain, which are necessary for any type of mental activity. These are a unit for regulating tone on waking, a unit for obtaining, processing and storing information arriving from the outside world and a unit for programming, regulating and verifying mental activity (Luria, 1973). Man's mental processes in general, and his conscious activity in particular, always take place with the participation of all three units, each of which has its role to play in mental processes and makes its contribution to their performance.

A unique feature is that each basic unit itself is hierarchical in structure and consists of at least three cortical zones, assembled one above the other. In terms of this, the primary (projection) area receives impulses from or sends impulses to the periphery. The secondary (projection-association) area is involved with incoming information being processed. Finally, the tertiary (zones of overlapping) area, considered as the most recent system of the cerebral hemispheres to develop and which in man is responsible for the most complex forms of mental activity requiring the concerted participation of many cortical areas.

An examination and analysis of the structure and functional properties of each unit will be considered.

i) **The unit for regulating tone and waking mental states**

Luria (1973) asserts that for human mental processes to follow their correct course, the waking state is essential. Man can only receive and analyse information under optimal waking conditions. Therefore, optimal level of cortical tone is essential for the organized course of mental activity.

Hence, the arousal cortex follows a law of strength, that is, every strong stimulus evokes a strong response, while every weak stimulus evokes a weak response. The law of strength possesses several characteristics - a degree of concentration of nervous processes, a balance in the relationships between excitation and inhibition by the high mobility of the nervous processes, so that it is easy to change from one activity to another (Luria, 1973).

It is the above mentioned characteristics which disappear in sleep in the state preceding it, when cortical tone diminishes.

The first functional unit of the brain is found mainly in the brain stem (midbrain, pons and medulla), the diencephalon, and the medial regions of the cortex. The structure which was found to play an important role in regulating cortical tone is the reticular formation (Golden, 1981). The reticular formation lies at the core of the brainstem (Filskov & Boll, 1981). This structure contains both well-defined nuclear masses, and more diffuse collections of cells. It receives afferents from all sensory and motor pathways passing through the brainstem, and has output to both the forebrain and spinal cord.

The ascending output is necessary to maintain normal consciousness and to arouse a sleeping animal, i.e., to activate the cortex and regulate the state of its activity (Filskov and Boll, 1981; Luria, 1973). The descending output helps maintain motor tone. The cyclic motor activity of respiration is controlled by the reciprocal centres in the brainstem. Actions controlling primitive but complex sequence of behaviour such as coughing, vomiting reside in the brainstem.

Some of the fibres of the reticular formation run upwards to terminate in higher nervous structures such as the thalamus, caudate body, archicortex and, finally, the structures of the neocortex. These structures are called the Ascending Reticular System. The ascending reticular system plays a decisive role in activating the cortex and regulating the state of its activity (Luria, 1973).

On the other hand, fibres of the reticular formation which run in the opposite direction, that is, originate in higher nervous structures of the neocortex and run down to the brainstem are called the descending reticular system. The descending reticular system subordinates the lower structures of the mesencephalon, hypothalamus, and brainstem to the control of programmes arising in the cortex and requires modification and modulation of the state of waking

for its performance. With the discovery of the reticular formation, a new principle was introduced: 'The vertical organization of all structures of the brain' (Luria, 1973, p.46). Thus, Luria suggests that one salient feature of brain organization is its vertical nature (Luria, 1973).

The reticular activating formation is the most important part of the first functional unit of the brain, and it has been described as non-specific. Its activating and inhibitory action affects all sensory and all motor functions of the body equally, and its function is to regulate states of sleep and waking, that is, the non-specific background against which different forms of activity take place (Luria, 1973).

Therefore, the reticular formation of the brainstem is a powerful mechanism for maintaining cortical tone and regulating the functional state of the brain, and it also determines the level of wakefulness.

As previously mentioned, the nervous system always exhibits a certain tone of activity (level of cortical tone), and the maintenance of this tone is an important function of all biological activity. However, in some situations the level of cortical tone is insufficient and must be raised, accordingly. Such situations are referred to as the primary

sources of activation, and there are at least three principle sources of activation. The action of each of these sources is transmitted through the active reticular formation by its many parts.

(a) **Metabolic Processes of the Organism**
('Internal Economy')

Metabolic processes are involved in the maintenance of the internal equilibrium of the organism (Homeostasis). Digestive and respiratory processes are examples of simple reticular formation of the medulla and mesencephalon together with the hypothalamus play an important role in the simplest, but vital form of activation.

Furthermore, more complex forms of activation are connected with metabolic processes organized in certain inborn behavioural systems - commonly known as systems of instinctive food-getting and sexual behaviour. A common feature of the two subdivisions is that metabolic processes taking place in the body are the source of activation. On the other hand, the difference between the two subdivisions lies in the unequal complexity of their level of organization, i.e., the first, the more basic processes evoke only primitive, automatic responses connected with oxygen deficiency or the release of reserve substances from the organic depots in

starvation. The second is organized into complex behavioural systems, resulting in appropriate needs being satisfied and the necessary balance of the internal economy of the organism (Luria, 1973).

b) **Arrival of Stimuli from the Outside World**

According to Luria (1973) man lives in a world of constant incoming information and the need for this information is sometimes just as vital as the need for organic metabolism. Deprivation of a constant inflow of information, results in sleep and can lead to some form of mental behaviour, e.g., hallucination.

Since man lives in a constantly changing environment, he must be alert to any change and be able to mobilize himself to cope in any situation. This state of readiness is called the orienting reflex, and it also forms the basis for investigative activity (Luria, 1973).

Every response to a unique situation requires a comparison of the new stimulus with the old, previously encountered stimuli. Such a comparison alone can show whether a given stimulus is in fact unique and it must give rise to an orienting reflex, or, whether it is old and its appearance

requires no special mobilization of the organism. This process of comparison is termed habituation, and is closely linked to memory.

Many neurons of the hippocampus and caudate nucleus, which was thought to have no specific functions, are in fact responsible for comparing stimuli, reacting to the appearance of novel stimuli, and blocking their activity with the development of habituation to repeated stimuli (Luria, 1973).

c) Goal oriented/directed behaviour

Much of man's behaviour is evoked by intentions and plans which are social in origin, and are formed during man's conscious life, and are defined by the use of external and internal speech. Every plan formulated in speech defines a certain goal and formulates a plan of action to achieve that goal. Every time the goal is reached, the activity stops. If the goal is not attained, alternative strategies of behaviour must be developed (Luria, 1973).

The fulfillment of a plan or the achievement of a goal requires a certain amount of energy, and this is only possible if a certain level of activity can be maintained. When discussing the mechanisms of the working of the first

functional unit, much emphasis has been placed on the ascending connections of the activating reticular system. The descending connections exist from the prefrontal cortex to the nuclei of the thalamus and brainstem. The descending structures play an important role participating directly in the formation of intentions and plans, as well as modulating the lower systems of the reticular formation of the thalamus and brainstem, thereby making possible the most complex forms of conscious behaviour.

Lesions of the first functional unit lead to several disturbances, viz. akinetic state (tendency to become fatigued rapidly), depressed emotional tone marked by indifference. But defects of memory are the most obvious symptoms.

The systems of the first functional unit not only maintain cortical tone, but also experience the differentiating influence of the cortex, and the first functional unit does not function in isolation, but in conjunction with the higher levels of the cortex.

Finally, the first functional unit of the brain plays a vital role in the regulation of the state of cortical activity and the level of alertness.

(ii) The unit for receiving, analysing and storing information

The second functional unit of the brain consists of parts possessing high modal specificity, that is, its component parts are adapted to the reception of visual, auditory, vestibular, or general sensory information. Also, the systems of this unit incorporate the central systems of gustatory and olfactory reception.

The primary function of the second functional unit is the reception, analysis and storage of information. The second functional unit is located in the lateral regions of the neocortex on the convex surface of the hemispheres, that is, the posterior regions. These regions include the visual (Occipital), auditory (Temporal), and general sensory (Parietal) regions (Luria, 1973).

Historically, this unit does not consist of a continuous nerve net, but of isolated neurons which lie in the parts of the cortex. Also, unlike the systems of the first unit, it does not work in accordance with the principle of gradual changes but rather the 'All or nothing' rule (Luria, 1973), that is, by receiving discrete impulses and relaying them to other groups of neurons.

The functions of this unit are to receive stimuli travelling to the brain via the peripheral receptors, to analyse these stimuli into a very large number of very small component elements, and finally combine these into the required dynamic functional structures, that is, the synthesis into whole functional systems.

Each of the systems of the second functional unit has a hierarchical organization:

a) A primary zone that sorts and records sensory information.

b) Secondary zone that organizes the information and codes it.

c) Tertiary zone where the information from different sources overlap and are combined to form the foundation for the organization of behaviour (Luria, 1973), that is, by receiving discrete impulses and relaying them to other groups of neurons.

The primary zones (projection areas) form the basis for the reception of stimuli form the environment and are surrounded by the systems of the secondary cortical zones. Also, all regions of the cortex constituting the second

functional unit of the brain are hierarchical in structure, so that specific sensory inputs are arranged systematically in the cortex.

In this way sensory information from different parts of the body are projected to particular sensory cortical areas, e.g., auditory tones are projected to specific areas of the auditory cortex (Luria, 1973; Walsh, 1978).

The following primary areas are represented in the cortex: the primary visual cortex (occipital), the primary auditory cortex (temporal), and the primary general sensory cortex (parietal).

The secondary zones lie above the primary zones. Similarly to the secondary zones of the visual and auditory cortex, these areas consist mainly of associative neurons of layers II and III, and their stimulation leads to the appearance of more complex forms of cutaneous and kinesthetic sensation.

The principle modally-specific zones of the second functional system, are built in accordance with hierarchical organization, which applies equally to all these zones, each of which must be regarded as the central, cortical apparatus of a modally-specific analyser (Luria, 1973).

The secondary zones are adapted for the reception, analysis and the storage of information arriving from the outside world, that is, the cerebral mechanisms of modally-specific forms of gnostic processes.

Human gnostic activity never takes place in isolation with a single modality (vision, hearing, touch), but rather the perception and representation of any object is a complex procedure, the result of many types of activities (polymodal), firstly, expanded in character, but later concentrated and condensed. Therefore, it relies on the combined working of a complete system of cortical zones.

The tertiary zones, commonly called the zones of overlapping of the cortical ends of the various analysers, are responsible for enabling groups of several analysers to work together.

These zones of overlapping lie on the boundary between the occipital, temporal, and post-central cortex. The greater part is formed by the inferior parietal region, which has developed to a considerable size in man, that is, just about one quarter of the total mass of the tertiary

zones. Therefore, one can conclude by stating that the tertiary zones or the posterior associative centre are specifically human structures (Luria, 1973).

The tertiary zones of the posterior regions of the brain are made up almost entirely of cells of the associative layers II and III of the cortex, and their main function is the integration of excitation arriving from different analysers. Majority of the neurons in these zones are multimodal in nature and they respond to general features, e.g., spatial arrangement, the number of components, to which neurons of the primary and even the secondary cortical zones are unable to respond.

The tertiary structures of the posterior zones of the cortex include Brodmann's areas 5, 7, 39 and 40, that is, the superior and inferior zones of the parietal region and temporal areas of the temporo-occipital region.

The most important function of the tertiary zones is connected with the spatial organization of discrete impulses of excitation entering the various regions and with the conversion of successive stimuli into simultaneously processed groups (Luria, 1973).

Therefore, the tertiary zones of the posterior cortical regions are essential not only for successful integration of information reaching man through his visual system, but also for the transition from direct visually represented syntheses to the level of symbolic processes. The tertiary zones of the posterior cortical region play a vital role in the conversion of concrete perception into abstract thinking, which takes place in the form of internal schemes and for the memorising of organized experience, that is, not only for the reception and coding of information, but also for storage.

(a) Law of the Hierarchical Structure of the Cortical Zones

Relationships between the primary, secondary and tertiary cortical zones are responsible for increasingly complex synthesis of incoming information. The relationships between the primary, secondary and tertiary cortical zones do not remain the same, but change in the course of ontogenetic development.

In the young child the formation of properly working secondary zones could not take place without the integrity of the primary zones which forms the base, and proper working of the tertiary zones would not be possible without ade-

quate development of the secondary cortical zones which supply the necessary material for the creation of major cognitive syntheses (Luria, 1973).

Thus, a disturbance of the lower zones of the cortex in infancy leads to incomplete development of the higher cortical zones. Vygotsky (1956, 1960), stated that the matrix line of interaction between cortical zones runs 'from below upward' (Luria, 1973, p. 74).

On the other hand, in the adult person with his fully developed higher psychological functions, the higher cortical zones assume the dominant role. When an adult perceives the world around him, he codes (organizes) his impressions into logical systems, fits them into certain schemes -- the highest, tertiary zones of the cortex control the work of the secondary zones. If the secondary zones are affected by a pathological lesion, the tertiary zones have a compensatory influence. Finally, the work of the adult human cerebral cortex reveals not so much the dependence of the higher zones on the lower as the opposite, that is, dependence of the lower (modally specific) zones on the higher.

The hierarchical principle of the working of individual zones of the second brain unit is the first fundamental law which provides a clue to its functional organization.

(b) **Law of Diminishing Specificity of the Hierarchically Arranged Cortical Zones Composing It**

The primary zones of each part of the cortex possess maximal modal specificity. This property is a feature both of the primary areas of the visual (occipital) cortex, and of the primary areas of auditory (temporal) or the general sensory (postcentral) cortex.

The secondary cortical areas possess modal specificity to a much lesser degree. These areas are called projection-association areas, because they retain their modally specific gnostic function, integrating in some cases visual (secondary occipital areas), auditory (secondary temporal areas), and tactile (secondary parietal areas) information.

The law of diminishing specificity is another aspect of hierarchical structure of individual cortical areas forming the second brain system and responsible for the transition

from discrete reflection of particular modally-specific cues to the integrated reflection of more general and abstract schemes of the perceived world.

Finally, the primary cortical zones are characterized by the highest modal specificity. The secondary and tertiary cortical zones with their predominance of multimodal and associative neurons, possess higher functional properties than the primary cortical zones. Despite the diminishing specificity, these zones are capable of playing an organizing integrative role in the work of the more specific areas.

(c) **LAW of the Progressive Lateralization of functions**

The law of lateralization implies a transfer of function from the primary cortical areas to the secondary cortical area, and finally to the tertiary areas.

The primary cortical areas of both cerebral hemispheres have identical roles. Also, there is no question of any dominance of the primary areas of either hemispheres. But the situation differs with regard to the secondary and further more, the tertiary areas. With the emergence of speech, some sort of laterization of functions took place,

found only in man (not in animals), and thus has become an important principle of the functional organization of the brain.

The left hemisphere (right-handed persons) is dominant and it is responsible for speech functions, whereas the right-hemisphere is subordinate. Therefore, this principle of lateralization of functions has become an important principle of the functional organization of the cerebral cortex.

The left (dominant) hemisphere (in right handers) plays an important role not only in the cerebral organization of speech, but also in the cerebral organization of all higher forms of cognitive activity connected with speech - perception organized into logical schemes, active verbal memory and logical thought. The right (non-dominant) hemisphere has a dual function, that is, plays a subordinate role in the cerebal organization.

The function of lateralization of higher functions in the cerebral cortex operates only with the transition to the secondary, and in particular, to the tertiary zones which are concerned with the coding of information reaching the cortex, and performed in man with the aid of speech.

Therefore, the functions of the secondary and tertiary zones of the left (dominant) hemisphere start to differ radically from functions of the secondary and tertiary zones of the right (non-dominant) hemisphere. Hence, the great majority of symptoms of disturbance of higher psychological processes in patients with local brain lesions refer to symptoms as a result of lesions in the secondary and tertiary zones of the left (dominant) hemisphere, yet lesions of the same zones in the right (non-dominant) hemisphere have received less emphasis (Luria, 1973).

Finally, it must be remembered that the linguistic dominance of one (the left) hemisphere is not always possible, and the law of lateralization is only relative in character.

According to Zangwill (1960) and Subirana (1969), only one quarter of all persons are completely right-handed, and slightly more than one-third show absolute dominance of the left-hemisphere, whereas the rest are distinguished by slight dominance of the left-hemisphere, and in one-tenth of all cases dominance of the left-hemisphere is totally absent.

The second functional system of the cerebral cortex is a system for the reception, coding and storage of information. It is located in the posterior divisions of the cerebral hemisphere and it incorporates auditory (temporal), general sensory (parietal) and visual (occipital) regions of the cortex.

The organization of the structures forming the second unit, that is the unit for receiving, analyzing and storing information is hierarchical in nature. These units are sub-divided into primary (projection) areas, receiving the corresponding information and analyzing it into its elementary components, secondary (projection-association) areas, responsible for the coding (synthesis) of these elements and converting somatotopical projections into functional organization, and the tertiary (zones of overlapping) areas, responsible for the working of the various analysers and the production of symbolic schemes, the basis for complex forms or gnostic activity.

The hierarchically organized zones of the cortex constituting systems of the second brain unit, work according to the principle of diminishing modal specificity and increasing functional lateralization. These two principles are responsible for the brain carrying out its most complex forms of activity, that is, the basis of human cognitive ac-

tivity, linked by its origin with work and structurally with the participation of speech in the organization of mental processes.

(iii) **The Unit for Programming, Regulation and Verification of Activity**

The reception, coding and storage of information constitute only one aspect of human cognitive processes (Luria, 1973). Another function is the organization of conscious activity. This function is linked with the third functional system of the brain, responsible for programming, regulation and verification of behaviour.

Man not only reacts passively to incoming information, but creates intentions, that is, forms plans and programmes and regulates his behaviour so that it conforms to these plans and programmes. Finally, he verifies his conscious activity, comparing the effects of his actions with the original intentions and rectifying any mistakes he has made (Luria, 1973).

The structures of the third functional unit, that is, the system for programming, regulation and verification are located in the anterior regions of the hemispheres, anterior to the precentral gyrus.

The outlet channel for this unit is the motor cortex (Brodmann's area 4). The motor projection cortex cannot work in isolation. All of a person's movements require, to some extent, a tonic background provided by the basal motor ganglia and the fibres of the extra-pyramidal system. This system is important because it ensures a plastic background for all voluntary movements.

The primary (projection) motor cortex is the only outlet channel for motor impulses, as Bernstein concluded, 'the anterior horns of the brain' (Luria, 1973). The motor impulses which it sends to the periphery must be well prepared and incorporated into certain programmes, and thereafter only can impulses be sent out through the precentral gyrus, which then gives rise to the necessary purposive movements. The preparation of the motor impulses cannot be undertaken by the pyramidal cells only. It must be carried out both in the structures of the precentral gyrus, and also in those structures of the secondary areas of the motor cortex, which prepare the motor programmes and then transmit them to the giant pyramidal cells. Within the precentral gyrus itself, the structure responsible for preparation of motor programmes for transmission to giant pyramidal cells includes the upper layers of the cortex and the extracellular grey matter.

However, the precentral gyrus is only a projection area, an effector apparatus of the cortex. The secondary and tertiary zones play a decisive role in the preparation of the motor impulses, governed by the same principles of hierarchical organization and diminishing specificity, which govern the functional organization of the system for reception, coding and storage of information. An important difference is that in the second, afferent system of the brain the processes go from the primary to the secondary and then to the tertiary zones. In the third unit the process starts at the highest levels of the tertiary and secondary zones where the motor plans and programmes are formed and then pass through the structures of the primary motor area, which sends the prepared motor impulses to the periphery.

The second feature distinguishing the work of the third, efferent unit of the cortex from that of the second afferent unit is that the unit itself does not contain a number of different modally-specific zones representing individual analysers, but consists entirely of systems of efferent, motor type, and is itself under the constant influence of structures of the afferent unit.

The function of the principle secondary zone of the third unit is conducted by the premotor areas of the frontal region. The secondary zone adheres to the same vertical type of situation

characteristic of the motor cortex. Therefore, the premotor areas can be classified among the secondary divisions of the cortex and they play the same organizing role with respect to movements as is played by the secondary zones of the cortex.

The most important part of the third functional unit of the brain is the frontal lobes. The prefrontal divisions of the brain are particularly significant because they do not contain pyramidal cells and are known as the granular frontal cortex. These areas of the tertiary zones of the cortex play a decisive role in the formation of intentions and programmes, and in the regulation and verification of the most complex forms of human behaviour. The prefrontal region of the brain has many connections both with lower levels of the brain (the medial, ventral and pulvinar nuclei of the thalamus, and with other structures), and with all other parts of the cortex. These connections are two-way in character. The prefrontal divisions of the cortical structures are in a favourable position both for the reception and synthesis of the complex system of afferent impulses arriving from all parts of the brain and for the organization of efferent impulses.

The prefrontal cortex plays a vital role in regulating the state of mental activity, changing in accordance with man's complex intentions and plans formulated with the aid of speech. The role of the frontal lobes in the regulation of states of mental

activity which is the background for behaviour, is one of the most important ways in which the prefrontal regions of the brain participate in the organization of human behaviour. It must be remembered that the prefrontal regions of the cortex do not mature until very late in ontogeny. These regions of the brain undergo powerful development in the later stages of evolution, and in man, occupy one-quarter of the total mass of the brain. The tertiary portions of the frontal lobes are in fact a superstructure above all other parts of the cerebral cortex, and they perform a more general integrative and inhibitory function of general regulation of behaviour.

Research has shown that destruction of the prefrontal cortex leads to a profound disturbance of complex behavioural programmes and a distinct disinhibition of immediate responses to irrelevant stimuli thereby making the performance of complex behaviour programmes impossible.

It can be concluded that the frontal lobes of the brain are important structures responsible for the orientation of an animal's behaviour not only to the present, but also to the future, and they are also responsible for the most complex forms of active behaviour. A number of research findings show that the most complex forms of action are associated with the frontal lobes which not only perform the function of synthesis of external stimuli, preparation for action, and formation of programmes,

but also the function of allowing for the effect of the action carried out and the verification that it has taken the proper course. An important distinguishing feature of the regulation of human conscious activity is that this regulation takes place with the close participation of speech.

Although the simplest forms of behaviour can take place without the aid of speech, higher mental processes are formed and take place on the basis of speech activity which is predominant in the early stages of development, but later becomes overlearned or automatized (Vygotsky, 1956; 1960).

Therefore, it is obvious to seek the programming, regulation and verifying action of the human brain in the forms of conscious activity whose regulation takes place through the intimate participation of speech.

INTERACTION BETWEEN THE THREE PRINCIPLE FUNCTIONAL UNITS OF THE BRAIN

It would be a mistake to imagine that the three principle functional units carry out a certain form of activity completely independently, e.g., that the second functional unit is entirely responsible for the function of perception and thought, while the third is responsible for the function of movement and for the construction of action. But this is untrue, since each form of

conscious activity is always a complex functional system and takes place through the combined working of all three brain units.

Therefore, it can be concluded that perception takes place through the combined action of all three functional units of the brain. The first provides the necessary cortical tone, the second carries out the analysis and synthesis of incoming information, and the third provides for the necessary controlled searching movements which give perceptual activity its active character. Also, voluntary movement and more especially, manipulations of objects are based on the combined working of different parts of the brain. The first brain unit supplies the necessary muscle tone, without which coordinated movements would be impossible. The second unit provides the afferent syntheses within which the framework of movement takes place. The third unit subordinates the movement and action to the corresponding plans, produces the programmes for the performance of motor actions, and provides the necessary regulation and checking of the course of the movements without which their organized and purposive character would be lost.

Thus, Luria's neuropsychological method involves several stages. Firstly, in order to identify a lesion in a functional system, it is necessary to discover what factors are involved in a particular mental activity. Second, the structures in the

brain constituting the neuronal basis of the activity are identified. Thirdly, the identification of a particular symptom leads to a hypothesis about its location in the brain.

Also, single factors may be common to several different activities. Therefore, each system containing a deficient factor will be identified. Thus, the principle of 'double dissociation' (Luria, 1973) allows for the identification of symptoms which may then be traced to a common lesion.

Finally, the three functional units of the brain, do not work in isolation.

As Luria postulates (1973, p. 99).

'Each form of conscious activity is always a complex functional system and takes place through the combined working of all three brain units, each of which makes its own contribution'.

CHAPTER THREE

3. LITERATURE REVIEW

A survey of the literature reveals that several studies investigating issues related to the Luria-Nebraska Neurological Battery have been performed. However, the thesis aims specifically to look at the influence of age, sex, and socio-economic status on performance on the LNNB. Therefore, the literature review will aim to include articles concerned with these variables. All other studies concerning the LNNB will be cited in the body of the thesis, where relevant.

In the first study on the LNNB, Golden, Hammeke, and Purish (1978) examined the diagnostic efficiency of the test items in discriminating between normal and brain-damaged patients. The diagnoses of the brain-injured patients in this study were normally supported by the computerized axial tomography scan, electroencephalogram, angiogram, skull X-rays, neurological history, pneumoencephalogram, and/or surgery. The computerized axial tomography scan was the most frequently used technique (60 percent of the patients).

The neurological group in this study comprised 50 patients, 23 females and 27 males. The group consisted of 15 left hemisphere, 15 right hemisphere, and 20 diffuse brain injury patients. The average age of the neurological patients was 44.3 years (S.D. = 18.8 years). In addition, the average level of education was 10.3 years (S.D. = 2.8 years).

The control group consisted of 50 patients, 26 females and 24 males, who were hospitalized for a variety of medical problems, viz., back injuries, infectious diseases, and chronic pain. The average age of the control patients was 42.0 years (S.D. = 14.8 years). The authors found no significant differences between the control and neurological patients for age and sex, although the two groups did differ significantly with regard to education {t (98) = 3.51, $p < .01$}.

Of the 285 items (original battery) on the Luria-Nebraska Neuropsychological Battery, 253 were found to discriminate significantly at the .05 level. On 32 items which failed to show significance, the neurological group performed poorly on 30 items and showed identical performance with the control group on two items only. Application of 30

of these items in a discriminant analysis classified the 50 brain-damaged and 50 normal controls with 100 percent accuracy.

In this study, the 30 items that discriminated between the brain-damaged and normal controls with 100 percent accuracy were not specified, and their selection was not fully motivated. The 30 select items represents approximately ten percent of the Luria-Nebraska Neuropsychological Battery, which could be misleading to the overall effect of the whole battery which was the focus of the study.

In an effort to cross-validate the results of the initial study, Moses and Golden (1979) compared a sample of 50 neurological and 50 control patients on the standardized Luria-Nebraska Neuropsychological Battery. The neurological sample consisted of cerebral trauma, neoplasm, infectious disease, cerebral vascular disorder, degenerative disease, epilepsy, metabolic and toxic disorder cases. Neurological diagnostic methods included the computerized axial tomography scan, encephalogrm, pneumoencephalogram, angiogram, and skull films.

The control patients were hospitalized in non-neurological, orthopedic, or internal medicine ward with disorders that did not affect brain functioning. Patients with spinal cord injuries were also included.

The average age of the combined samples was 43.8 years, with the average level of education being 11.3 years. The neurological group comprised forty-four males and six females, while the control group comprised forty-one males and nine females.

The authors found no significant differences between the experimental and control groups with respect to age, education, or sex distribution. An interesting finding was that the results obtained in this study were identical to the results reported in the original study by Golden, Hammeke, and Purisch (1978).

Moses and Golden (1979) defined hit rates as the standard of comparison employed by Golden et al. (1978). This criterion referred to how well the Luria Nebraska Neuropsychological Battery discriminated between diagnostically different groups. This discrimination applies to psychiatric and neurological patients (Lezak, 1983). Hit

rates ranging from 62 to 80 percent for the brain-injured group and from 72 to 98% for the control group were reported.

As in the study by Golden et al. (1978), this study used a neurological group reflecting a heterogeneity in neurological disease profiles. This variable could have affected the performances on the Luria-Nebraska Neuropsychological Battery since it is known that the neuropathological processes differ in the various neurological diseases.

Also sex was poorly controlled in the study. There was an unequal distribution of sex since the ratio of female to male was 3:17 (15 female and 85 male). Although Moses and Golden (1979) found no statistically significant difference between the groups in sex distribution, the influence of the unequal sex ratio on the performance of the neurological and control groups, respectively, is unknown and warrants further investigation.

Moses and Golden (1980) replicated the results of the original study (Purisch, Golden and Hammeke, 1978), that compared schizophrenic and neurological patients. The authors used the same neurological sample described in the Moses and Golden (1979) study, and, in addition, they ob-

tained a sample of 50 schizophrenic patients. The schizophrenic sample consisted of the following diagnostic types, viz., paranoid schizophrenia (N = 20), undifferentiated schizophrenia (N = 23), simple schizophrenia (N = 4), and schizo-affective disorders (N = 3).

The results of this study were quite similar to those of the original study. The authors used the cut-off scores determined by Purisch, Golden, and Hammeke (1978), and found the cross-validation results of eight of the 13 scales (previously writing and reading subscales were combined) to be slightly improved over the original study, while the results of the other five scales were slightly reduced in differentiating the groups. Overall, the cross-validation study yielded a hit rate of 87 percent compared with the 88 percent of the Purisch, Golden and Hammeke (1978) study. Also, all schizophrenics included in this study had normal eletroencephalograms and normal physical neurological examinations.

No significant differences were obtained between the groups with respect to mean age, education, or sex distribution. There was a significant difference between the samples for illness chronicity, with the psychiatric group

demonstrating significantly more chronic symptomatology. It is possible that this variable could have influenced the findings of this study.

Golden, Moses, and Graber (1980), performed a differential diagnostic comparison of ventricular brain ratio (VBR), among four groups of subjects. Fifty normal controls with at least average intelligence, 30 nonpsychotic psychiatric patients with personality or neurotic disorders, 50 chronic schizophrenics and 40 chronic alcoholics comprised the study groups. Within the schizophrenic subgroup there was a multiple correlation of .72 between the ventricular brain ratio and the Luria-Nebraska Neuropsychological Battery measures. The ventricular brain ratio values for the normal and mixed nonpsychotic psychiatric groups were comparable. The chronic alcoholic group had significantly greater ventricular brain ratio values than the normal and mixed non-psychotic psychiatric groups. The chronic schizophrenics had significantly larger cerebral ventricular size as measured by ventricular brain ratio than all of the other three groups.

In this study, the control group of 50 had at least average intelligence. The authors do not mention exactly the subjects average intelligence scores. No secondary or

tertiary educational data are cited. Age, sex and socio-economic status were not controlled in this study and these variables could have influenced the findings in this study.

Malloy and Webster (1981) investigated the ability of the Luria-Nebraska Neuro-psychological Battery scores to discriminate between three study samples. One group consisted of 'pseudoneurologic' cases with suspected cognitive deficit. A second group comprised 'borderline' impaired cases with negative neurological and computerized tomography (C.T.) head scan results but with positive encephalogram findings. A third group consisted of definite brain damaged patients with positive findings on all of the medical diagnostic measures.

The three groups were matched for age and educational level. On the Luria-Nebraska Neuropsychological Battery, a brain damage performance was actuarially defined as three or more scales exceeding critical level values.

The authors found that the Luria-Nebraska Neuro-psychological Battery was able to improve significantly upon the base rate for identification of brain dysfunction. They found that false positive (25 percent) and false negative (21 percent) rates were within clinically acceptable limits for diagnostic discrimination with these criterion groups.

The overall correct classification rate for the three samples was 80 percent. The borderline and brain damaged groups performed very similarly. This suggests that the Luria-Nebraska Neuro-psychological Battery did not discriminate very well between these groups.

Sex was not controlled in this study and it could have influenced the findings. Also, the definition of borderline is not clear thus making it difficult to interpret the failure of the analysis to discriminate between borderline and brain damaged groups.

De Obaldia, Leber, and Parsons (1981) studied a group of 30 male alcoholics. Fifteen of these subjects were recently abstinent (2-3 weeks) from ethanol and 15 of them had been abstinent for a prolonged period (10-12 weeks) at the time of testing. A control group of 15 normal, healthy volunteers provided the comparisons. The three groups were compared scalewise on the Luria Nebraska Neuropsychological Battery measures with a series of one-way analyses of variance. The groups were compared pairwise using t-tests for each of the Luria Nebraska Neuropsychological Battery scales thereafter. Both alcoholic groups showed more cognitive deficit than did the control group on all measures except the C8 (reading) scale, but the alcohol groups did not

differ from each other. The alcoholic groups showed a mild, consistent performance level deficit relative to the controls.

The alcoholic and control groups were separated by a full standard deviation on the S1 (Pathognomonic) scale, suggesting that the results on this key measure alone show significant group differences. To hypothesize alcoholic cognitive deficit on key measures relative to control group performance is reasonable.

This overall performance level pattern obtained by De Obaldi et al. (1981) is a finding that appears to be reproducible over studies, although to date, samples have been small, and subject-to-variable ratios have been inadequate.

Notwithstanding the importance of the findings in this study, sex was controlled in both the alcoholic groups, that is, all the experimental subjects were male, but the sex of the control group was not mentioned and this variable could have affected the final results. Also, the ages of the subjects were not controlled and could have confounded the results obtained.

Golden, Moses, Graber and Berg (1981) conducted a study to develop and validate objective rules for interpreting the Luria-Nebraska Neuropsychological Battery. This study was designed to assist in establishing an objective system for the interpretation of the Luria-Nebraska Neuropsychological Battery. The initial goal was to test several hypotheses. Firstly, in normal individuals, the average score on the Luria-Nebraska Neuropsychological Battery should be significantly predicted by demographic factors. Second, in normal individuals, few scores exceed the predicted average score plus 10 points (this score is called the critical level). Third, in a patient with neurological problems, many scores should exceed the critical level. Therefore, the authors contended that the critical level could act as an individualized cutoff point, identifying normal and abnormal scores in the patient's profile. From the results of these analyses, a set of rules could be distinguished to maximize discrimination of normal from neurological patients in terms of the deviation of their performance from their critical level.

The first analysis found a .74 multiple correlation between age and education with the average Luria-Nebraska Neuropsychological Battery score in 60 normal subjects. Also, less than one score per patient was over a cutoff of the predicted average plus 10 points. The second analysis

found that 60 neurological patients had an average of 8.3 scores over a similar cutoff. The third analysis was a comparative study. The sample comprised 60 normal control and 60 brain damaged patients. The average age of the normal controls was 43.2 years (S.D. = 15.4), with a mean of 13.0 years of education (S.D. = 2.9). On the otherhand, the average age of the neurological patients was 43.6 years (S.D. = 13.8) with a mean educational level of 12.6 years.

The neurological group included Cerebrovascular disorder, closed head trauma, neoplasm, laceration, abscess, and degenerative disease patients. The neurological group was tested an average of 19.3 months (S.D. = 10.2) after onset of the symptoms of the disease. Also, none of these subjects had participated in previous published studies by the authors.

Golden et al. (1981) found an average of 1.2 (S.D. - 1.8) scores above the critical level in the control group, whereas 7.5 (S.D. = 3.9) scores exceeded the critical level in the neurological group. The difference between the groups on this measure was found to be significant ($t(118) = 11.36$, $p \leq 0.0001$). Also, 51 out of 60 (85 percent) of the neurological patients were correctly classified, and 50 out of 60 (83 percent) of the normal controls were correctly classified, a total hit rate of 101 out of 120 (84 percent).

Generally, the analyses found that the average score of the Luria-Nebraska Neuropsychological Battery among normal subjects appears to be predictable by age and education. In addition, it was found that normal patients tended to have few, if any, scores above their critical level, whereas neurological patients tend to have significantly more elevated scores. Different scales did not show any statistically significant tendency to misdiagnose normals, (with a range of 3.3 percent to 20 percent error across scales being reported).

Several issues emanating from this study are noteworthy. Firstly, in most cases, the patients in this study were Caucasians from middle - to - lower class backgrounds. There is a possibility that socio-economic status could have affected the results. Thus, the authors, Golden et al. (1981) emphasize that similar studies should be conducted in other populations to establish applicable procedures and hit rates. Secondly, the authors suggest that other methods of interpretation should be used, e.g., profile interpretation, localization scales, qualitative evaluation of item patterns, and presence of specific pathognomonic signs. Third, sex was not controlled in this study and it could have affected the final results. Fourth, errors could be made in overestimating appropriate educational level, particularly

among those with little formal training. Also, underestimating education amongst those who were self-taught is a methodological concern.

Burkhart (1982) studied a mixed neuropsychiatric medical control sample of 98 subjects. He used correlational techniques to assess the multivariate relationship of the 14 Luria Nebraska Neuropsychological Battery variables to the WAIS Full Scale I.Q. score. He studied subsamples of his subjects (brain-damaged versus control; brain damaged versus psychiatric) and found highly significant relationships between the Luria Nebraska Neuropsychological Battery clinical and summary scales and the WAIS Full Scale I.Q., respectively. The author attempted to conclude that I.Q. predicted Luria Nebraska Neuropsychological Battery performance level independent of disorder type.

A criticism of this study is that Burkhart's (1982) analyses were seriously compromised by an insufficient subject - to - variable ratio. The exact subject distribution among the various conditions is not reported. The author attempted to use four covariates (sex, age, educational level, and diagnosis) in regression analyses, to control for all relevant variables of interest, further compromising analyses. This does not appear to be justifiable because of the small sample sizes used in the study.

Golden, Berg and Graber (1982) evaluated the test-retest reliability of the Luria-Nebraska Neuropsychological Battery. The sample consisted of twenty-seven patients with evidence of long-standing brain disorders who scored in the moderately impaired range on the Luria-Nebraska Neuropsycho-logical Battery (scores above 50 but below 80) on initial testing. Tests were repeated after an average interval of 167 days (S.D. = 133,8). The final study sample consisted of 14 males and 13 females averaging 35,3 years (S.D. = 11,2) of age. Also, the average educational level was 11,3 years (S.D. = 2,2). In addition, all patients had been judged as having chronic, unchanging organic conditions, as well as significant problems in living, which resulted in at least two hospitilizations.

Test - retest correlations ranged from .77 to .96, averaging .88 over the 14 Luria-Nebraska Neuropsychological Battery scales. All correlations were significant at the .0001 level.

The authors concluded that the results confirm that the scores on the LNNB are stable over time. Also, the lowest test-retest reliability of .77 is well within acceptable clinical limits. The authors emphasize, however, that further replication of such results, as well as expansion to

other scales of the test, are necessary. It is noteworthy to point out that the specific brain disorders afflicting patients were not indicated in the study. This factor limits the extent to which generalizations can be made about specific pathological subgroups.

Spitzform (1982) questioned the utility of the Luria-Nebraska Neuropsychological Battery in an aged population by studying a normal, elderly sample. He also explored the discrimination of normal from brain-impaired subjects by using hit rates as described by Moses and Golden (1979).

Fourteen subjects over the age of 65 were recruited to this study. All subjects completed the entire Luria-Nebraska Neuropsychological Battery. Critical levels for the Luria-Nebraska Neuropsychological Battery were calculated on the basis of age and education corrections given in the manual (Golden, Hammeke and Purisch, 1980). All subjects were interviewed to obtain demographic information, activity level, and medical history, including previous hospitalizations, current medications, and outpatient mental health treatment.

The 14 subjects comprised thirteen females and one male, with ages ranging from 65 to 83 years. The mean age was 71.4 years and the standard deviation 4.8. The level of educa-

tion ranged from two years of high school to three years of college with a mean of 11.92 years of schooling (S.D. = 1.2). Nearly all subjects had an active involvement in community and senior-citizen activities.

As expected in a sample of this age, the interview revealed numerous reports of medical hospitalizations and many prescription medications, e.g., undiagnosed falls and black-outs, heart attacks, cardiac arrests, strokes, high blood pressure and arthritis. The Luria-Nebraska Neuropsychological Battery summary scale scores for the 14 subjects were evaluated using the recommended objective rules of Golden et al. (1980). Specifically, profiles with more than one scale score above the critical level for that subject were classified as impaired. Only one subject was classified in the impaired range, with a total of five scale scores exceeding the critical level. This subject classified was considered one of two subjects with likely neuropsychological deficits on the basis of their medical history.

Finally, the mean Luria-Nebraska Neuropsychological Battery scale scores for the thirteen remaining subjects which included the male, fell in the nonimpaired range. A mean age of 71.8 years (S.D. = 4.9) and mean level of education of 12.1 years (S.D. = 1.1) was reported. Thus, using medi-

cal history as the criterion, the Luria-Nebraska Neuropsychological Battery correctly identified all twelve normal individuals and one out of two was judged to be impaired. Thus, 13 out of 14 subjects were correctly classified, with a hit rate of 93 percent for this sample.

Several methodological criticisms may be cited with respect to this study. The sample was too small (N = 14), and the results could have been biased because of the specific recruitment criteria. The unequal distribution of females to males, that is, 13 : 1 respectively, could have affected the final results of this study. The results are likely to reflect a female performance. There is doubt created with the classification of one subject with likely neuropsychological involvement on the basis of medical history data, while more objective measures of brain impairment such as computerized axial tomography scans would have been preferred. It could be hypothesized that the sample of normal elderly individuals had special characteristics, viz., above-average intelligence, income greater that 7000 dollars yearly, and numerous weekly activities outside the home (activities not specific). Therefore, it is clear that this sample is not representative of all individuals over 65. Thus, we can conclude that the performance of these subjects

on the Luria-Nebraska Neuropsychological Battery was noteworthy in that age alone was not associated with higher scale scores.

Although the sample is not representative of the population from which it was drawn, it is surprising that the motor scale mean (X = 11,8) was below that of the original Golden et al. (1980) control group (x = 19,2). It has been commonly cited that motor speed deteriorates with increasing age. (Golden, 1980). But the unusually high level of out-of-home activity in this sample could have affected this finding.

Finally, although the hit rate demonstrated by the Luria-Nebraska Neuropsychological Battery on this sample of normal elderly subjects (controlled for age and education) was high, further research with this instrument in an elderly population will provide additional data which can serve to clarify and amplify the above findings.

Moses, Cardellino, and Thompson (1983), investigated the discriminability of a mixed group of fifty schizophrenic and schizoaffective disorder subjects diagnosed according to DSM - III Criteria (American Psychiatric Association, 1980), from a mixed neurologically impaired group (N = 51). The two groups were matched for age and educational level. A

series of discriminant analyses illustrated that the two groups were differentiated on an overall performance level. The pathognomonic scale (S1) alone was able to distinguish between the groups. Classification hit rates ranged from 81 percent with all 14 Luria-Nebraska Neuropsychological Battery variables included, and 78 percent with pathognomonic Scale (S1) alone.

In addition, a post-hoc analysis showed that educational level was a powerful predictor of performance level among chronic schizophrenic and schizoaffective disorder patients. In particular, it appeared that failure to complete high school predicted considerably more cognitive impairment across the Luria-Nebraska Neuropsychological Battery measures than was the case with subjects who had completed a year at college (Moses & Maruish, 2/1988).

Methodological shortcomings of this study include a failure to control or report sex as a variable. Also, a control group of normal individuals would have provided a good comparison group but was not considered in this study.

Rogalski, Val, Prasad, and Weiler (1985) administered the Luria Nebraska Neuropsychological Battery to a sample of 20 patients with the diagnosis of borderline personality syndrome. The authors made use of the Gunderson's

psychoanalytic formulation of the syndrome as a diagnostic criterion rather than the standardised, objectively-defined DSM-III-R criteria for Borderline Personality Disorder (American Psychiatric Association, 1987). Although the diagnostic criteria used in this study were operationally ambiguous, it was interesting to note that the group of Borderline Syndrome Patients revealed a low-lying Luria Nebraska Neuropsychological Battery profile. The males showed slightly more deficit than the females on scalewise group plots of the data, but the cross-sex differences were not statistically significant. Both sexes scored very near to the 40 T-Score level overall. There was very little cognitive deficit of significance amongst these subjects.

A major shortcoming in this study was that age was not a controlled variable, and it could have affected the final scores on the Luria Nebraska Neuropsychological Battery. Also the final study sample was too small (N = 20) and a bigger study sample was recommended for future research.

Swendseid (1985) extended previous aging research with the Luria Nebraska Neuropsychological Battery to examine the effects of age and nonneurologic physical illness on the Luria Nebraska Neuropsychological Battery performance level patterns. She studied young and elderly (over age 70) subjects in physically ill and optimally healthy groups respec-

tively. Four such groups were derived: young, optimally healthy; young, physically ill; elderly, optimally healthy; elderly, physically ill. Relative to the younger subjects, elderly subjects performed less well, as suggested from previous research, but poor health also impacted negatively on neuropsychological performance. It was found that the unhealthy elderly group performed within normal limits on the Luria Nebraska Neuropsychological Battery. Correlates of poorer performance were greater age, cardiovascular disease and depression.

Langell, Purisch, and Golden (1986) compared the performances of paranoid and nonparanoid schizophrenics with a nonpsychiatric control group on the clinical and summary scales of the Luria-Nebraska Neuropsychological Battery. This was done by a series of direct discriminant analyses in which all 14 Luria-Nebraska Neuropsychological Battery variables were entered as predictors in each analysis. Forty-five subjects in each of the paranoid, nonparanoid and the nonpsychiatric (control) groups were matched for age, educational level, sex, and handedness.

High group discriminability rates were found between all three groups (86 percent overall hit rate). For subgroup contrasts, 88 percent for paranoid versus nonparanoid, and 93 percent for paranoid versus normals were reported. There

was greater consistency of deficit among the nonparanoid than among paranoid schizophrenics in comparison with normals. Differences between paranoid and nonparanoid schizophrenics were reported as involving complex motor functions, attention/concentration, as well as the processing, storage, and retrieval of complex information (Moses and Maruish, 2/1988).

It is difficult to interpret the findings of this study particularly with respect to the greater impairment of performance among nonparanoid patients. Perhaps this is due to the classification of patients into distinct diagnostic categories. No information regarding the criteria used for these diagnoses nor the professionals performing the diagnoses is forthcoming in the study.

Silverstein, McDonald, and Meltzer (1986) examined the stability of the Luria-Nebraska Neuropsychological Battery test results in different psychiatric groups over periods of 1.5 to 2.5 years. The patients were not retested at any standard interval, and in some groups variability of the intertest interval exceeded a year. Patients examined were diagnosed as schizophrenic, schizoaffective disorder, major depressive, or manic. The findings suggested that cognitive

deficit as measured by the Luria-Nebraska Neuropsychological Battery remained relatively stable over time and over the acute versus chronic phase of the disorder.

Methodological criticisms that may be levelled at the study are the following. The total number of subjects that comprised the final study sample was not mentioned. Thus, the ratio of the number of subjects to variables, if less than five to one, could have confounded the results. A subject to variable ratio of ten to one has been recommended (Keppel, 1983). The lack of a control group cautions that the above data be considered as pilot observations which require further experimental evaluation before firm conclusions be drawn.

CHAPTER FOUR

METHODOLOGY

In this chapter, the following aspects will be discussed, viz., subjects, apparatus and procedure.

4.1 Subjects

The target area was Reservoir Hills, a suburb lying just on the outskirts of Durban (See Appendix A). Approximately one hundred and twenty biographical inventories (Appendix B) were administered to sixty female and sixty male adults to elicit the necessary information regarding age, sex and socio-economic status, as well as some personal information. From the respondents, 80 subjects were selected for the final study sample, according to the following criteria:

(i) Forty female and forty male.

(ii) Two distinct age groups, viz., 25-40 year olds and 50-60 year olds.

(iii) Socio-economic status was distinguished into higher and lower, according to a formula proposed by Schlemmer and Stopforth (1979). There was an equal number of female and male respondents in the entire study sample.

All eighty subjects were in active employment, during the period of the fieldwork. The subjects were randomly selected from one Indian residential area in Durban, that is, Reservoir Hills (Appendix A), because of it's accessibility and convenience.

4.2 Apparatus

The biographical inventory (Appendix B) was used for the selection of the final study sample, comprising 80 subjects. The purpose of the Biographical inventory was to elicit the relevant information regarding age, sex and socio-economic status. Furthermore, questions were posed regarding events of present and past neurological diseases as well as neurosurgical operations due to disease to the central nervous system. Also, a screening schedule was used to elicit information regarding episodes of seizures, psychological and psychiatric illnesses. The above mentioned criteria were also applied to the immediate family of the subjects, that is, the spouse, siblings, children and parents.

The Luria-Nebraska Neuropsychological Battery is a relatively new instrument derived from test procedures developed by the Russian neuropsychologist, A.R. Luria (1966, 1973). The 269 items of the battery are divided into eleven sections (clinical scales), that assess motor; rhythm; tactile; visual-spatial; receptive; expressive, reading; writing; arithmetic; memory and intellectual skills.

Three additional scales (summary scales) are scored. The Left Hemisphere scale, consists of all motor and tactile items performed with the right hand and arm only. The Right Hemisphere scale is derived from all motor and tactile items performed with the left hand and arm only, and the Pathognomonic scale which is represented by the thirty-four items empirically determined to be most sensitive to brain damage.

Each item in the Luria-Nebraska Neuropsychological Battery is scored numerically, viz., 0 (no impairment), 1 (Borderline), or 2 (impaired). Performances are classed 0, 1 or 2 on the basis of cutoffs empirically determined to provide the maximum discrimination between brain-damaged and normal subjects (Golden, Hammeke, and Purisch, 1980). The Luria-Nebraska scales may be transformed into standardized (T) scores, with higher scores corresponding to poorer performance (Golden et al., 1981).

4.3 Procedure

The Luria-Nebraska Nebraska Neuropsychological Battery Form 1 (Appendix 3) was administered and interpreted according to the LNNB manual (Golden, Hammeke and Purisch, 1980). The procedure of testing adhered strictly to the instructions outlined in the manual.

All prospective subjects were contacted telephonically to arrange a suitable day and time to discuss the proposed study, clarify any doubts, and fill in the biographical inventory. All subjects were given an opportunity to withdraw at any stage of the study. Once the subject completed the biographical inventory, and satisfied all the necessary criteria, they were contacted telephonically to arrange a convenient day and time for the test battery to be administered. Testing was staggered to optimize performance, as suggested by the authors of the text (Golden et al., 1983). The subjects were reassured that all information received would to be treated in strict confidence.

INDEX TO CHAPTER FIVE

5. RESULTS OF THE INVESTIGATION

The results of this investigation will be presented in four parts. Part One will deal with the demographic features of the sample (age, sex, income, etc.). Part Two will examine hypothesis one, that is, there will be a significant difference in the performance of the 25 - 40 year olds versus the 50 - 60 year olds on the Luria - Nebraska Neuropsychological Battery. Part Three will be concerned with hypothesis two, that is, there will be a significant difference between the performances of males and females on the Luria - Nebraska Neuropsychological Battery. Part Four will concentrate on hypothesis three, that is, there will be a significant relationship between socio - economic status (SES) and performance on the Luria - Nebraska Neuropsychological Battery.

5.1 PART ONE : DEMOGRAPHIC FEATURES OF THE SAMPLE

TABLE 1 - AGE x SEX DISTRIBUTION OF THE FINAL STUDY SAMPLE

	25 - 40 year olds	50 - 60 year olds
Female	20	20
Male	20	20
	40	40

Table 1 above indicates that the final study sample comprised 80 subjects. These subjects were selected randomly (cluster sampling) from approximately one hundred and twenty respondents, in one residential area, that is, Reservoir Hills, Durban. (Appendix 2). Thereafter, the final study sample completed the biographical inventory (Appendix 3) individually. This inventory elicited the relevant

biographical data (eg., age, sex, occupational title, income per annum, etc.) from each respondent.

With regard to socio - economic status, the guide proposed by Schlemmer and Stopporth (1979) was used to categorise the subjects according to occupational title / status. This guide is recommended by the authors for Indian occupational categorisation in South Africa. The final score elicited for socio - economic status according to the guide is referred to as prestige status (a numerical score index - ie., the higher the score, the more professional as well as higher the income per annum.

5.2 **PART TWO** : Hypothesis 1 - There will be a significant difference between the performances of the 25 - 40 year olds and 50 - 60 year olds on the Luria - Nebraska Neuropsychological Battery.

5.2.1 AGE AND TOTAL LNNB PERFORMANCE

A Manova Programme (2 x 14) was performed using SAS (1988, Release 6.03 edition), and the results generated were used to analyse the effects of age. These findings are reflected in the table below.

TABLE 2 : Summary table of Age versus Total Luria - Nebraska Neuropsychological Battery Scores for females and males. (N = 80)

Source of variation	SS	df	MS	F	P
Age	83269.51	1	83269.51	25.16	≤ 0.001 ***
Error	258190,88	78	3310.14		
Corrected Total	341460.39	79			

*** Significant at 0.001 level.

The results in Table 2 suggest that age was a significant variable (F (1.79) = 25.16, p ≤ 0.001). The mean of the older group (50-60) year olds) was 134.18 and the mean of the younger group (25-40 year olds) was 69.65. Thus there was a significantly higher mean total Luria-Nebraska Neuropsychological Battery score obtained by the older group.

The total Luria-Nebraska Neuropsychological Battery scores are derived from the 14 sub scale scores. In an effort to investigate which scales contributed to the total Luria-Nebraska Neuropsychological Battery significant

difference, each sub scale was analysed separately and the results are reflected hereafter.

5.2.2 Age and Motor Scale

Table 3 : Summary Table of Age versus Motor Scale of the Luria -Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Motor	551.25	1	551.25	15.77	≤ 0.001 ***
Error	2726.30	78	34.95		
Corrected Total	3277.55	79			

*** Significant at 0.001 level.

It can be seen from the Table 3 that age had a significant influence on the performance of the 80 subjects on the motor subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 15.77$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 12.05 and the mean of the younger group (25-40 year olds) was 6.80. Thus these results indicated that there was a significantly higher mean motor scale score obtained by the older group.

5.2.3 Age and Rhythm Scale

Table 4 : Summary Table of Age versus Rhythm Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	551.25	1	551.25	15.77	≤ 0.001 ***
Error	2726.30	78	34.95		
Corrected Total	3277.55	79			

*** Significant at 0.001 level.

The results in Table 4 suggest that age had a significant influence on the performance of the 80 subjects on the rhythm subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 15,77$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 12.05 and the mean of the younger group (25-40 year olds) was 6.80. These results indicated that a significantly higher mean visual scale score was obtained by the older group.

5.2.4 Age and Tactile Scale

Table 5 : Summary Table of Age versus Tactile Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	68.45	1	68.45	14.69	*** ≤ 0.001
Error	363.50	78	4.66		
Corrected Total	431.95	79			

*** Significant at 0.001 level.

It can be seen from Table 5 that age had a significant effect on the performance of the 80 subjects on the Tactile subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 14.69$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 6.65 and the mean of the younger group (25-40 year olds) was 4.80. Thus a significantly higher mean Tactile scale score was obtained by the older group.

5.2.5 Age and Visual Scale

Table 6 : Summary Table of Age versus Visual Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	470.45	1	470.45	22.25	*** ≤ 0.001
Error	1649.50	78	21.15		
Corrected Total	2119.95	79			

*** Significant at 0.001 level.

The results in Table 6 suggest that age had a significant effect on the performance of the 80 subjects on the visual subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 22.25$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 12.15 and the mean of the younger group (25 - 40 year olds) was 7.30. These results indicate that a significantly higher mean of the visual scale score was obtained by the older group.

5.2.6 Age and Receptive Speech Scale

Table 7 : Summary Table of Age versus Receptive Speech Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	750.31	1	750.31	20.03	≤ 0.001 ***
Error	2922.18	78	37.46		
Corrected Total	3672.49	79			

*** Significant at 0.001 level.

It can be seen from Table 7 that age had a significant influence on the performance of the 80 subjects on the Receptive Speech subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 20.03$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 9.30 and the mean of the younger group (25-40 year olds) was 3.18. Thus there was a significantly higher mean on the Receptive Speech Scale obtained by the older group.

5.2.7 Age and Expressive Speech Scale

Table 8 : Summary Table of Age versus Expressive Speech Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	720.00	1	720.00	19.18	≤ 0.001 ***
Error	2927.95	78	37.54		
Corrected Total	3647.95	79			

*** Significant at 0.001 level.

The results in Table 8 suggest that age had a significant effect on the performance of the 80 subjects on the Expressive Speech Scale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 19.18$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 9.23 and the mean of the younger group (25-40 year olds) was 3.23. These results indicate that a significantly higher mean Expressive Speech scale score was obtained by the older group.

5.2.8 Age and Writing Scale

Table 9 : Summary Table of Age versus Writing Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	551.25	1	551.25	15.77	≤ 0.001 ***
Error	2726.30	78	34.95		
Corrected Total	3277.55	79			

*** Significant at 0.001 level.

It can be seen from Table 9 that age had a significant influence on the performance of the 80 subjects on the Writing subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 15.77$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 12.05 and the mean of the younger group (25-40 year olds) was 6.80. Thus there a significantly a higher mean writing scale score obtained by the older group.

5.2.9 Age and Reading Scale

Table 10 : Summary Table of Age versus Reading Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	26.45	1	26.45	2.79	NS > 0.05
Error	738.75	78	9.47		
Corrected Total	765.20	79			

NS: Not significant at 0.05 level.

The results in Table 10 suggest that age did not have a significant effect on the performance of the 80 subjects on the Reading Subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 2.79$, $p > 0.05$).

5.2.10 Age and Arithmetic Scale

Table 11 : Summary Table of Age versus Arithmetic Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	112.81	1	112.81	8.89	$\leq 0.01^{**}$
Error	989.88	78	12.69		
Corrected Total	1102.69	79			

** Significant at 0.01 level.

It can be seen from the Table 11 that age had a significant influence on the performance of the 80 subjects on the Arithmetic scale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 8.89$, $p \leq 0.01$).

The mean of the older group (50-60 year olds) was 4.13 and the mean of the younger group (25-40 year olds) was 1.75. There was a significantly higher mean Arithmetic score obtained by the older group.

5.2.11 Age and Memory Scale

Table 12 : Summary Table of Age versus Memory Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	649.80	1	649.80	76.09	*** ≤ 0.001
Error	666.15	78	8.54		
Corrected Total	1315.95	79			

*** Significant at 0.001 level.

The results in Table 12 illustrate that age had a significant effect on the performance of the 80 subjects on the Memory Scale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 76.09$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 8.58 and the mean of the younger group was 2.88. These results indicate that a significantly higher mean memory score was obtained by the older group.

5.2.12 Age and Intellectual Processes Scale

Table 13 : Summary Table of Age versus Intellectual Processes Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	649.80	1	649.80	8.03	≤ 0.01 ***
Error	6311.75	78	80.92		
Corrected Total	6961.55	79			

** Significant at 0.01 level.

It can be seen from the Table 13 that age had a significant effect on the performance of the 80 subjects on the Intellectual Process subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 8.03$, $p \leq 0.01$).

The mean of the older group (50-60 year olds) was 17.93 and the mean of the younger group (25-40 year olds) was 12.23. Thus a significantly higher mean Intellectual Processes score was obtained by the older group.

5.2.13 Age and Pathognomonic Scale

Table 14 : Summary Table of Age versus Pathognomonic Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	884.45	1	884.45	24.88	*** ≤ 0.001
Error	2772.35	78	35.54		
Corrected Total	3656.80	79			

*** Significant at 0.001 level.

The results in Table 14 illustrate that age had a significant influence on the performance of the 80 subjects on the Pathognomonic Subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 24.88$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 13.53 and the mean of the younger group (25-40 year olds) was 6.80. These results indicate that a significantly higher mean Pathognomonic score was obtained by the older group.

5.2.14 Age and Left - Hemisphere Scale

Table 15 : Summary Table of Age versus Left - Hemisphere Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	720.00	1	720.00	20.34	≤ 0.001 **
Error	2760.75	78	35.39		
Corrected Total	3480.75	79			

** Significant at 0.001 level.

It can be seen from Table 15 that age had a significant effect on the performance of the 80 subjects on the Left - Hemisphere Subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 20.34$, $p \leq 0.001$).

The mean of the older group (50-60 year olds) was 10.38 and the mean of the younger group (25-40 year olds) was 4.38. Thus a significantly higher mean Left - Hemisphere score was obtained by the older group.

5.2.15 Age and Right - Hemisphere Scale

Table 16 : Summary Table of Age versus Right - Hemisphere Scale of the Luria-Nebraska Neuropsychological Battery of 80 female and male subjects.

Source of Variation	SS	df	MS	F	P
Age	1394.45	1	1394.45	32.13	*** ≤ 0.001
Error	3385.35	78	43.40		
Corrected Total	4779.30	79			

*** Significant at 0.001 level.

The results in Table 16 illustrate that age had a significant effect on the performance of the 80 subjects on the Right - Hemisphere subscale of the Luria-Nebraska Neuropsychological Battery ($F(1.79) = 32.13$, p , ≤ 0.001).

The mean of the older group (50-60 year olds) was 17.63 and the mean of the younger group (25-40 year olds) was 9.28. These results indicate that a significantly higher mean Right - Hemisphere score was obtained by the older group.

SUMMARY OF FINDINGS: HYPOTHESIS 1: AGE EFFECTS

Table 17 : Summary Table of Age versus Total and the 14 Subscales of the LNNB, listed from most significant to least / no significance.

SCALE OF LNNB	F	P
Total (LNNB)	25.16	*** ≤ 0.001
Visual	22.25	*** ≤ 0.001
Receptive Speech	20.03	*** ≤ 0.001
Memory	76.09	*** ≤ 0.001
Pathognomonic	24.88	*** ≤ 0.001
Left - Hemisphere	20.34	*** ≤ 0.001
Right - Hemisphere	32.13	*** ≤ 0.001
Motor	15.77	*** ≤ 0.001
Rhythm	15.77	*** ≤ 0.001
Writing	15.77	*** ≤ 0.001
Tactile	14.69	*** ≤ 0.001
Arithmetic	8.89	** ≤ 0.01
Intellectual Processes	8.03	** ≤ 0.01
Reading	2.79	NS > 0.05

P.T.O.

CONCLUSION: HYPOTHESIS 1 : AGE EFFECTS

Age had a very significant influence on 13 subscales of the Luria - Nebraska Neuropsychological Battery, (viz. Motor, Rhythm, Tactile, Visual, Receptive Speech, Expressive Speech, Writing, Arithmetic, Memory, Intellectual Processes, Pathognomonic, Left -Hemisphere, Right - Hemisphere, as well as the total Luria - Nebraska Neuropsychological Battery score.

Age did not have a significant effect on the reading subscale of the Luria - Nebraska Neuropsychological Battery.

5.3 PART THREE : HYPOTHESIS 2 : There will be a significant difference between the performance of females and males on the Luria - Nebraska Neuropsychological Battery.

5.3.1 SEX AND TOTAL LNNB PERFORMANCE

A Manova Programme (2 x 14) was performed using SAS (1988, Release 6.03 edition), and the results generated were to analyse the effects of sex. These findings are reflected in the table hereafter.

TABLE 18 : Summary table of Sex versus total Luria - Nebraska Neuropsychological Battery scores for Females and males (N=80).

Source of variation	SS	df	MS	F	P
Sex	5297.51	1	5297.51	1.23	NS > 0.05
Error	336162.88	78	4309.78		
Corrected Total	341460.39	79			

NS not significant at 0.05 level.

The results in Table 18 suggest that sex was not a significant variable (F(1.79) = 1,23, p> 0,05) in the total score performance of the subjects on the Luria - Nebraska Neuropsychological Battery.

The total Luria - Nebraska Neuropsychological Battery scores are derived from the 14 subscale scores. These subscales were analysed independently to investigate whether individual subscales showed significant difference as per sex.

5.3.2. Sex and Motor Scale

TABLE 19 : Summary table of Sex versus Motor Scale of Luria - Nebraska Neuropsychological Battery on 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	31.25	1	31.25	0.75	NS > 0.05
Error	3246.30	78	41.62		
Corrected Total	3277.55	79			

NS: Not significant at 0.05 level.

The results in Table 19 revealed that there was no significant difference in the performance of females and males on the motor subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 0.75$, $p > 0,05$).

5.3.2 Sex and Rhythm Scale

TABLE 20 : Summary table of Sex versus Rhythm Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	31.25	1	31.25	0.75	NS > 0.05
Error	3246.30	78	41.62		
Corrected Total	3277.55	79			

NS not significant at 0.05 level.

The results in Table 20 revealed that there was no significant difference in the performance of females and males on the Rhythm Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 0.75$, $p > 0.05$).

5.3.3 Sex and Tactile Scale

TABLE 21 : Summary table of Sex versus Tactile Scale of Luria Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	0.00	1	0.00	0.00	NS > 0.05
Error	431.95	78	5.54		
Corrected Total	431.95	79			

NS not significant at 0.05 level.

The results in Table 21 indicated that there was no significant difference in the performances of females and males on the Tactile Subscale Luria - Nebraska Neuropsychological Battery ($F(1.79) = 0.00$, $p > 0.05$).

5.3.4 Sex and Visual Scale

TABLE 22 : Summary table of Sex versus Visual Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	192.20	1	192.20	7.78	≤ 0.05 *
Error	1927.75	78	24.71		
Corrected Total	2119.95	79			

* Significant at 0.05 level.

The results in Table 22 illustrate that sex had a significant influence on the performance of the 80 subjects on the Visual Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 7.78$, $p \leq 0.05$).

The mean of the females (n=40) was 11.28 and the mean of the males (n=40) was 8.18. These results indicate that a significantly higher mean was obtained by the females as compared to the males.

5.3.5 Sex and Receptive Speech Scale

TABLE 23 : Summary table of Sex versus Receptive Speech Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	159.61	1	159.61	3.54	NS > 0.05
Error	3512.88	78	45.04		
Corrected Total	3672.49	79			

NS: Not significant at 0.05 level.

The results in Table 23 revealed that there was no significant difference in the performance between females and males on the Receptive Speech Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 3.54$, $p > 0.05$).

5.3.6 Sex and Expressive Speech Scale

TABLE 24 : Summary table of Sex versus Expressive Speech Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	1.25	1	1.25	0.03	NS > 0.05
Error	3646.70	78	46.75		
Corrected Total	3647.95	79			

NS: Not significant at 0.05 level.

The results in Table 24 revealed that there was no significant difference in the performance between females and males on the Expressive Speech Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 0.03$, $p > 0,05$).

5.3.7 Sex and Writing Scale

TABLE 25 : Summary table of Sex versus Writing Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	31.25	1	31.25	0.75	NS > 0.05
Error	3246.30	78	41.62		
Corrected Total	3277.55	79			

NS: Not significant at 0.05 level.

The results in Table 25 revealed that there was no significant difference in the performances of females and males on the Writing Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 0.75$, $p > 0.05$).

5.3.8 Sex and Reading Scale

TABLE 26 : Summary table of Sex versus Reading Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	18.05	1	18.05	1.88	NS > 0.05
Error	747.15	78	9.58		
Corrected Total	765.20	79			

NS: Not significant at 0.05 level.

The results in Table 26 indicated that there was no significant difference in the performances of females and males on the Writing Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 1.88$, $p > 0.05$).

5.3.9 Sex and Arithmetic Scale

TABLE 27 : Summary table of Sex versus Arithmetic Scale of the Luria-Nebraska Neuropsychological Battery of the subjects.

Source of variation	SS	df	MS	F	P
Sex	40.61	1	40.61	2.98	NS > 0.05
Error	1062.08	78	13.62		
Corrected Total	1102.69	79			

NS: Not significant at 0.05 level.

The results in Table 27 revealed that there was no significant difference in the performance between females and males on the Arithmetic Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 2.98$, $p > 0.05$).

5.3.10 Sex and Memory Scale

TABLE 28 : Summary table of Sex versus Memory Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	0.20	1	0.20	0.01	NS > 0.05
Error	1315.75	78	16.87		
Corrected Total	1315.95	79			

NS: Not significant at 0.05 level.

The results in Table 28 revealed that there was no significant difference in the performances of females and males on the Memory Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1,79) = 0.01$, $p > 0.05$).

5.3.11 Sex and Intellectual Processes

TABLE 29 : Summary table of Sex versus Intellectual Processes of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	336.20	1	336.20	3.96	* ≤ 0.05
Error	6625.35	78	84.94		
Corrected Total	6961.55	79			

* Significant at 0.05 level.

The results in Table 29 revealed that there was a significant difference in the performances of females and males on the Intellectual Processes subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 3.96$, $p, \leq 0,05$).

The mean of the females was 17.13 and the mean of the males was 13.03. There was a higher mean score obtained by the females.

5.3.12 Sex and Pathognomonic Scale

TABLE 30 : Summary table of Sex versus Pathognomonic Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	20.00	1	20.00	0.43	NS > 0.05
Error	3636.80	78	46.63		
Corrected Total	3656.80	79			

NS: Not significant at 0.05 level.

The results in Table 30 revealed that there was no significant difference in the performances of females and males on the Pathognomonic Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 0.43$, $p > 0.05$).

5.3.13 Sex and Left - Hemisphere Scale

TABLE 31 : Summary table of Sex versus Left Hemisphere Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	36.45	1	36.45	0.83	NS > 0.05
Error	3444.30	78	44.16		
Corrected Total	3480.75	79			

NS: Not significant at 0.05 level.

The results in Table 31 revealed that there was no significant difference in the performances of females and males on the Left Hemisphere Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1,79) = 0.83$, $p > 0.05$).

5.3.14 Sex and Right - Hemisphere Scale

TABLE 32 : Summary table of Sex versus Right - Hemisphere Scale of the Luria - Nebraska Neuropsychological Battery of 80 subjects.

Source of variation	SS	df	MS	F	P
Sex	92.45	1	92.45	1.54	NS > 0.05
Error	4687.35	78	60.09		
Corrected Total	4779.80	79			

NS: Not significant at 0.05 level.

The results in Table 32 revealed that there was no significant differences between females and males on the Right - Hemisphere Subscale of the Luria - Nebraska Neuropsychological Battery ($F(1.79) = 1.54$, $p > 0.05$).

Table 33 : Summary Table of effect of sex on the performance on the Luria - Nebraska Neuropsychological Battery including the total, listed from the most significant to least / no significance.

SCALE OF LNNB	F	P
Visual	7.78	** ≤ 0.01
Intellectual Processes	3.96	* ≤ 0.05
Total (LNNB)	1.23	NS > 0.05
Motor	0.75	NS > 0.05
Rhythm	0.75	NS > 0.05
Tactile	0.00	NS > 0.05
Receptive Speech	3.54	NS > 0.05
Expressive Speech	0.03	NS > 0.05
Writing	0.75	NS > 0.05
Reading	1.88	NS > 0.05
Arithmetic	2.98	NS > 0.05
Memory	0.01	NS > 0.05
Pathognomonic	0.43	NS > 0.05
Left Hemisphere	0.83	NS > 0.05
Right Hemisphere	1.54	NS > 0.05

CONCLUSION: HYPOTHESIS 1: AGE EFFECTS

Twelve subscales (Motor, Rhythm, Tactile, Receptive, Speech, Expressive Speech, Writing, Reading, Arithmetic, Memory, Pathognomonic, Left - Hemisphere and Right - Hemisphere) as well as the total of the Luria - Nebraska Neuropsychological Battery were not significantly affected by sex.

Only two subscales, viz., visual and intellectual processes were significantly affected by the sex factor.

5.4 PART FOUR : HYPOTHESIS 3 - There will be a significant relationship between socio - economic status and performance on the Luria - Nebraska Neuropsychological Battery.

HOW WAS S.E.S. DERIVED

The socio economic status was determined by using a comprehensive guide proposed by Schlemmer and Stopworth (1979) which categorises all subjects according to the occupational status. This guide has a dual purpose. Firstly it is a way of differentiating systematically between occupations which represent different levels of achievement in work status and, secondly, occupational status is an index of social achievements, of a particular kind.

The final score elicited for socio - economic status according to the guide is referred to as PRESTIGE STATUS (a numerical score), with a higher score indicating the more professional as well as a higher income per annum. Prestige status rating was validated against income and level of education.

Finally, the guide was informative and comprehensive which made subject classification simple and less time - consuming. On completion of the administration of the Luria - Nebraska Neuropsychological Battery, Form 1, the scores were analysed on the computer. The raw scores of all 269 items for each subject were copied on the V.P. Planner; that is, spread sheets. Once this task was completed, the information was transposed on the SAS Data Set (1988, Release, 6.03 edition)

SPEARMAN RANK ORDER CORRELATION

According to Hinkle et al (1982), the Spearman RHO is the correlation coefficient that should be used when the level of measurement for both variables being correlated is ordinal. In this particular case the Luria - Nebraska Neuropsychological Battery scales and the prestige status scales (indicator of socio - economic status) are ordinal data, hence Spearman Rank Order correlation was used to analyse the data.

5.4.1 Relationship between SES and LNNB Performance for Female Subjects.

Table 50 : Relationship between the Socioeconomic Status and the performance of 40 female subjects on the Luria - Nebraska Neuropsychological Battery, analysed by Spearman Rho Correlation Coefficient.

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.530	*** ≤ 0.001
Intellectual Processes	- 0.603	*** ≤ 0.001
Left - Hemisphere	- 0.525	*** ≤ 0.001
Arithmetic	- 0.512	*** ≤ 0.001
Visual	- 0.502	** ≤ 0.01
Receptive Speech	- 0.478	** ≤ 0.01
Reading	- 0.436	** ≤ 0.01
Expressive Speech	- 0.404	** ≤ 0.01
Right Hemisphere	- 0.391	** ≤ 0.01
Memory	- 0.369	* ≤ 0.05
Pathognomonic	- 0.363	* ≤ 0.05
Writing	- 0.288	> 0.05
Motor	- 0.288	> 0.05
Rhythm	- 0.288	> 0.05
Tactile	- 0.242	> 0.05

Table 50 indicates that there was a significant negative correlation between SES and performance of the 40 female subjects on the total LNNB, as well as the intellectual processes, left hemisphere, arithmetic, visual, receptive speech , reading, expressive speech, right hemisphere, memory and pathognomonic scale in decreasing absolute value. No significant relationship was found between SES and the writing, motor, rhythm and tactile scales.

5.4.2 Relationship between SES and LNNB Performance for Males

Table 51 : Relationship between the socioeconomic status and the performance of 40 males on the Luria- Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.556	*** ≤ 0.001
Motor	- 0.579	*** ≤ 0.001
Rhythm	- 0.579	*** ≤ 0.001
Writing	- 0.579	*** ≤ 0.001
Right - Hemisphere	- 0.566	*** ≤ 0.001
Left - Hemisphere	- 0.546	*** ≤ 0.001
Arithmetic	- 0.513	*** ≤ 0.001
Expressive Speech	- 0.502	*** ≤ 0.001
Intellectual Processes	- 0.453	** ≤ 0.01
Memory	- 0.446	** ≤ 0.01
Tactile	- 0.445	** ≤ 0.01
Pathognomonic	- 0.417	** ≤ 0.01
Reading	- 0.404	** ≤ 0.01
Receptive Speech	- 0.398	** ≤ 0.01
Visual	- 0.344	* ≤ 0.05

From the results in Table 51, it can be concluded that there is a significant -ve correlation between socio - economic status and the performance of the 40 male subjects on the Luria - Nebraska Neuropsychological Battery scores on all subscales.

5.4.3 Relationship between SES and LNNB Performance of Older Subjects (50 - 60 year olds).

Table 52 : The relationship between the socioeconomic status and performance of older subjects on the Luria-Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.680	*** ≤ 0.001
Tactile	- 0.732	*** ≤ 0.001
Left - Hemisphere	- 0.705	*** ≤ 0.001
Expressive Speech	- 0.690	*** ≤ 0.001
Right - Hemisphere	- 0.688	*** ≤ 0.001
Pathognomonic	- 0.657	*** ≤ 0.001
Motor	- 0.622	*** ≤ 0.001
Rhythm	- 0.622	*** ≤ 0.001
Writing	- 0.622	*** ≤ 0.001
Intellectual Processes	- 0.612	*** ≤ 0.001
Arithmetic	- 0.592	*** ≤ 0.001
Visual	- 0.567	*** ≤ 0.001
Receptive Speech	- 0.544	*** ≤ 0.001
Reading	- 0.523	*** ≤ 0.001
Memory	- 0.459	** ≤ 0.01

From the results in Table 52, it can be concluded that there is a significant -ve correlation between socio - economic status and the performance of 20 older female and older male subjects (50 -60 year olds), on the total Luria - Nebraska Neuropsychological Battery score and all subscale scores.

5.4.4 Relationship between SES and LNNB Performance Younger Subjects (25 - 40 year olds)

Table 53 : The relationship between the socio-economic status and performance of 20 younger female and 20 younger male subjects (25 - 40 year olds) on the Luria - Nebraska Neuropsychological Battery, analysed according to the Spearman Rho Correlation Coefficient.

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.401	$\leq$ 0.01 **
Memory	- 0.502	$\leq$ 0.01 **
Left - Hemisphere	- 0.387	$\leq$ 0.01 **
Intellectual Processes	- 0.355	$\leq$ 0.05 *
Receptive Speech	- 0.349	$\leq$ 0.05 *
Right - Hemisphere	- 0.313	$\leq$ 0.05 *
Arithmetic	- 0.301	$>$ 0.05
Reading	- 0.213	$>$ 0.05
Visual	- 0.259	$>$ 0.05
Motor	- 0.235	$>$ 0.05
Rhythm	- 0.235	$>$ 0.05
Expressive Speech	- 0.228	$>$ 0.05
Tactile	- 0.138	$>$ 0.05
Pathognomonic	- 0.137	$>$ 0.05

From the results in Table 53, it can be concluded that there is a significant -ve correlation between socio - economic status and the scores of 20 younger male and female subjects (25-40 year olds), on the total Luria - Nebraska Neuropsychological Battery. A breakdown analysis reveals that only the Memory, Left - Hemisphere, Right - Hemisphere, Intellectual Processes and Receptive Speech subscales revealed a significant -ve correlation.

5.4.5 Relationship between SES and LNNB Performance of older females (50 - 60 year olds)

Table 54 : The relationship between the socioeconomic status and performance of 20 Older female subjects on the Luria - Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.672	** ≤ 0.01
Tactile	- 0.757	*** ≤ 0.001
Pathognomonic	- 0.714	*** ≤ 0.001
Visual	- 0.693	*** ≤ 0.001
Right - Hemisphere	- 0.678	*** ≤ 0.001
Left - Hemisphere	- 0.675	*** ≤ 0.001
Expressive Speech	- 0.673	*** ≤ 0.001
Receptive Speech	- 0.636	** ≤ 0.01
Intellectual Processes	- 0.622	** ≤ 0.01
Arithmetic	- 0.594	** ≤ 0.01
Writing	- 0.513	* ≤ 0.05
Motor	- 0.513	* ≤ 0.05
Rhythm	- 0.513	* ≤ 0.05
Reading	- 0.496	* ≤ 0.05
Memory	- 0.446	* ≤ 0.05

From the results in Table 54, it can be concluded that there is a significant -ve correlation between socio - economic status and the scores of 20 female subjects (50 - 60 year olds) on the total Luria - Nebraska Neuropsychological Battery and on all the subscales.

5.4.6 Relationship between SES and LNNB Performance of Younger Females (25 - 40 year olds)

Table 55 : The relationship between socioeconomic status and performance of 20 Younger female subjects on the Luria-Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.490	$\leq$ 0.05 *
Intellectual Processes	- 0.624	$\leq$ 0.01 **
Receptive Speech	- 0.599	$\leq$ 0.01 **
Reading	- 0.532	$\leq$ 0.05 *
Visual	- 0.523	$\leq$ 0.05 *
Arithmetic	- 0.507	$\leq$ 0.05 *
Left Hemisphere	- 0.500	$\leq$ 0.05 *
Memory	- 0.646	$\leq$ 0.01 **
Tactile	- 0.327	$>$ 0.05
Right - Hemisphere	- 0.203	$>$ 0.05
Expressive Speech	- 0.133	$>$ 0.05
Pathognomonic	- 0.058	$>$ 0.05
Motor	- 0.029	$>$ 0.05
Rhythm	- 0.029	$>$ 0.05
Writing	- 0.029	$>$ 0.05

From the results in Table 55 it can be concluded that there is a significant -ve correlation between Socio-Economic status and the performance of 20 younger female subjects (25 - 40 year old) on the total Luria - Nebraska Neuropsychological Battery scores and the memory, Intellectual Processes, Receptive Speech, Reading, Visual, Arithmetic and Left-Hemisphere subscales.

5.4.7 Relationship between SES and LNNB Performance of older Males (50 - 60 year olds)

Table 56 : The relationship between socioeconomic status and performance of 20 Older male subjects on the Luria-Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.741	*** ≤ 0.001
Left - Hemisphere	- 0.763	*** ≤ 0.001
Right - Hemisphere	- 0.748	*** ≤ 0.001
Writing	- 0.747	*** ≤ 0.001
Motor	- 0.747	*** ≤ 0.001
Rhythm	- 0.747	*** ≤ 0.001
Tactile	- 0.746	*** ≤ 0.001
Expressive Speech	- 0.694	*** ≤ 0.001
Arithmetic	- 0.688	*** ≤ 0.001
Intellectual Processes	- 0.676	*** ≤ 0.001
Receptive Speech	- 0.653	** ≤ 0.01
Pathognomonic	- 0.636	** ≤ 0.01
Visual	- 0.620	** ≤ 0.01
Reading	- 0.598	** ≤ 0.01
Memory	- 0.525	* ≤ 0.05

From the results in Table 56 it can be concluded that there was a significant -ve correlation between Socio-Economic status and the performance of 20 male subjects (50 - 60 year old) on the total Luria-Nebraska Neuropsychological Battery total and all the subscales.

5.4.8 Relationship between SES and LNNB Performance of Younger Males (25 - 40 year olds).

Table 57 : The relationship between socioeconomic status and performance of 20 Younger male subjects on the Luria-Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.397	> 0.05
Right - Hemisphere	- 0.412	> 0.05
Motor	- 0.347	> 0.05
Rhythm	- 0.347	> 0.05
Writing	- 0.347	> 0.05
Memory	- 0.343	> 0.05
Expressive Speech	- 0.263	> 0.05
Left - Hemisphere	- 0.259	> 0.05
Reading	- 0.194	> 0.05
Arithmetic	- 0.189	> 0.05
Intellectual Processes	- 0.118	> 0.05
Pathognomonic	- 0.044	> 0.05
Tactile	- 0.014	> 0.05
Visual	- 0.007	> 0.05
Receptive Speech	- 0.005	> 0.05

From the results in Table 57 it can be concluded that there was no significant -ve correlation between Socio-Economic status and the performance of 20 younger male subjects (25 - 40 year old) on the total Luria-Nebraska Neuropsychological Battery total and all the subscales.

5.4.9 Relationship between Socioeconomic Status and Performance in the Entire Group

Table 58 : The relationship of socioeconomic status and performance of total number of subjects on the Luria-Nebraska Neuropsychological Battery

SCALE OF LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY	r	p
Total (LNNB)	- 0.512	*** ≤ 0.001
Motor	- 0.448	*** ≤ 0.001
Rhythm	- 0.448	*** ≤ 0.001
Receptive Speech	- 0.429	*** ≤ 0.001
Expressive Speech	- 0.466	*** ≤ 0.001
Writing	- 0.448	*** ≤ 0.001
Arithmetic	- 0.460	*** ≤ 0.001
Intellectual Processes	- 0.497	*** ≤ 0.001
Left - Hemisphere	- 0.530	*** ≤ 0.001
Right - Hemisphere	- 0.464	*** ≤ 0.001
Reading	- 0.410	*** ≤ 0.001
Memory	- 0.406	*** ≤ 0.001
Pathognomonic	- 0.408	*** ≤ 0.001
Visual	- 0.396	*** ≤ 0.001
Tactile	- 0.345	** ≤ 0.01

From the results in Table 58 it can be concluded that there was a significant -ve correlation between Socio-Economic status and the performance of 80 subjects (40 males and 40 females) on the total Luria-Nebraska Neuropsychological Battery total and on all the subscales.

Table 59 : Overall Summary of correlation between Socio-Economic status and performance of the Luria - Nebraska Neuropsychological Battery.

	r	p
Total Sample and Total LNNB	- 0.512	*** ≤ 0.001
Total Sample and Total LNNB		
All Female (N = 40)	- 0.530	*** ≤ 0.001
All Male (N = 40)	- 0.556	*** ≤ 0.001
All older Female and Male (N=40)	- 0.680	*** ≤ 0.001
All younger Female and Male (N = 40)	- 0.401	** ≤ 0.01
Older Female (N = 20)	- 0.672	** ≤ 0.01
Older Male (N = 20)	- 0.741	*** ≤ 0.001
Younger Female (N = 20)	- 0.490	* ≤ 0.05
Younger Male (N = 20)	- 0.397	> 0.05

The findings will be discussed in the light of the aims and hypotheses listed in chapter one.

CHAPTER SIX

DISCUSSION

Several aims were postulated in Chapter One. In accordance with these aims, hypotheses were advanced and tested in the results section. The discussion that follows will thus present an examination of the hypotheses.

Hypothesis 1: There will be a significant difference between the performances of the 25-40 year olds and the 50-60 year olds on the Luria-Nebraska Neuropsychological Battery.

The results in Table 2 suggest age formed a significant effect in the total score performance of the subjects on the Luria-Nebraska Neuropsychological Battery ($F(1,79) = 25,16$, $p \leq 0,001$). The mean score of the older group (50-60 year olds) was found to 134,18 and the mean score of the younger group (25-40 year olds) was 69,65. These findings indicate that the older group performed significantly worse than the younger group on the Luria-Nebraska Neuropsychological Battery. These findings suggest that with increasing age, more errors may be detected in the performance of the test battery. It appears that different normative values should be applied to subjects over fifty years of age and to those between 25 and forty years of age.

The results with respect to the effects of age on neuropsychological performance appear to be consistent with those of other studies (Lezak, 1983). It has been suggested that changes in cerebral organisation with advancing age may account for these differences. For example, Jacobs, Kinkel, Painter and Murawski (1978) reported that ventricular size increases with age even in healthy persons. This finding suggests that there is some cortical and subcortical atrophy which may account for changes in cognitive functioning.

The results in tables 3 to 17 indicate that age differences in performance on the various scales of the Luria-Nebraska Neuropsychological Battery were found. The older group performed consistently poorer on the visual ($F(1,79) = 22,25$, $p \leq 0,001$), motor ($F(1,79) = 15,77$, $p \leq 0,0001$), rhythm ($F(1,79) = 15,77$, $p \leq 0,001$), tactile ($F(1,79) = 14,69$, $p \leq 0,001$), receptive speech ($F(1,79) = 20,03$, $p \leq 0,001$), expressive speech ($F(1,79) = 19,18$, $p \leq 0,001$), writing ($F(1,79) = 15,77$, $p \leq 0,001$), arithmetic ($F(1,79) = 8,89$, $p \leq 0,01$), memory ($F(1,79) = 76,09$, $p \leq 0,001$), intellectual processes ($F(1,79) = 8,03$, $p \leq 0,01$), pathognomonic ($F(1,79) = 24,88$, $p \leq 0,001$), left hemisphere ($F(1,79) = 20,34$, $p \leq 0,001$) and the right hemisphere ($F(1,79) = 32,13$, $p \leq 0,001$) scales. There was no significant difference between the older and younger age groups with respect to performance on the reading scale ($F(1,79) = 2,79$, $p > 0,05$).

The findings suggest that while a significantly poorer performance on the scales of the Luria-Nebraska Neuropsychological Battery may be expected with age, an exception is the reading scale. It appears that such consistent findings across age ranges supports the proposal that reading skills, which are learned, reflect a relatively stable psychological phenomenon. This suggestion has been supported by other researchers. Yendall, Fromin, Reddon and Stefanyk (1986) reported in their study using the Controlled Word Association and Language Modalities Test for Aphasia that language functions appear to improve or remain fairly constant over age. The authors note that, on the other hand, nonverbal skills such as tactile recognition show decrements in performance with age.

Hypothesis 2: There will be a significant difference between the performance of females and males on the Luria-Nebraska Neuropsychological Battery.

A survey of the literature strongly suggests that the male and female brain have definite anatomical differences. Browne (1983) noted that such differences may range from variations in the sizes of the hemispheres to those relating to memotransmitter concentrations. In addition, the effects of socialization practices on the behaviour has been cited as a mediating influence.

Psychological tests have acknowledged these influences to the extent that norms for males and females have been the rule in test formulation.

The results in Table 18 indicate that no sex differences were found in the total score performance of the sample on the Luria-Nebraska Neuropsychological Battery ($F(1,79) = 1,23$, $p > 0,05$). This finding suggests that the male and female performances across both age groups were not significantly different with respect to total Luria-Nebraska Neuropsychological Battery scores. This finding is surprising and suggests that the total score is not sensitive enough to discriminate between male and female performance.

An examination of individual scale performances (Tables 19 to 33) reveals non-significant results with exception of the intellectual processing and visual scales, $F(1,79) = 3,96)$, $p \leq 0,05$ and $F(1,79) = 7,78$, $p \leq 0,01$, respectively. These findings suggest that with the exception of the intellectual processes and visual scales, all other scales failed to discriminate between male and a female performance. Two possible explanations may be advanced for these findings. Firstly, it is possible that the items on these scales may be robust and take into account sex differences. Secondly, the converse is also possible, that the items are not sufficiently sensitive to discriminate between performance of the sexes.

On the visual scales, the mean score for the females was 11,28 and that of the males was 8,18. This indicates that the females scored significantly poorer on the visual scale than the males. This finding appears to support research findings that males appear to be superior at visual-related tasks that require right hemisphere skills for their resolution. Browne (1983) reported that when males and females were required to mentally construct a three-dimensional object or picture from a two-dimensional pattern, males consistently outperformed females. These differences appear to make their appearance as early as adolescence and persist throughout adulthood.

The mean performance of the females on the intellectual processes scale was 17,13 while the mean of the males on this scale was 13,03. Once again, males performed significantly better than females. Several authors (Anastasi, 1981; Ward 1990) suggest that tests purporting to investigate intellectual processes have been biased in favour of male expectations both in favour of definitions and items included in the test battery. It is possible that the items on the intellectual processes scale may reflect this bias and thus may be due to socialization patterns. Other researchers have reported higher scores among males than females on tests designed to measure intellectual levels using the Wechsler Adult Intelligence Scale (Snow and Weinstock, 1990).

The findings regarding the non-significance of sex-differences in the performance on the Luria-Nebraska Neuropsychological Battery are important for two major reasons. Firstly, these findings support those of other researchers (Ivison, 1977; Wechsler, 1958) who note that group differences in neuropsychological performance rarely amount to as much as one-half of a standard deviation so that the overlap in the distribution of male and female scores is much greater than the distance between them. Secondly, in support of the first assertion, it is noteworthy that despite the sex significance of performances on the visual and intellectual processes scale, the effects are not strong enough to affect overall total Luria-Nebraska scores.

It appears therefore that the test battery can be used without undue caution to interpretation as per sex, except when the scores on the visual and intellectual processes scales are being viewed in isolation.

Hypothesis 3: There will be a significant relationship between socio-economic status and performances on the Luria-Nebraska Neuropsychological Battery.

This hypothesis was analysed by computing the Spearman Rho correlation co-efficient between socio-economic status and total Luria-Nebraska Neuropsychological Score for the entire group. Thereafter, correlational analyses were performed as per age and sex.

The results in Table 58 indicate that there was a significant negative correlation between the total Luria-Nebraska Neuropsychological Battery score and socio-economic status for the entire group ($r = -0,512$, $p \leq 0,001$). There was also a significant negative correlation between socio-economic status and each of the scales: motor ($r = -0,448$, $p \leq 0,001$); rhythm ($r = -0,448$, $p \leq 0,001$); receptive speech ($r = -0,429$, $p \leq 0,001$); expressive speech ($r = -0,466$, $p \leq 0,001$); writing ($r = -0,448$, $p \leq 0,001$); arithmetic ($r = -0,460$, $p \leq 0,001$); intellectual processes ($r = -0,497$; $p \leq 0,001$); left-hemisphere ($r = -0,530$, $p \leq 0,001$); right-hemisphere ($r = -0,464$, $p \leq 0,001$); reading ($r = -0,410$, $p \leq 0,001$); memory ($r = -0,406$, $p \leq 0,001$); pathognomonic ($r = -0,408$, $p \leq 0,001$); visual ($r = -0,396$, $p \leq 0,001$) and tactile ($r = -0,345$; $p \leq 0,01$). The intellectual processes and left-hemisphere scales have the strongest negative correlational values, perhaps suggesting that skills associated with left hemisphere function are verbally mediated and thus may be more influenced by socio-economic variables. This suggestion has been supported by the research findings of Snow and Weinstock (1990) who reported that

socio-economic status is related to performance on the Wechsler Adult Intelligence Scales. Golden (1980) has argued that the Intellectual Processes Scale measures intellectual behaviours.

Among the older subjects (50-60 year olds), there was a significant negative relationship between socio-economic status and the total Luria-Nebraska Neuropsychological Battery scores ($r = -0,680$, $p \leq 0,001$). It is interesting that this value has actually risen in absolute magnitude which suggests that with increasing age, socio-economic variables have a stronger mediating influence on neuropsychological performance. Also, all of the scale scores showed significant negative correlation values with socio-economic status: tactile ($r = -0,732$, $p \leq 0,001$); left-hemisphere ($r = -0,705$, $p \leq 0,001$); expressive speech ($r = -0,690$, $p = \leq 0,001$); right-hemisphere ($r = -0,688$, $p \leq 0,001$); pathognomonic ($r = -0,657$, $p \leq 0,001$); motor ($r = -0,622$, $p \leq 0,001$); rhythmic ($r = -0,622$, $p \leq 0,001$); writing ($r = -0,622$, $p \leq 0,001$); intellectual processes ($r = -0,612$, $P \leq 0,001$); arithmetic ($r = -0,592$, $p \leq 0,001$); visual ($r = -0,567$, $p \leq 0,001$); receptive speech ($r = -0,544$, $p \leq 0,001$) reading ($r = -0,523$, $p \leq 0,001$) and memory ($r = -0,459$, $p \leq 0,01$). Two observations are worthy of comment in these findings. Firstly, with the exception of the memory scale, all other scale correlational values with socio-economic status are above 0,5. According to Hinkle, Wiersma and Jurs (1982), a correlational value above 0,5 using a parametric technique is remarkable

in psychometric research. Secondly, the scales with the highest correlational values with socio-economic status were those relating to the tactile, left- and right-hemispheres, respectively, as well as the expressive speech scores. The literature does not advance any posible explanation for these findings but these results suggest that language functions may be biased in favour of higher socio-economic status groups. However, the consistent findings associated with the tactile and right-hemisphere scale correlation scores are not surprising since tactile dysfunction is associated with right hemisphere involvement (Lezak, 1983).

Among the younger subjects (25-40 year olds), significant negative correlations were obtained between socio-economic status and total Luria-Nebraska Neuropsychological Battery ($r = -0,401$, $p \leq 0,01$), memory ($r = -0,502$, $p \leq 0,01$), left hemisphere ($r = -0,387$, $p \leq 0,01$), intellectual processes ($r = -0,355$, $p \leq 0,05$); receptive speech ($r = -0,349$, $p \leq 0,05$) and right-hemisphere ($r = -0,313$, $p \leq 0,05$) scores. It seems that socio-economic variables do not have such a pervasive influence on neuropsychological performance as has been the case with older subjects. In fact, only one correlational value (memory scale) reached a magnitude of 0,5 which is considered strong in psychometric research.

The results in Tables 54 and 56 indicate that the total and individual scale scores of the Luria-Nebraska Neuropsychological Battery significantly correlated with socio-economic status among the older females and older males, respectively. These findings are consistent with those reported earlier. While among younger females (Table 55), there was a significant negative correlation with socio-economic status and the total Luria-Nebraska Neuropsychological Battery score ($r = -0,490$, $p \leq 0,05$), and the scores of the Intellectual Processes ($r = -0,624$, $p \leq 0,01$), Receptive Speech ($r = -0,599$, $p \leq 0,01$), Reading ($r = -0,532$, $p \leq 0,05$), Visual ($r = -0,523$, $p \leq 0,05$), Arithmetic ($r = -0,507$, $p \leq 0,05$), left-hemisphere ($r = -0,500$, $p \leq 0,05$) and Memory ($r = -0,646$, $p \leq 0,01$) scales, similar significant correlations were absent for younger males (Table 57). It is interesting to note the differential influence of sex on the relationship between socio-economic status and performance on the total Luria-Nebraska Neuropsychological Battery and on the aforementioned subscales of the Battery. It is possible that socialization effects may be reflected in these results as Golden and Vicente (1983) argue that socialization influences are most significant in early childhood and adulthood.

While the older males (50 to 60 year olds) revealed a significant negative correlation between socio-economic status and total and individual scale scores of the Luria-Nebraska Neuropsychological Battery, the findings are different for the younger

males (25-40 year olds, table 57). No significant correlations were found between socio-economic status and any of the Luria-Nebraska Neuropsychological Battery scores in the latter group. No explanation concerning these results may be derived from the literature. However, it appears that the effects of socialization in its varied forms may account for some of these findings.

It would appear, therefore, that socio-economic variables are not mediating influences in the neuropsychological performances of young males. It is clear that the area warrants further investigation in an effort to explain these findings.

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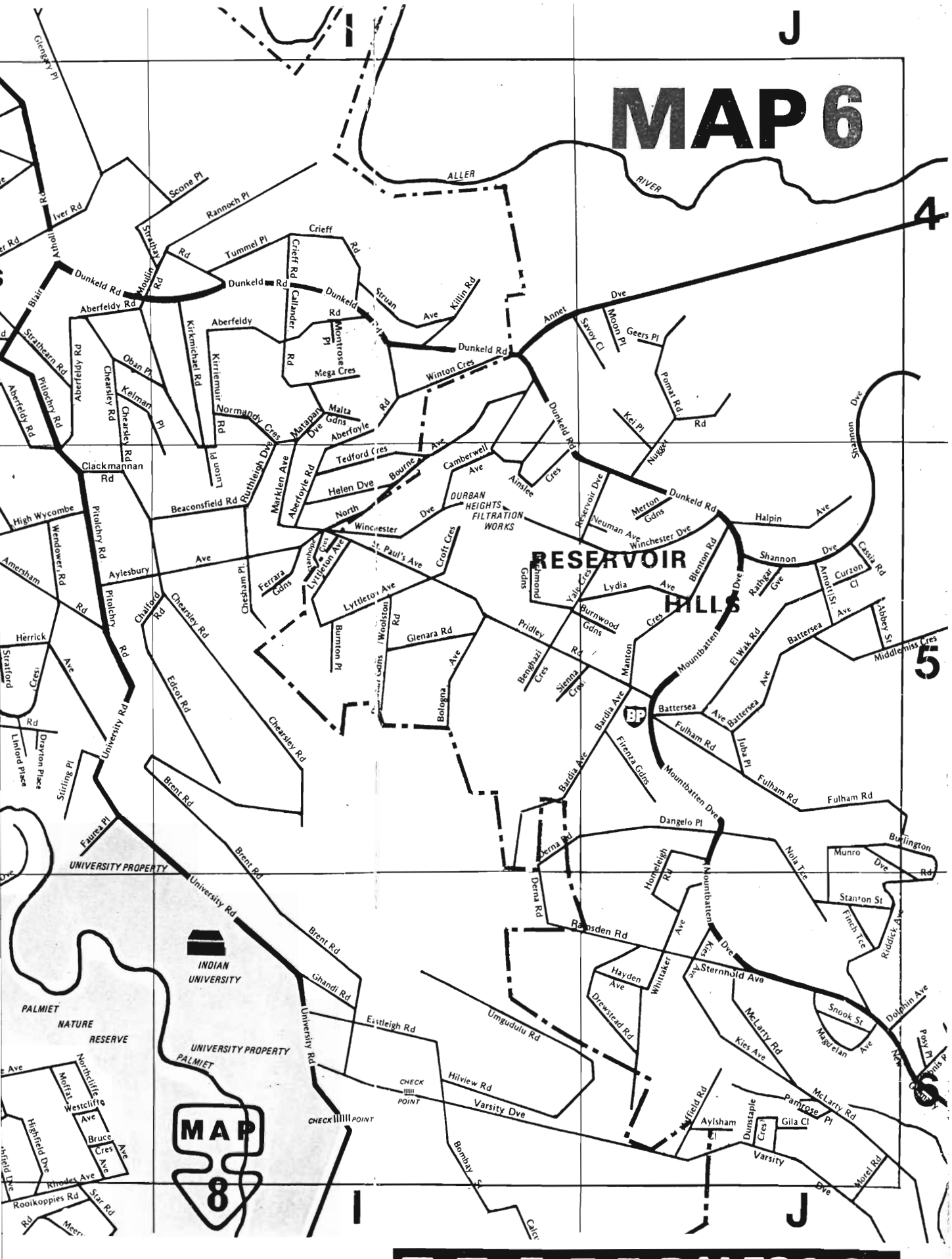
APPENDIX A



APPENDIX B

UNIVERSITY OF DURBAN - WESTVILLE

BIOGRAPHICAL INVENTORY

INSTRUCTIONS

Please complete the following questionnaire as FULLY as possible. All information supplied will be welcomed by the researcher and treated in STRICT CONFIDENCE.

A. DETAILS OF RESPONDENT

1. SURNAME :_____
2. FIRST NAMES :_____
3. DATE OF BIRTH :_____
4. SEX :_____
5. HANDEDNESS (L OR R) :_____
6. LEVEL OF EDUCATION :_____
7. VOCATION :_____
8. PHONE NO. - WORK :_____
   HOME :_____
9. APPROXIMATE INCOME PER MONTH :_____
10. FAMILY SIZE :_____
11. BIRTH ORDER :_____
12. MARITAL STATUS :_____
13. RELIGION :_____
14. LANGUAGE SPOKEN AT HOME :_____
15. DATE OF TEST :_____
16. SUGGESTED DAYS AND TIMES AVAILABLE :_____

B. PSYCHOLOGICAL/PSYCHIATRIC

Please place a CROSS (X) in the relevant column.

	SUBJECT	MOTHER/ FATHER	SIBLINGS	CHILDREN	SPOUSE
(a) DEPRESSION					
(b) ANXIETY					
(c) ALCOHOL USE					
(d) STIMULANTS/ DRUG USE					
(e) TREATED BY A PSYCHOLOGIST/ PSYCHIATRIST					

C. NEUROLOGICAL DISEASES

Please place a CROSS (X) in the relevant column.

	SUBJECT	MOTHER/ FATHER	SIBLINGS	CHILDREN	SPOUSE
(a) HEADACHES					
(b) STROKE					
(c) TUMOURS					
(d) INFECTIONS, E.G. MENINGITIS					
(e) HEAD INJURY					
(f) DEVELOPMENTAL DISORDERS, E.G. CEREBRAL PALSY					
(g) SEIZURES, E.G. EPILEPSY					

D. NEUROSURGERY

(i) NATURE :_____

_____

(ii) WHEN :_____

_____

(iii) PRESENT STATUS :_____

_____

Thank you for your co-operation.

APPENDIX C

Luria-Nebraska Neuropsychological Battery

Patient Response Booklet

by

Charles J. Golden, Ph.D.
Thomas A. Hammeke, Ph.D.
Arnold D. Purisch, Ph.D.

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Name: _____ Date: _____ Age: _____

Sex: M F Marital Status: _____ Race: _____

Occupation: _____ Education: _____ Hand Dominance: L R

Place of Examination: _____ Examiner _____

Motor Functions Scale

Item Number	Description	Scoring	Scale Score
(1)	Thumb-finger sequential touch, RIGHT hand. # in 10 seconds : [____]	0 = >6 1 = 5-6 2 = ≤5	0 1 2
(2)	Thumb-finger sequential touch, LEFT hand. # in 10 seconds: [____]	0 = >8 1 = 5-8 2 = ≤5	0 1 2
(3)	Alternating clench/extension, RIGHT hand. # in 10 seconds: [____]	0 = >12 1 = 7-12 2 = ≤7	0 1 2
(4)	Alternating clench/extension, LEFT hand. # in 10 seconds: [____]	0 = >15 1 = 8-15 2 = ≤8	0 1 2
	For the next several items I am going to blindfold you and put your hand in a certain position. After I am finished, I want you to put your hand in the same position.		
(6)	Right thumb against fifth finger for 2 seconds, then separate.	0 = correct 2 = incorrect	0 2
(5)	Left thumb against fifth finger for 2 seconds, then separate.	0 = correct 2 = incorrect	0 2
	Now I am going to put your hand in a certain position again, but this time I will ask you to repeat the position with your other hand.		
(7)	Left thumb against middle finger for 2 seconds.	0 = correct 2 = incorrect	0 2
(8)	Right thumb against middle finger for 2 seconds.	0 = correct 2 = incorrect	0 2
	[Remove blindfold.] **I am going to show you some hand movements. Please copy them exactly and make sure that you use the same hand as I do.**		
(9)	DEMONSTRATE. Right hand with bent fingers under chin.	0 = correct 2 = incorrect	0 2
(10)	DEMONSTRATE. Left hand with bent fingers under chin.	0 = correct 2 = incorrect	0 2
(11)	DEMONSTRATE. Tips of vertical right-hand fingers, palm left, touch chin.	0 = correct 2 = incorrect	0 2
(12)	DEMONSTRATE. Tips of vertical left-hand fingers, palm right, touch chin.	0 = correct 2 = incorrect	0 2
(13)	DEMONSTRATE. Tips of horizontal right-hand fingers (palm down) placed against palm of vertical left hand.	0 = correct 2 = incorrect	0 2
(14)	DEMONSTRATE. Tips of horizontal left-hand fingers (palm down) placed against palm of vertical right hand.	0 = correct 2 = incorrect	0 2

Motor Functions Scale Continued

Item Number	Description	Scoring	Scale Score		
(15)	DEMONSTRATE: Raise right hand, palm out, to height of your head.	0 = correct 2 = incorrect	0		2
(16)	DEMONSTRATE: Raise left hand, palm out, to height of your head.	0 = correct 2 = incorrect	0		2
(17)	DEMONSTRATE: Right hand points to left eye.	0 = correct 2 = incorrect	0		2
(18)	DEMONSTRATE: Left hand points to right eye.	0 = correct 2 = incorrect	0		2
	[Do not demonstrate items 19 & 20.]				
(19)	**Point to your left eye with your right hand.**	0 = correct 2 = incorrect	0		2
(20)	**Touch your right ear with your left hand.**	0 = correct 2 = incorrect	0		2
(21)	**I want you to copy what I do and change the positions of your two hands like this. First, you are to clench your right hand and at the same time extend the fingers of your left hand; then I want you to reverse the positions of your two hands. That is, I want you to clench the fingers of your left hand and extend the fingers of your right hand at the same time, changing smoothly from one hand to the other.** [Demonstrate with palms facing down and allow *S* to practice.] **Do it as quickly as possible.** # of sequences in 10 seconds: [____]	0 = >8 1 = 6-8 2 = <6	0	1	2
(22)	**Tap your right hand twice and your left hand once, changing from one hand to the other without interruption.** [Demonstrate and allow *S* to practice.] **Do this as fast as you can until I tell you to stop.** # of sequences in 10 seconds: [____]	0 = >8 1 = 7-8 2 = <7	0	1	2
(23)	**Now, tap your left hand twice and your right hand once, changing from one hand to the other without interruption.** [Demonstrate and allow *S* to practice.] **Do this as fast as you can until I tell you to stop.** # of sequences in 10 seconds: [____]	0 = >10 1 = 5-10 2 = <5	0	1	2
	[Present Patient Response Booklet.]				
(24)	**I want you to draw this pattern as quickly as you can without lifting your pencil from the paper.** [Present D1. Allow 20 seconds. Permit second trial if *S* lifts pencil on first.]	0 = correct 2 = incorrect	0		2
(25)	**Pretend you are holding a tea (coffee) pot in your hand and you have a cup available. Show me how to pour and stir tea (coffee).**	0 = correct 2 = incorrect	0		2
(26)	**Show me how you would thread a needle.**	0 = correct 2 = incorrect	0		2
(27)	**Show me how you would use a pair of scissors.**	0 = correct 2 = incorrect	0		2

Motor Functions Scale Continued

Item Number	Description	Scoring	Scale Score		
(28)	**Puff out your cheeks.**	0 = correct 2 = incorrect	0		2
(29)	**Stick your tongue out as far as possible and keep it there until I ask you to put it back in your mouth.** [3-second minimum extension]	0 = correct 2 = incorrect	0		2
(30)	**Stick your tongue out and roll it up.**	0 = correct 2 = incorrect	0		2
(31)	**Put your tongue between your upper teeth and upper lip.**	0 = correct 2 = incorrect	0		2
(32)	**I am going to ask you to make three movements with your mouth. I will show you the movements, then I want you to do them. First, I want you to show your teeth, then stick out your tongue, and third, place your tongue between your lower teeth and lower lip, like this.** [Demonstrate sequence.] **Now I want you to do these three movements. Remember, first show your teeth, then stick out your tongue, then place your tongue between your lower teeth and lower lip.**	0 = correct 2 = incorrect	0		2
(33)	**Now do these same three movements rapidly several times until I tell you to stop. Remember, first show your teeth, then stick out your tongue, and then place your tongue between your lower teeth and lower lip.** [Demonstrate and allow S to practice.] # of sequences in 10 seconds. [____]	0 = >3 1 = 2-3 2 = ≤2	0	1	2
(34)	**Show me how to chew.**	0 = correct 2 = incorrect	0		2
(35)	**Show me how to whistle.** [If S uses fingers, ask. **What is another way to whistle without using your fingers?**]	0 = correct 2 = incorrect	0		2
	[Present Patient Response Booklet.]				
(36)	**Without lifting the pencil from the paper, I want you to draw the best circle you can as quickly as you can.** [Permit second drawing if pencil is lifted. Time response and allow 15 seconds for each drawing.]	See Manual	0	1	2
(37)	Time for item #36: [____]	0 = 1-3 secs 1 = 4-5 secs 2 = 6-16 secs	0	1	2
(38)	**Without lifting the pencil from the paper, I want you to draw the best square you can as quickly as you can.** [Time response and allow 15 seconds.]	See Manual	0	1	2
(39)	Time for item #38: [____]	0 = 1-3 secs 1 = 4-5 secs 2 = 6-16 secs	0	1	2

Motor Functions Scale Continued

Item Number	Description	Scoring	Scale Score		
(40)	**Without lifting your pencil from the paper, I want you to draw the best triangle you can as quickly as you can and make all three sides equal.** [Time response and allow 15 seconds.]	See Manual	0	1	2
(41)	Time for item #40: [____]	0 = 1-3 secs 1 = 4-5 secs 2 = 6-16 secs	0	1	2
(42)	**Without lifting your pencil from the paper, copy this figure as best and as quickly as you can.** [Present D2. See scoring criteria for item #36. Time response.]	See Manual	0	1	2
(43)	Time for item #42: [____]	0 = 1-3 secs 1 = 4-5 secs 2 = 6-16 secs	0	1	2
(44)	**Without lifting your pencil from the paper, copy this figure as best and as quickly as you can.** [Present D3. See scoring criteria for item #38. Time response.]	See Manual	0	1	2
(45)	Time for item #44: [____]	0 = 1-3 secs 1 = 4-7 secs 2 = 8-16 secs	0	1	2
(46)	**Without lifting your pencil from the paper, copy this figure as best and as quickly as you can.** [Present D4. See scoring criteria for item #40. Time response.]	See Manual	0	1	2
(47)	Time for item #46. [____]	0 = 1-3 secs 1 = 4-6 secs 2 = 7-16 secs	0	1	2

(48)	**Now, I am going to knock on the table. If I knock once, I want you to knock twice; and if I knock twice, I would like you to knock once.** [1: ____ 2: ____ 2: ____ 1: ____]	# errors
		0 = none
		1 = 1
		2 = 2-4
			0	1	2

(49)	**Please take my hand. Now, if I say "red" I want you to squeeze my hand, and if I say "green" do nothing.** [R: ____ G: ____ G: ____ R: ____]	# errors
		0 = none
		1 = 1
		2 = 2-4
			0	1	2

(50)	**If I knock once, I want you to raise your right hand. If I knock twice, I want you to raise your left hand.** [1: ____ 2: ____ 1: ____ 2: ____]	# errors
		0 = 0-1
		1 = 2
		2 = 3-4
			0	1	2

(51)	**If I knock hard, you knock gently; if I knock gently, then knock hard.** [Demonstrate hard & gentle knocks.] [G: ____ H: ____ H: ____ G: ____]	# errors
		0 = none
		1 = 1-2
		2 = 3-4
			0	1	2

MOTOR FUNCTIONS SCALE TOTAL: [ ]

Rhythm Scale

Item Number	Description	Scoring	Scale Score		

(52)	**Now you are going to hear two tones on a tape from this tape recorder. I want you to tell me whether the tones you hear are the same or different.** [Play the tape. The tape is stopped between items.] [S: ___ D: ___ S: ___ D: ___ D: ___]	# errors
		0 = none
		1 = 1-2
		2 = 3-5
			0	1	2

(53)	**I will again play two tones from the tape. I want you to tell me whether the first tone or the second tone is higher in pitch.** [Play the tape, stop between items.] [1st: ___ 2nd: ___ 2nd: ___ 1st: ___ 2nd: ___]	# errors
		0 = none
		1 = 1
		2 = 2-5
			0	1	2

(54)	**Now you will hear two groups of sounds. There will be about four tones in each group. You will hear the first group of tones, then there will be a pause. Then you will hear the second group of tones. I want you to tell me whether the two groups are identical or different. Make sure that you listen entirely to both groups.** [Play the tape, stop between items.] [S: ___ D: ___ S: ___ D: ___ D: ___ S. ___]	# errors
		0 = none
		1 = 1-2
		2 = 3-6
			0	1	2

(55)	**I am going to play two tones. After you listen to them, I want you to hum them.** [low-high: ___ high-low: ___]
	Now there will be three tones. Listen to all three of them before you hum them for me. [low-high-low: ___ high-low-high: ___]
		# errors
		0 = none
		1 = 1-2
		2 = 3-4
			0	1	2

(56)	**I am going to play a tune from the tape. After you hear it, I would like you to sing it.** [Play from tape: "My Bonnie Lies Over the Ocean."]	0 = correct 2 = incorrect	0		2
(57)	**I would like you to sing the first line of "Home On the Range."** [If *S* does not know this song, substitute "Happy Birthday" or a song from *S*'s ethnic/national past.]	0 = correct 2 = incorrect	0		2

(58)	**I am going to play a group of beeps. After each group of beeps you hear, I want you to tell me how many beeps are in the group.** [Stop tape after each group] [2: ___ 3: ___ 2: ___ 3: ___]	# errors
		0 = none
		1 = 1
		2 = 2-4
			0	1	2

(59)	**Now I am going to play several groups of beeps. I want you to tell me how many beeps are in the groups all together. Keep counting until I tell you that all the beeps have ended.** [Stop tape after each group of beeps.] [8: ___ 12: ___]	# errors
		0 = none
		1 = 1
		2 = 2
			0	1	2

(60)	**Now listen carefully. How many beeps are there in each of these groups?** [Stop tape after each group.] [4: ___ 3: ___ 5: ___ 5: ___]	# errors
		0 = none
		1 = 1
		2 = 3-4
			0	1	2

(61)	**Now I am going to play several groups of beeps in which some of the beeps are loud and some of the beeps are soft. I want you to listen carefully and tell me how many beeps there are in each group.** [6: ___ 8. ___]	# errors
		0 = none
		1 = 1
		2 = 2
			0	1	2

Rhythm Scale Continued

Item Number	Description	Scoring	Scale Score

(62)	**You will now hear a rhythm on the tape. When I tell you that the rhythm is over I want you to tap with your hand the rhythm that you heard on the tape.** [trial 1: ____ trial 2: ____ trial 3: ____]
	In the next section some beeps are loud and some beeps are soft. I want you again to repeat the pattern of the rhythm, but this time tap gently for soft beeps and tap hard for loud beeps. [trial 4: ____ trial 5: ____]
		# errors
		0 = 0-1
		1 = 2-4
		2 = 5
			0 1 2

(63)	**Now I want you to make a series of:** [If S fails to make a series, say, "I want you to make a series. Do the rhythm more than once."] **two taps:** [____] **three taps:** [____] **two taps:** [____] **two strong and three weak taps:** [____] **three weak and two strong taps:** [____] **two taps and three taps:** [____]	# errors
		0 = none
		1 = 1
		2 = 2-6
			0 1 2

RHYTHM SCALE TOTAL: ____

Tactile Functions Scale

Item Number	Description	Scoring	Scale Score
	THE SUBJECT SHOULD BE BLINDFOLDED FOR ALL ITEMS		
	I am going to touch you with the eraser end of the pencil. Tell me where I am touching you. [Alternate right side and left side sequences.]		
	Right: [1: ____ F: ____ 3: ____ 5: ____ P: ____ 2: ____ S: ____ 4: ____]		
	Left: [P: ____ 2: ____ 3: ____ S: ____ 5: ____ 4: ____ F: ____ 1: ____]		
(64)	Number of RIGHT side errors:	0 = none 1 = 1 2 = 2-8	0 1 2
(65)	Number of LEFT side errors:	0 = none 1 = 1 2 = 2-8	0 1 2
	I am now going to touch you with either the point or the head of a pin. When I touch you, tell me whether it is the point or the head. [Alternate between hands.]		
	Back of right hand. [P: ____ H: ____ P: ____ P: ____ H: ____]		
	Back of left hand: [H: ____ P: ____ P: ____ H: ____ H: ____]		

actile Functions Scale Continued

Item umber	Description	Scoring	Scale Score		
(66)	Number of RIGHT hand errors:	0 = none 1 = 1 2 = 2-5	0	1	2
(67)	Number of LEFT hand errors:	0 = none 1 = 1 2 = 2-5	0	1	2
	I am now going to touch you with the head of the pin. Some of the touches will be hard and some of the touches will be soft. This is a hard touch [DEMONSTRATE: depress 3mm] **and this is a soft touch** [DEMONSTRATE: depress 1mm]. **Do you notice the difference?** [If no difference is felt, repeat demonstration.] **Now, tell me whether you feel a hard or a soft touch.** [Alternate between wrists.] Back of right wrist: [S: ___ H: ___ H: ___ S: ___] Back of left wrist: [H: ___ S: ___ H: ___ S: ___]				
(68)	Number of RIGHT wrist errors:	0 = none 1 = 1 2 = 2-4	0	1	2
(69)	Number of LEFT wrist errors:	0 = none 1 = 1 2 = 2-4	0	1	2
	Now I am going to touch you again and I want you to tell me how many points you feel. [Alternate between right and left middle fingers to determine threshold of two-point discrimination. Alternate single and two-point stimuli. See Manual.]				
(70)	Two-point distance, RIGHT hand:	0 = 5mm 1 = 10mm 2 = > 10mm	0	1	2
(71)	Two-point distance, LEFT hand:	0 = 5mm 1 = 10mm 2 = >10mm	0	1	2
	Now I am going to move an object along your arm, either up your arm towards your shoulder or down your arm towards your fingers. Tell me whether I am moving the object up or down. [Alternate stimuli as follows:] 1) Up right arm: [___] 2) Down left arm: [___] 3) Down right arm: [___] 4) Up left arm: [___]				
(72)	RIGHT arm errors:	0 = none 1 = 1 2 = 2	0	1	2

Tactile Functions Scale Continued

Item Number	Description	Scoring	Scale Score
(73)	LEFT arm errors:	0 = none 1 = 1 2 = 2	0 1 2
	I am going to trace either a cross, a triangle, or a circle on your wrist. I want you to tell me what I am tracing. [Trace alternately on back of right and left wrists. Remind *S* of the three forms after the first error.] 1) Circle/right: [____] 2) Triangle/left: [____] 3) Cross/right: [____] 4) Cross/left: [____] 5) Triangle/right: [____] 6) Circle/left: [____]		
(74)	RIGHT wrist errors:	0 = none 1 = 1 2 = 2-3	0 1 2
(75)	LEFT wrist errors:	0 = none 1 = 1 2 = 2-3	0 1 2
	Now I am going to trace a number on the back of your wrists. What number is this? [Trace the number "3."]		
(76)	RIGHT wrist performance:	0 = correct 2 = incorrect	0 2
(77)	LEFT :wrist performance:	0 = correct 2 = incorrect	0 2
	Now I am going to trace a letter on the back of your wrist. What letter is this? [Trace the letter "S."]		
(78)	RIGHT wrist performance:	0 = correct 2 = incorrect	0 2
(79)	LEFT wrist performance:	0 = correct 2 = incorrect	0 2
(80)	**Now I will put your left arm in a certain position. Try to put your right arm in this same position.** [Extend left arm in front at 90° from body trunk. See Manual.]	0 = correct 2 = incorrect	0 2

Tactile Functions Scale Continued

Item Number	Description	Scoring	Scale Score
(81)	**Now I will put your right arm in a certain position. Try to put your left arm in the same position.** [Extend right arm in front 90° from trunk.]	0 = correct 2 = incorrect	0 2

I am going to place an object in one of your hands and I want you to tell me exactly what the object is. [Follow the sequence below. Discontinue timing after 10 seconds for each item. See Manual.]

Right Hand		Time	Left Hand		Time
1) quarter	[___]	___	2) eraser	[___]	___
3) key	[___]	___	4) paper clip	[___]	___
5) eraser	[___]	___	6) key	[___]	___
7) paper clip	[___]	___	8) quarter	[___]	___
Total Right:	[___]	___	Total Left:	[___]	___

(82)	RIGHT hand errors:	0 = none 1 = 1 2 = 2-4	0 1 2
(83)	RIGHT hand time:	0 = 1-11 secs 1 = 12-25 secs 2 = 26-44 secs	0 1 2
(84)	LEFT hand errors:	0 = none 1 = 1 2 = 2-4	0 1 2
(85)	LEFT hand time:	0 = 1-7 secs 1 = 8-26 secs 2 = 27-44 secs	0 1 2

TACTILE FUNCTIONS SCALE TOTAL: ☐

REMOVE THE BLINDFOLD

Visual Functions Scale

Item Number	Description	Scoring	Scale Score

(86)	**I am going to present you with several objects. Please tell me what they are.** [Allow 10 seconds per item.]
	1) pencil [___] 3) rubber band [___]
	2) eraser [___] 4) quarter [___]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0 1 2

Visual Functions Scale Continued

Item Number	Description	Scoring	Scale Score	

(87)	**I am now going to show you several pictures. Tell me what they are.** [Allow 10 seconds per card.]
	
	G3 (handbag, purse, pocketbook): [____]
	G4 (nutcracker): [____]
	G5 (vial, glass [measuring], test tube, rain gauge, graduated cylinder): [____]
	G6 (camera [with or without lenses]): [____]
	G7 (egg carton): [____]
		# errors
		0 = 0-1
		1 = 2
		2 = 3-5
			0	1

(88)	**Now I am going to show you some more pictures. Tell me what they are.** [Allow 10 seconds per card.]
	
	G8a (book): [____]
	G8b (book): [____]
	G9a (sunglasses, glasses, spectacles): [____]
	G9b (sunglasses, glasses, spectacles): [____]
	G9c (sunglasses): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0	1

(89)	**Tell me what these pictures are.** [Allow 10 seconds per card.]
	
	G10 (telephone): [____]
	G11 (man's profile, man's face): [____]
	[If *S* replies "a person," "the thinker," etc., say: "What makes it look like that?"]
		# errors
		0 = none
		1 = 1
		2 = 2
			0	1

(90)	**There are a number of items in this picture. Please name as many as you can.** [Present G13. Allow 15 seconds.]
	
	1) pail, bucket [____] 2) scissors, shears [____] 3) rake [____]
	4) (paint) brush, baster [____] 5) hatchet, ax [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3-5
			0	1

(91)	**Now tell me what objects you can make out in this picture.** [Present G14. Allow 15 seconds.]
	
	1) coffee/tea pot (kettle) [____] 2) fork [____] 3) bottle [____]
	4) glass, wire basket [____] 5) bowl, dish, saucer, basin [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3-5
			0	1

	Please look at this card. [Present G19 as an example.] **The larger design at the top has a piece missing. Below it are several alternate pieces that all have the right shape to fit in the space that is missing in the larger design. I want you to show me which piece at the bottom has a design on it that will enable it to complete the pattern of the larger design.** [If *S* misses G19, point out the error and the correct answer, saying "See how the pattern matches," then continue on to the regular items G17 and G18, allowing 30 seconds per item. See Manual for scoring time.] G17 (top right): [____] Time: ____ G18 (bottom left): [____] Time: ____			
(92)	Errors in G17 + G18:	0 = none 1 = 1 2 = 2	0	1

Visual Functions Scale Continued

Item Number	Description	Scoring	Scale Score		
(93)	Time for G17 + G18:	0 = 1-9 secs 1 = 10-35 secs 2 = 36-62 secs	0	1	2
	[Present G26.]				

(94)	**Tell me what time these clocks tell on this card.** [Allow 10 seconds per clock. Answers must be within one minute of correct response.]
	7:53 [____] 5:09 [____] 1:25 [____] 10:35 [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3-4
			0	1	2

	[Present Patient Response Booklet.]				

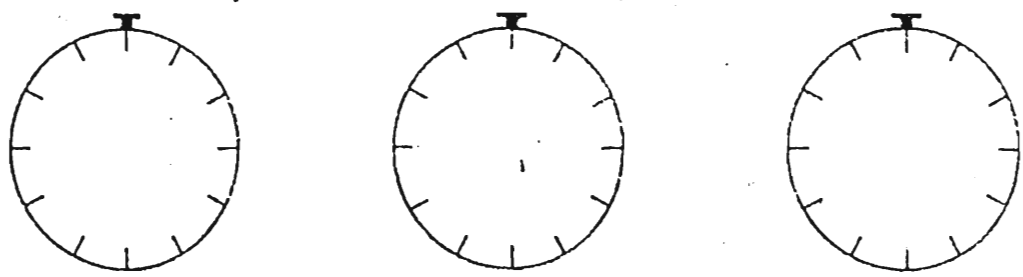
(95)	**I want you to draw the hands of a clock on this sheet with blank faces for the following times. Make sure you draw the minute hand longer than the hour hand.** [If the examiner is not certain which is the minute hand and which is the hour hand, *S* should be asked. Allow 20 seconds per clock.]
	12:50 [____] **4:35** [____] **11:10** [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3
			0	1	2

	[Present G27.]				

(96)	**If this compass were on a map, which way would be:**
	North? [____] **East?** [____] **West?** [____]
	[If *S* gives an incorrect response for North, correct, but count that response as wrong. Allow 10 seconds per response.]
		# errors
		0 = none
		1 = 1-2
		2 = 3
			0	1	2

	This drawing shows a stack of blocks. [Briefly present G29, then remove.] **When I show you this card again, I want you to tell me how many blocks make up the stack. Be sure to include the blocks you see as well as the ones you don't see.** [Allow 20 seconds maximum per item. See Manual for scoring time. If *S* makes an error on G29, say upon presentation of G30: "Be sure to include those you don't see."] G29(15): [____] Time: ____ G31(15): [____] Time: ____ G30(18) [____] Time: ____ G32(10). [____] Time: ____				
(97)	Number of Errors in block items:	0 = none 1 = 1-2 2 = 3-4	0	1	2
(98)	Total Time for block items:	0 = 1-28 secs 1 = 29-49 secs 2 = 50-84 secs	0	1	2

95. Clock faces



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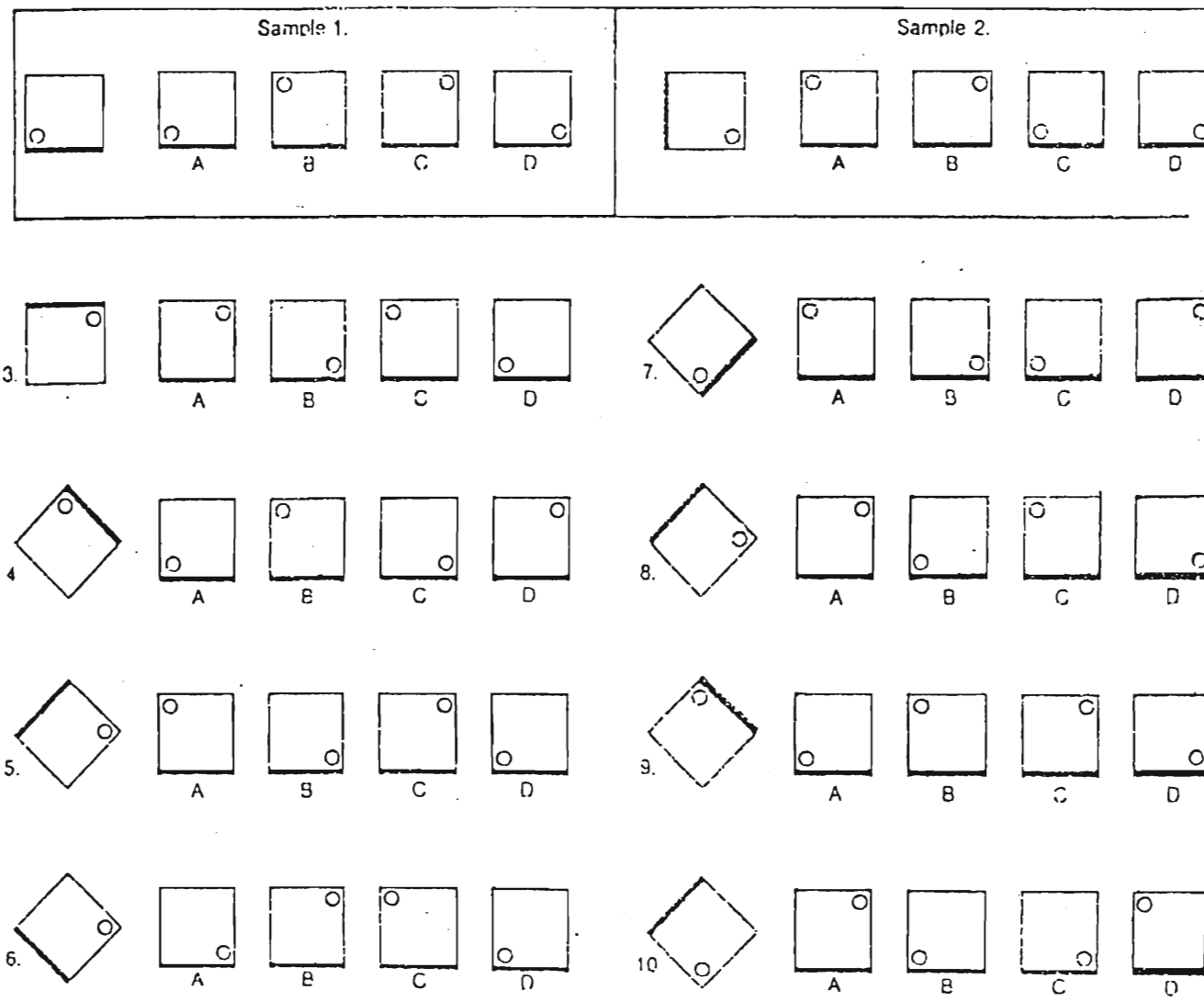
99. Visual-Spatial



Visual Functions Scale Continued

Item Number	Description	Scoring	Scale Score
	[Present Patient Response Booklet.]		

(99)	**At the left of this sheet of paper is a square with a circle in one corner.** [Point to figure labeled Sample 1.] **Notice the heavy dark line on one side of the square. This is the base line. Now look at the squares** [point to the four choices in Sample 1] **and notice that each square has a circle in one corner and the bottom of each square is a heavy line, the base line. One of the four squares is just like the sample square. By using the base line as a reference point, you can tell which square is just like the sample. Now I want you to circle the letter under the square that is just like the sample square.** [Allow response.] **Square A is the correct square because the circle is in this corner next to the base line, just as it is in the sample. Now look at Sample 2. This is the same type of problem, with a heavy base line on the left side of the square.** [Trace with pencil.] **To solve the problem you have to turn the sample square in your head so that the base line is on the bottom, like it is in the possible answers. Now you circle the letter under the correct square.** [Allow response.] **Square B is the correct choice because if you turn the sample so that the base line is at the bottom, the circle will be in the upper right-hand corner just as it is in the square. Now I want you to do the rest of these items** [Point to 3 through 10] **by circling the letter under the correct square. Do them as quickly as you can, but try not to make any mistakes. If you are having trouble with one problem, skip it and come back to it later.** [Allow 90 seconds. See Manual.]
	
	3(d): [____] 4(c): [____] 5(a): [____] 6(b): [____] 7(c): [____] 8(c): [____]
	9(d): [____] 10(a): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-8
			0 1 2

VISUAL FUNCTIONS SCALE TOTAL: [ ]

Receptive Speech Scale

Item Number	Description	Scoring	Scale Score
	[Refer to Pronunciation Guide on Cassette Tape.]		

(100)	**I am now going to say some sounds to you that represent individual letters. I want you to listen to what I say and then repeat exactly the sound that you hear. For example, if you hear "tuh," I want you to say "tuh" after I do.** [Proceed with following items separately.]
	
	buh: [____] **puh:** [____] **muh:** [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3
			0 1 2

Receptive Speech Scale Continued

Item Number	Description	Scoring	Scale Score
	[Present Patient Response Booklet.]		

(101)	**Now I am going to say some sounds and I want you to write down the letter of the alphabet that the sound represents. For example, if you hear "tuh," I want you to write down the letter T.** [Examiner should again say: **buh; puh; muh.**]	# errors
		0 = none
		1 = 1-2
		2 = 3
			0 1 2

(102)	**Now I am going to say two sounds. After I say them I want you to repeat them right after me.** [Score each sound as right or wrong.]
	1) **muh—puh:** [____/____] 4) **duh—tuh:** [____/____]
	2) **puh—suh:** [____/____] 5) **kuh—guh:** [____/____]
	3) **buh—puh:** [____/____] 6) **ruh—luh:** [____/____]
		# errors
		0 = 1-2
		1 = 2-4
		2 = 5-12
			0 1 2

(103)	**I am again going to say two sounds as I just did before. This time, however, I want you to write down the letters represented by the two sounds rather than saying them aloud: muh—puh; puh—suh; buh—puh; duh—tuh; kuh—guh; ruh—luh.** [See Manual.]	# errors
		0 = 0-1
		1 = 2-5
		2 = 6-12
			0 1 2

(104)	**Now I will say three sounds. After I complete them, repeat them after me.** [Again score each sound.]
	1) **ā—ō—ā:** [__/__/__] 5) **duh-luh-duh:** [__/__/__]
	2) **ū—ā—ī:** [__/__/__] 6) **bī—bā—bō:** [__/__/__]
	3) **muh-suh-duh:** [__/__/__] 7) **bī—bō—bā:** [__/__/__]
	4) **buh-puh-buh:** [__/__/__]
		# errors
		0 = 0-2
		1 = 3-8
		2 = 9-21
			0 1 2

(105)	**I am again going to say three sounds. After I have finished the three sounds I want you to write down the letter represented by each sound: ā—ō—ā; ū—ā—ī; muh-suh-duh; buh-puh-buh; duh-luh-duh. I am now going to go on and say several more sets of three sounds. This time I want you to write down all the letters that go with the sounds you hear, not just the first letter. For example, if you hear "sh," you should write down S and H instead of just S.** [See Manual.] **bī—bā—bō; bī—bō—bā.**	# errors
		0 = 0-2
		1 = 3-8
		2 = 9-21
			0 1 2

(106)	**If you hear "buh," I want you to lift your right hand; if you hear "puh," I want you to lift your left hand:**
	1) **buh**(r): [____] 2) **puh**(l): [____] 3) **puh**(l): [____] 4) **buh**(r): [____]
		# errors
		0 = 0 or 4
		1 = 1
		2 = 2-3
			0 1 2

(107)	**Now I am going to say two letter sounds. I want you to tell me whether the letters you hear are the same or different from one another.** [First say "buh—puh" at the same pitch. Allow response. Then say "buh" twice, but with the second at a higher pitch (hear example on cassette tape).]
	buh—puh [____] **buh—buh** [____]
		# errors
		0 = none
		2 = any
			0 2

(108)	**Please point to your eye:** [____]; **nose:** [____]; **ear:** [____].	# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

Receptive Speech Scale Continued

Item Number	Description	Scoring	Scale Score

(109)	**I want you now to point, in order, to your eye, nose, ear, eye, nose. Let me repeat that once before you do that: I want you to point, in order, to your eye, nose, ear, eye, nose.** [The five items should be repeated about 1 second apart and *S* kept from responding until the entire sequence has been given.]
	
	[Place H10-H16 from *S*'s left to right.]
		# errors
		0 = none
		2 = any
			0 2

(110)	**Among these pictures, I want you to point to the shoe** (H10): [____]; **the candle** (H14): [____]; **and the stove** (H12): [____].	# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(111)	**Point to your knee:** [____]; **elbow:** [____]; **cheekbone:** [____].	# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(112)	**I am going to say some words. Please tell me what they mean:** [See Manual.]
	cat: _____ [____]
	bat: _____ [____]
	pat: _____ [____]
	
	[Place H17-H22 from *S*'s left to right.]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(113)	**Here are some pictures. Point to a picture that shows: typewriting** (H19). [____]; **mealtime** (H18): [____]; **summer** (H22): [____]	# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(114)	**Put your hand on your head:** [____] **Move a foot:** [____]
	[See Manual.]
	
	[Point to your watch and say:]
		# errors
		0 = none
		2 = any
			0 2

(115)	**Tell me whose this is:** [____]. [Allow response. Then point to any object belonging to *S* and say:]
	Who does this belong to?: [____].
	
	[Place H23-H25 from *S*'s left to right.]
		# errors
		0 = none
		2 = any
			0 2

(116)	**Among these pictures, point to the one that is used to light a fire.** (H25)	0 = correct 2 = incorrect	0 2

(117)	**Here are two cards. One is grey and one is black.** [Present H26 and H27.]
	If it is night now, I would like you to point to the grey card, and if it is day now, I would like you to point to the black card: [____] [Allow response.]
	This time, if it is day now, I want you to point to the black card, and if it is night now, I want you to point to the grey card: [____]
		# errors
		0 = none
		2 = any
			0 2

Receptive Speech Scale Continued

Item Number	Description	Scoring	Scale Score

(118)	[Place a pencil, a key, and a comb clockwise in a triangle before the subject.] **Point at the pencil:** [____]; **point at the key:** [____].	# errors
		0 = none
		2 = any
			0 2

(119)	[Keep the triangle of pencil, key, and comb on the table.] **Point with the key toward the pencil:** [____]; **point with the pencil toward the key:** [____].	# errors
		0 = none
		2 = any
			0 2

(120)	**Point to the pencil with the key:** [____]; **now, point to the comb with the pencil:** [____].	# errors
		0 = none
		2 = any
			0 2

	[Present H28]		
(121)	**On this card I would like you to point to the daughter's mother.** [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2
(122)	**Will you tell me whether the "father's brother" and the "brother's father" are two persons or the same person?** (2) [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2
	[Present Patient Response Booklet.]		

(123)	**I would like you to draw a cross beneath a circle:** [____]; **now would you please draw a circle to the right of a cross?:** [____] [See Manual.]	# errors
		0 = none
		2 = any
			0 2

(124)	**Tell me which is right: "Spring comes before summer," or "Summer comes before spring."** [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2
(125)	**Which boy is shorter if Tom is taller than Arnie?** (Arnie) [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2
(126)	**Tell me which of these sentences is correct: "A fly is bigger than an elephant," or "An elephant is bigger than a fly."** [Allow 10 seconds for response.]	0 = correct 2 = incorrect	0 2

(127)	**Look at these cards.** [Place H26 and H27 before S.] **Please answer the following questions: Which of the two is lighter?** (H26) [____]. **Which of the two is less light?** (H27) [____]. **Which of the two is darker?** (H27) [____]; **Which of the two is less dark?** (H26) [____]. [Allow 10 seconds per response.]	# errors
		0 = none
		1 = 1
		2 = 2-4
			0 1 2

(128)	**Tell me which girl is lightest, if Mary is lighter than Jane but darker than Sue?** (Sue) [____] **Which girl is darkest, if Mary is lighter than Jane but darker than Sue?** (Jane) [____]. [Allow 15 seconds per response.]	# errors
		0 = 0-1
		2 = 2
			0 2

(129)	**Someone has just told you that "Arnie hit Tom." Who was the victim?** (Tom) [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2
(130)	**If I had lunch after I cleaned up the house, what did I do first?** (clean) [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2

Receptive Speech Scale Continued

Item Number	Description	Scoring	Scale Score
(131)	**Is the following sentence said by a disciplined or undisciplined person: "I am unaccustomed to disobeying rules"?** (disciplined) [Allow 10 seconds for response.]	0 = correct 2 = incorrect	0 2
	[Be careful not to pause while saying the following sentence.]		

(132)	**Please listen to this statement: "The woman who worked at the store came to the school where Mary studied to give a talk." Tell me, who gave a talk?** (woman) [____]; **Tell me, what was Mary doing?** (studying, attending school) [____]. [Allow 10 seconds per response.]	# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

RECEPTIVE SPEECH SCALE TOTAL: [ ]

Expressive Speech Scale

Item Number	Description	Scoring	Scale Score

(133)	**Repeat the following sounds:**
	A (as in late): [____]
	I (as in light): [____]
	M (as in milk): [____]
	B (as in baby): [____]
	SH (as in shine): [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3-5
			0 1 2

(134)	**Please repeat the following sounds:**
	SP (as in spot): [____]
	TH (as in thaw): [____]
	PL (as in plate): [____]
	STR (as in string): [____]
	AWK (as in awkward): [____]
		# errors
		0 = none
		1 = 1-2
		2 = 3-5
			0 1 2

(135)	**I am now going to say two words; please repeat them after me:** [See Manual.]
	see — seen: [____] **tree — trick:** [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(136)	**Please repeat the following words:**
	house: [____] **table:** [____] **apple:** [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(137)	**Please repeat these words:**
	hairbrush: [____] **screwdriver:** [____] **laborious:** [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

Expressive Speech Scale Continued

Item Number	Description	Scoring	Scale Score

(138)	**Please repeat the following:**
	rhinoceros: [___] **surveillance:** [___] **hierarchy:** [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(139)	**Please repeat these words after me:** **cat — hat — bat:** [___]	0 = correct 2 = incorrect	0 2

(140)	**Please repeat:**
	streptomycin: [___] **Massachusetts Episcopal:** [___]
		# errors
		0 = 0-1
		2 = 2
			0 2

(141)	**Please repeat the following series of words:**
	hat — sun — bell: [___] **hat — bell — sun:** [___]
		# errors
		0 = none
		2 = 1-2
			0 2

(142)	**Please repeat the following series of words:**
	house — ball — chair: [___] **ball — chair — house:** [___]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(143)	**Say the sounds that go with these letters:** [Present J1. See Manual.]
	(a) [___] (i) [___] (m) [___] (b) [___] (sh) [___]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(144)	**Please say the sounds that go with these letters:** [Present J2.]
	(sp) [___] (th) [___] (pl) [___] (str) [___] (awk) [___]
		# errors
		0 = none
		1 = 1-2
		2 = 3-5
			0 1 2

(145)	**Read these words:** [Present J3.]
	(see—seen) [___/___] (tree—trick) [___/___]
		# errors
		0 = none
		2 = any
			0 2

(146)	**Please read these words:** [Present J4.]
	(cat) [___] (dog) [___] (man) [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(147)	**Please read these words:** [Present J5.]
	(house) [___] (table) [___] (apple) [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(148)	**Please read these words:** [Present J6.]
	(hairbrush) [___] (screwdriver) [___] (laborious) [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(149)	**Please read these words:** [Present J7.]
	(rhinoceros) [___] (surveillance) [___] (hierarchy) [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

Expressive Speech Scale Continued

Item Number	Description	Scoring	Scale Score

(150)	**Please read these words:** [Present J8.]
	(cat) [____] (hat) [____] (bat) [____]
		# errors
		0 = none
		2 = any
			0 2

(151)	**Please read these words:** [Present J9.]
	(streptomycin) [____] (massachusetts episcopal) [____]
		# errors
		0 = 0-1
		2 = 2
			0 2

(152)	**Please read these words:** [Present J10.]
	(hat) [____] (sun) [____] (bell) [____]
		# errors
		0 = none
		2 = any
			0 2

(153)	**Please read these words:** [Present J11.]
	(house) [____] (ball) [____] (chair) [____]
		# errors
		0 = none
		2 = any
			0 2

(154)	**Please repeat the following sentences after me:**
	The weather is fine today: [____]
	The sun shines and the sky is blue: [____]
		# errors
		0 = none
		2 = any
			0 2

(155)	**Please repeat the following sentences:** [See Manual.]
	The apple trees grew in the garden behind a high fence: [____]
	On the edge of the forest, the hunter killed the wolf: [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(156)	**Repeat: The house is on fire; the moon is shining; the broom is sweeping.**
	[Say as one sentence. See Manual.] [____] [____] [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(157)	**I am going to show you some pictures. Tell me what objects are in the pictures.** [Allow 10 seconds per card. Score 1st response.]
	J14 (guitar) [____]
	J15 (table) [____]
	J16 (can opener) [____]
	J17 (candle) [____]
	J18 (stapler) [____]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(158)	**I am going to show you some cards that represent parts of the body. I want you to tell me which part:**
	J19 (foot, ankle): [____]
	J20 (forearm, elbow, arm): [____]
	J21 ([specific] finger [nail]): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(159)	**I am going to describe several items to you and I want you to tell me what they are:**
	What do you use to fix your hair each morning?
	(comb, [hair] brush). [____]
	What shows you what time it is?
	(watch, clock, other timepiece). [____]
	What protects you from the rain?
	(umbrella, raincoat). [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

Expressive Speech Scale Continued

Item Number	Description	Scoring	Scale Score
(160)	**Count from 1 to 20 out loud.** [Discontinue after error or 15 seconds.]	0 = correct 2 = incorrect	0 2
(161)	**Count backwards from 20 to 1, starting with 20 then 19, 18, and so on until I tell you to stop.** [Discontinue after error or 20 seconds.]	0 = correct 2 = incorrect	0 2
(162)	**Tell me the days of the week.** [Discontinue after error or 10 seconds.]	0 = correct 2 = incorrect	0 2
(163)	**Now I want you to say the days of the week backwards, starting with Sunday.** [Discontinue after error or 15 seconds.]	0 = correct 2 = incorrect	0 2
	Look at this picture and tell me what is happening. Present J29. Time from card presentation to *S* response; discontinue after 30 seconds. Count number of words spoken in first 5 seconds of response. See Manual.]		
(164)	Time until response onset: [___]	0 = 1-3 secs 1 = 4-5 secs 2 = 6-31 secs	0 1 2
(165)	Number of words in 1st 5 seconds of response: [___]	0 = >8 1 = 6-8 2 = 0-5	0 1 2
	I am going to read the story out loud from card J30 and give you a copy of it. [Present J30.] **Follow along carefully because when I am through, I am going to take the card away and you are going to have to tell the story back to me in your own words.**		
	Yesterday Peter who was seven years old went down to the river to fish. He took his dog Prince with him. The river had overflowed its banks after the rainy weather. Peter slipped and fell into deep water. He would have drowned if the dog had not dived in and helped him to reach the shore.		
	[After reading the story, take the card away and say **Go ahead, please tell me about the story.** Time to *S* response; discontinue after 30 seconds. Count number of words in 1st 5 seconds of response.]		
(166)	Time until response onset: [___]	0 = 1-2 secs 1 = 3-5 secs 2 = 6-31 secs	0 1 2
(167)	Number of words in 1st 5 seconds of response: [___]	0 = >9 1 = 8-9 2 = 0-7	0 1 2
	Please make up a speech for me about the conflict between generations. [If *S* replies that (s)he doesn't know anything about it, say: **"Just say what you think is right."** If *S* still refuses to respond, say: **"Tell me about the weather."** Time to *S* response, discontinue after 30 seconds. Count number of words in 1st 5 seconds of response.]		
(168)	Time until response onset: [___]	0 = 1-10 secs 1 = 11-22 secs 2 = 23-31 secs	0 1 2
(169)	Number of words in 1st 5 seconds of response: [___]	0 = >9 1 = 6-9 2 = 0-5	0 1 2

Expressive Speech Scale Continued

Item Number	Description	Scoring	Scale Score
	I am going to show you some cards with sentences that have a word missing. Please give me a word that you think can fill in each sentence. [Record response and time until response. Allow 15 seconds per item. See Manual.]		
	time: response: J32: _____ _____ [___] J33: _____ _____ [___] J34: _____ _____ [___] Total: _____		
(170)	Number of errors:	0 = none 1 = 1 2 = 2-3	0 1 2
(171)	Total response time.	0 = 1-6 secs 1 = 7-22 secs 2 = 23-48 secs	0 1 2

(172)	**Here is a card that has three words on it. Make up a sentence that includes all three of these words.** [Present J35. Allow 20 seconds. See Manual.]_____
	_____
	_____
		# errors
		0 = none
		2 = any
			0 2

	Now I am going to give you a card on which the words are mixed up. If they are arranged correctly, they can make a sentence. I want you to arrange them so they do make a sentence. [If *S* responds incorrectly, say: "That is not quite right; keep trying." Allow 60 seconds per item. Time each response. See Manual.] J36: (I have asked the [my] teacher to mark my [the] paper.) [___] Time: _____ J37: (The [a] woodcutter went into a [the] forest and got wood.) [___] Time: _____		
(173)	Number of sentences with errors:	0 = 0-1 2 = 2	0 2
(174)	Total response time.	0 = 1-121 secs 2 = 122 secs	0 2
		EXPRESSIVE SPEECH SCALE TOTAL	

Writing Scale

Item Number	Description	Scoring	Scale Score

(175)	**How many letters are there in the following words:** [Allow 10 seconds per word.]
	cat (3): [____] **trap** (4): [____] **banana** (6): [____] **hedge** (5): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0 1 2

(176)	**Tell me:** [Allow 10 seconds per response.]
	the second letter in "cat" (a): [____]
	the first letter in "match" (m): [____]
	the third letter in "hedge" (d): [____]
	the letter in "stop" that comes after "o" (p): [____]
	the letter in "bridge" that comes before "g" (d): [____]
	
	[Present Patient Response Booklet.]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(177)	**Please copy these letters in your own normal handwriting.**
	[Present K1. Allow 20 seconds. See Manual.]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(178)	**Now copy these.** [Present K2. Allow 30 seconds.]	# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(179)	**I will show you a card that has three words on it. I will show it to you for 5 seconds. When I remove the card, I want you to write the words on the card down on your paper.** [Present K3 for 5 seconds. Allow 30 seconds for response. See Manual.]	# errors
		0 = none
		2 = any
			0 2

(180)	**Please write your first and last names.** [Allow 15 seconds.]	0 = correct 2 = incorrect	0 2
(181)	**I am going to say some letters. Please write them down: F; T; H; L.**	0 = correct 2 = incorrect	0 2

(182)	**Now write these sounds:**
	ba [____] **da** [____] **back** [____] **pack** [____]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0 1 2

(183)	**Now write these words: wren** [____]; **knife** [____].	# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(184)	**Please write: physiology** [____]; **probabilistic** [____].	# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

Writing Scale Continued

Item Number	Description	Scoring	Scale Score

(185)	**Now I am going to say groups of words or phrases. Please write them after I finish each group of words or phrase.** [See Manual.]
	hat—sun—dog [___/___/___]
	all of a sudden [___/___/___/___]
	last year before Christmas [___/___/___/___]
		# errors
		0 = none
		1 = 1
		2 = 2-11
			0 1 2

	Write a few sentences about your main ideas on bringing up children. [Start timing immediately. Allow 60 seconds. If *S* stops before limit, say: "Try to write more if you can." If *S* is still writing at the end of 60 seconds, say: "Finish the sentence you are on and then stop." See Manual.]		
(186)	Rating of grammar: [___]; spelling: [___]; and content: [___].	0 = 0 1 = 1-2 2 = 3	0 1 2
(187)	Number of words written in 60 seconds: [___]	0 = ≥11 1 = 10-11 2 = <10	0 1 2
		WRITING SCALE TOTAL:	[ ]

Reading Scale

Item Number	Description	Scoring	Scale Score

(188)	**What sound is made by these letters:**
	G—R—O: [___] P—L—Y: [___]
	[Allow 10 seconds per item. See Manual.]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(189)	**Tell me the word that is made by the following letters:**
	S—T—O—N—E: [___] K—N—I—G—H—T: [___]
	[Allow 10 seconds per item.]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(190)	**Look at this card.** [Present K4.] **Read the letters you see:**
	K: [___] S: [___] W: [___] R: [___] T: [___]
	[Allow 10 seconds. Score for errors and/or omissions.]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(191)	**Of the letters B, J, or S, which stands for the name "John"?** [Allow 10 seconds.]	0 = correct 2 = incorrect	0 2

(192)	**Now read these sounds.** [Present K5. Allow 10 seconds per item. See Manual.]
	po: [___] cor: [___] cra: [___] spro: [___] prot: [___]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

Reading Scale Continued

Item Number	Description	Scoring	Scale Score

(193)	**I am going to show you several cards. Read the word on each card.** [Present individually K6-K10. Allow 10 seconds per item.]
	K6 (juice): [____]
	K7 (bread): [____]
	K8 (bonfire): [____]
	K9 (cloakroom): [____]
	K10 (fertilizer): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(194)	**I am going to show you some cards with some letters on them. Read them as separate letters.** [Present K11-K13. Allow 10 seconds per item.]
	K11 (UN): [____] K12 (USA): [____] K13 (USSR): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(195)	**Please read these words.** [Present K14-K15. Allow 10 seconds per item.]
	K14 (insubordination): [____] K15 (indistinguishable): [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(196)	**Please read these words.** [Present K16-K17. Allow 10 seconds per item.]
	K16 (astrocytoma): [____] K17 (hemopoiesis): [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(197)	**Now I am going to show you cards with sentences on them. Please read them to me.** [Present K18 and K20. Allow 10 seconds per item.]
	K18 (The man went out for a walk): [____]
	K20 (There are flowers in the garden): [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(198)	**Now read these sentences carefully.** [Present K21 and K22. Allow 10 seconds per item.]
	K21 (The sun rises in the west): [____]
	K22 (The boy went to bed, because she was ill): [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

	Now I am going to show you a card with a paragraph. Read it out loud to me quickly, but carefully. [Present K23. Allow 30 seconds maximum. Record total time and circle missed words. See Manual.] John was a boy who liked apples—especially if they were stolen. One dark night he went into an orchard, plucked what he took to be an apple and set his teeth in it. It was, however, a very unripe pear and his loose front tooth stuck in the fruit. Now he only steals apples in the daytime. (Time. [_____])		
(199)	Total number of words in error:	0 = none 1 = 1-3 2 = >3	0 1 2
(200)	Total time to read paragraph:	0 = 1-19 secs 1 = 20-26 secs 2 = 27-31 secs	0 1 2

READING SCALE TOTAL: [ ]

Arithmetic Scale

Item Number	Description	Scoring	Scale Score
	[Present Patient Response Booklet.]		

(201)	**Write down the numbers I say:** [Allow 10 seconds per number group. Score each number.]
	7 [___] **9** [___] **3** [___] **3** [___] **5** [___] **7** [___]
		# errors
		0 = none
		1 = 1
		2 = 2-6
			0 1 2

(202)	**Write down the roman numerals for the following numbers:** [Allow 10 seconds per number.]
	4 and 6 (IV, VI): [___/___] **9 and 11** (IX, XI): [___/___]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0 1 2

(203)	**Write down the regular numbers:** [Allow 10 seconds per number.]
	17 and 71: [___/___] **69 and 96:** [___/___]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0 1 2

(204)	**Write down the numbers:** [Allow 10 seconds per number.]
	27: [___] **34:** [___] **158:** [___] **396:** [___] **9,845:** [___]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(205)	**Please write down the following numbers:** [Allow 10 seconds per number.]
	14: [___] **17:** [___] **19:** [___] **109:** [___] **1,023:** [___]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

(206)	**Read the numbers on this card.** [Present L1. Allow 10 seconds.]
	7 — 9 — 3 [___/___/___] 3 — 5 — 7 [___/___/___]
		# errors
		0 = none
		1 = 1
		2 = 2-6
			0 1 2

(207)	**Read the numbers on these cards.** [Present L2 and L3. Allow 10 seconds per card.]
	L2: (IV): [___] (VI): [___] (IX): [___] (XI): [___]
	L3: (17): [___] (71): [___] (69): [___] (96): [___]
		# errors
		0 = none
		1 = 1
		2 = 2-8
			0 1 2

(208)	**Read the numbers on this card.** [Present L3.5. Allow 15 seconds.]
	L3.5: (27): [___] (34): [___] (158): [___] (396): [___] (9845): [___]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0 1 2

	[Present L4.]		

(209)	**There are three numbers on this card, arranged from top to bottom. Read each number as a whole number.** [Point to each item individually. If on the first item S says "1-5-8," tell S: "I want you to read it as if it were a single number." Allow 10 seconds per number.]
	L4: (158): [___] (396): [___] (1023): [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(210)	**I am going to tell you two numbers. Tell me which number is larger:** [Allow 10 seconds per item.]
	17 or 68: [___] **23 or 56:** [___] **189 or 201:** [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

Arithmetic Scale Continued

Item Number	Description	Scoring	Scale Score		
	[Present L5.]				

(211)	**Look at this card and show me by pointing which of the top two numbers is larger** (201): [____]
	Which of the bottom two numbers is larger (3002): [____]
	[Allow 10 seconds per item.]
		# errors
		0 = none
		1 = 1
		2 = 2
			0	1	2

	[Present Patient Response Booklet.]				

(212)	**Now I will ask you to solve some problems and you may write them down if you like. How much is:** [Allow 10 seconds per item.]
	3 x 3: [____] **5 x 4:** [____] **7 x 8:** [____]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0	1	2

(213)	**Please solve these problems. You may also write them if you like:**
	[Allow 10 seconds per item, including writing.]
	3 + 4: [____] **6 + 7:** [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0	1	2

(214)	**Now solve these problems:** [Allow 10 seconds per item, including writing.]
	7 - 4: [____] **8 - 5:** [____]
		# errors
		0 = none
		2 = 1-2
			0		2

(215)	**Now solve these problems:** [Allow 20 seconds per item, including writing.]
	27 + 8 (35): [____] **44 + 57** (101): [____]
	31 - 7 (24): [____] **44 - 14** (30): [____]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0	1	2

	[Remove Patient Response Booklet. Present L6.]				
(216)	**On this card the numbers are arranged up and down. Add all three of them together in your head.** (21)	0 = correct 2 = incorrect	0		2
	[Present L7.]				
(217)	**Now subtract the number that is above from the one that is below.** (6) [Allow 10 seconds.]	0 = correct 2 = incorrect	0		2

(218)	**I am going to show you some numbers that form mathematical equations on this card.** [Present L8.] **What is the missing sign in each of these problems: a plus, a minus, or another sign?** [Point to each problem individually. Allow 10 seconds per item.]
	10 (X) 2 = 20: [____]
	10 (+) 2 = 12: [____]
	10 (-) 2 = 8: [____]
	10 (÷) 2 = 5: [____]
		# errors
		0 = none
		1 = 1
		2 = 2-4
			0	1	2

(219)	**What is the missing number in each equation on this card?** [Present L9. Allow 10 seconds per item.]
	12 - (4) = 8: [____] 12 + (7) = 19: [____]
		# errors
		0 = none
		1 = 1
		2 = 2
			0	1	2

Arithmetic Scale Continued

Item Number	Description	Scoring	Scale Score

(220)	**What is the answer to the top problem on this card?** [Present L10.] **Figure the answer in your head. Now do this bottom problem.** [Allow 20 seconds per item.] 27 + 34 + 14 = (75): [____] 158 + 396 = (554): [____]	# errors
		0 = 0-1
		2 = 2
			0 2

(221)	**I want you to count down from 100 by 7s like this: 100 — 93 — 86, and so on. Please start at 100 and subtract 7 each time.** [Correct after each mistake in the following manner. "No, that is not the correct answer. What is (previous correct response) minus 7?" Score based on 1st 6 subtractions. Allow 30 seconds.] 100, (93) [____]; (86) [____]; (79) [____]; (72) [____]; (65) [____]; (58) [____].	# errors
		0 = 0-2
		1 = 3-5
		2 = 6
			0 1 2

(222)	**Now I want you to do the same thing, but this time start at 100 and subtract 13 each time.** [Correct mistakes and score as in item #221. Allow 45 seconds.] 100, (87) [____]; (74) [____]; (61) [____]; (48) [____]; (35) [____]; (22) [____].	# errors
		0 = 0-2
		1 = 3-5
		2 = 6
			0 1 2

ARITHMETIC SCALE TOTAL: [ ]

Memory Scale

Item Number	Description	Scoring	Scale Score

NO STIMULUS REPETITIONS ARE ALLOWED FOR ANY ITEM IN THIS SECTION.

I am going to say seven words. After I finish saying them, I want you to repeat as many of them back to me as you can remember. [Present words at the rate of one per second:] **house; forest; cat; night; table; needle; pie.** [Have *S* recall as many of the words as possible. Go on to next trial if *S* is unable to recall another word after a pause of 5 seconds since the last word given or if *S* has recalled all seven words.] **You remembered** (fill in number) **words out of the seven on that trial. I am going to say the same seven words again and I want you to try to recall as many as you can. Please begin only after I have finished. However, before I begin, I want you to tell me how many words you think you will remember this next time after I finish saying the words again. Remember, you got** (fill in number) **words out of seven on the last trial.** [Do this for each trial until *S* reaches either the criterion of two perfect trials in a row or five trials.]

trial	prediction	actual	house	forest	cat	night	table	needle	pie	errors	prediction minus (-) actual
1	____	____	____	____	____	____	____	____	____	____	____
2	____	____	____	____	____	____	____	____	____	____	____
3	____	____	____	____	____	____	____	____	____	____	____
4	____	____	____	____	____	____	____	____	____	____	____
5	____	____	____	____	____	____	____	____	____	____	____
									Total:	____	____

(223) Total number of errors (over all trials):

0 = 0-3
1 = 4-8
2 = 9-35

0 1 2

(224) [Sum of | prediction — actual | ÷ (# trials — 1)] X 100.

0 = 0-25
1 = 26-100
2 = >100

0 1 2

(225) Completed 2 perfect consecutive trials:

0 = yes
2 = no

0 2

(226) **I am going to show you a card with some pictures on it. You will have 5 seconds to examine it and then I will remove it.** [Present M3 for 5 seconds, then remove.] **I want you to count to 100 out loud.** [Continue for 30 seconds, then show *S* M4.] **Is the picture on this card exactly the same or different from the one on the card I showed before?** (different)

0 = correct
2 = incorrect

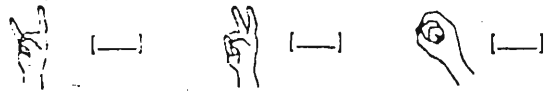
0 2

Memory Scale Continued

Item Number	Description	Scoring	Scale Score	
	[Present Patient Response Booklet.]			

(227)	**I am going to show you a card and I want you to look at it carefully. When I remove the card, I want you to draw as much from it as you can remember.** [Present M5 for 7 seconds. See Manual.]	# errors
		0 = none
		1 = 1
		2 = 2-5
			0	1

(228)	**Now I am going to tap a rhythm with my hand on the table. Listen carefully because when I finish, I want you to tap the same rhythm. Make sure that you have the same number of taps as I have and that you tap the same loud and soft taps as I do.** (L L S S L L S S): [___]	0 = correct 2 = incorrect	0	

(229)	**I am going to put my hand in three positions. I want you to remember what positions my hand made because I will then ask you to make the same positions.** [Present 3 positions each held for 2 seconds. See Manual.]
	 
	[___] [___] [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0	1

(230)	**Now I am going to show you a card. You will have 5 seconds to examine it and then I will remove it. I want you to repeat the words written on the card after I remove it.** [Present M6.]
	house [___] moon [___] street [___] boy [___] water [___]
		# errors
		0 = none
		1 = 1
		2 = 2-5
			0	1

(231)	**I want you to remember some words that I am going to say: house, tree, cat. Repeat them. Now look at this picture. What do you see?** [Present M7 and have S describe picture for 15 seconds.] **Now can you tell me, what were the words I asked you to remember?**
	house [___] tree [___] cat. [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0	1

(232)	**Now I am going to say some words and I want you to try and remember them: man, hat, door. Now please repeat those words to me.** [If incorrect, say once before proceeding: "Remember, the words are man, hat, door."] **Now try to remember these words: light, stove, cake. Please repeat these words. Tell me, what were the three words I said first?**
	man [___] hat [___] door [___]
	What were the three words I said second?
	light [___] stove [___] cake: [___]
		# errors
		0 = none
		1 = 1-4
		2 = 5-6
			0	1

(233)	**Now I am going to tell you two sentences and I want you to remember them: "The sun rises in the east." Please repeat that. "In May the apple trees blossom." Please repeat it.**
	What was the first sentence?
	The sun rises in the east: [___]
	What was the second sentence?
	In May the apple trees blossom [___]
		# errors
		0 = none
		1 = 1
		2 = 2
			0	1

(234)	**Now I am going to read you a short story. I want you to listen carefully because when I am finished I want you to repeat to me all that you can remember about the story.** [Read the following (also on M9), then ask S to tell story. Count the number of parts of this paragraph actually remembered not errors.]			

Memory Scale Continued

Item Number	Description	Scoring	Scale Score

	The Crow and the Doves:
	A crow heard/ that doves had plenty to eat./ He colored himself white/ and flew to the dove cote./ The doves thought/ he was one of them/ and took him in./ However, he could not help cawing/ like a crow./ The doves then realized that he was a crow/ and threw him out./ He went back to rejoin the crows./ but they did not recognize him/ and would not accept him./
		# units
		0 = >5
		1 = 4-5
		2 = <4
			0 1 2

(235)	Now I am going to show you some pictures. With each picture, I am going to say a word. When I finish, I will show you the pictures and I want you to say the word that goes with it. For example, I will show you this picture [Present M7] and say "horse." When I show you the picture later, what would you say? [Prompt S if necessary] You will have 5 seconds to look at each picture. [Allow 5 seconds for both administration and recall each time]
	M10 (energy): [___] M14 (family): [___]
	M11 (employment): [___] M15 (project): [___]
	M12 (party): [___] M16 (pollution): [___]
	M13 (happy): [___]
		# errors
		0 = none
		1 = 1
		2 = 2-7
			0 1 2

		MEMORY SCALE TOTAL:	[ ]

Intellectual Processes Scale

Item Number	Description	Scoring	Scale Score
(236)	Look carefully at this picture [present N1] and then tell me what is happening in the picture: _____	See Manual	0 1 2
(237)	What is happening in this picture? [Present N2] _____	See Manual	0 1 2
	I am going to show you some pictures. They are in the wrong order. I want you to put them in the right order so that they make sense. Please try to put them in the right order as quickly as you can and tell me when you are finished. [Present N3 - N13 cards from S's left to right in 1-5 sequence. Time after placement of last card. Allow 30 seconds]		
(238)	Card order: [___] [___] [___] [___] [___]	See Manual	0 1 2
(239)	Time to completion: [___]	0 = 1-22 secs 1 = 23-30 secs 2 = 31 secs	0 1 2

Intellectual Processes Scale Continued

Item Number	Description	Scoring	Scale Score		
	Look at these pictures. They are also in the wrong order. Put them in the right order so that they make sense. [Present N14 — N18 cards from S's left to right in 1-5 sequence. Time after placement of last card. Allow 30 seconds.]				
(240)	Card order (ABCDE). [____] [____] [____] [____] [____].	0 = correct 2 = incorrect	0		2
(241)	Time to completion: [____]	0 = 1-15 secs 1 = 16-24 secs 2 = 25-31 secs	0	1	2
(242)	**I am going to show you a card. I want you to tell me what is comical or absurd about the story in these pictures.** [Present N19. See Manual.]: _____ _____	0 = correct 2 = incorrect	0		2
(243)	**Tell me what is comical or absurd about these pictures.** [Present N22 and N23. See Manual.]: _____ _____	0 = correct 2 = incorrect	0		2
(244)	**Listen carefully to the story I am going to read from this card.** [Give M8 to S.] **When I am finished I am going to ask you some questions about it.** **The Hen and the Golden Eggs:** **A man had a hen which laid golden eggs. Wishing to obtain more gold without having to wait for it, he killed the hen. But he found nothing inside it, for it was just like any other hen.** **What did the man do?** _____ _____ Score (See Manual): [0] [1] **Did he do right?** _____ Score (See Manual): [0] [1] **What is the moral of the story?** _____ _____ _____ Score (See Manual): [0] [1] [2]	Total 0 = 0 1 = 1-2 2 = 3-4	0	1	2
(245)	**What is meant by these expressions:** **"Iron hand"?:** _____ _____ Score (See Manual) [0] [1] [2] **"green thumb"?:** _____ _____ Score (See Manual): [0] [1] [2]	Total 0 = 0-1 1 = 2 2 = 3-4	0	1	2

Intellectual Processes Scale Continued

Item Number	Description	Scoring	Scale Score		
(246)	**What does this saying mean: "Don't count your chickens before they have hatched"?** _____ _____ _____	See Manual	0	1	2

(247)	**I am going to show you a card on which there is a saying. Below the saying there are three possible explanations of it. Which is the correct one?** [Present N24, followed by N25.] N24 (c): [___] N25 (a): [___]	# errors
		0 = none
		1 = 1
		2 = 2
			0	1	2

(248)	**Now I will say some words that I want you to define. What do the following words mean:** **table?** _____ _____ Score (See Manual): [0] [1] [2] **island?** _____ _____ Score (See Manual): [0] [1] [2]	Total 0 = 0 1 = 1-2 2 = 3-4	0	1	2
(249)	**In what way are a table and a sofa alike?** _____ _____ _____ Score (See Manual): [0] [1] [2] **In what way are an ax and a saw alike?** _____ _____ _____ Score (See Manual): [0] [1] [2]	Total 0 = 0 1 = 1-2 2 = 3-4	0	1	2
(250)	**What is the difference between a fox and a dog?** _____ _____ _____ Score (See Manual): [0] [1] [2] **What is the difference between a stone and an egg?** _____ _____ _____ Score (See Manual): [0] [1] [2]	Total 0 = 0 1 = 1-2 2 = 3-4	0	1	2

(251)	**"Table" belongs to the group of objects called furniture.**
	What group does a rose belong to? (flower, plant): [___]
	What group does a carp belong to? (fish) [___]
		# errors
		0 = none
		2 = any
			0		2

Intellectual Processes Scale Continued

Item Number	Description	Scoring	Scale Score

(252)	**If we start with the group "animals," then a horse would be a member of the group. Give me an example of a member of the group "vehicles":**
	_____ [___]
	Give me an example of a member of the group "tools":
	_____ [___]
		# errors
		0 = none
		2 = any
			0 2

(253)	**If you consider a table as a whole, then the legs will be a part of the whole. Can you tell me what the parts are if the whole is a knife?** (blade &/or handle). [___]	0 = correct 2 = incorrect	0 2

(254)	**If we start with the part "wall," then the whole would be house. What will the whole be if the parts are pages?** (book, magazine, newspaper): [___]
	What will the whole be if the parts are trees? (forest, woods): [___]
		# errors
		0 = none
		1 = 1
		2 = 2
			0 1 2

(255)	**The opposite in meaning to the word "healthy" is "sick." What is the opposite of "high"?** (low) [___]
	What is the opposite of "fat"? (skinny, thin, slim, lean): [___]
		# errors
		0 = none
		2 = any
			0 2

(256)	**What word has the same relationship to "good" as "high" has to "low"?** (bad, evil): [___]
	What word has the same relationship to "wide" as "fat" has to "thin"? (narrow): [___]
	What word has the same relationship to "hand" as "shoe" has to "foot"? (glove, mitten). [___]
		# errors
		0 = none
		1 = 1
		2 = 2-3
			0 1 2

(257)	**Which of the four words I will now say does not belong to the same group as the other three: spoon — table — glass — plate?** (table) [___]
	Now which word does not belong to this combination: cigar — wine — cigarette — tobacco? (wine) [___]
		# errors
		0 = none
		2 = any
			0 2

	[Present N30 and let S read the card silently while you read it out loud. Do not remove the card. Time response and allow 10 seconds to solve problem after card is read. Repeat for N31-32.] **Peter had 2 apples and John had 6 apples. How many did they have together?:** [___]		
(258)	Correct answer: (8)	0 = correct 2 = incorrect	0 2
(259)	Response time: [___]	0 = 1 sec 1 = 2 secs 2 = 3-11 secs	0 1 2
	[Present N31.] **Jane had 7 apples and gave 3 away. How many did she have left?:** [___]		
(260)	Correct answer: (4)	0 = correct 2 = incorrect	0 2

Intellectual Processes Scale Continued

Item Number	Description	Scoring	Scale Score
(261)	Response time: [____]	0 = 1 sec 1 = 2 secs 2 = 3-11 secs	0 1 2
	[Present N32.] **Mary had 4 apples and Betty had 2 apples more than Mary. How many apples did they both have together?:** [____]		
(262)	Correct answer: (10)	0 = correct 2 = incorrect	0 2
(263)	Response time: [____]	0 = 1-2 secs 1 = 3 secs 2 = 4-11 secs	0 1 2
	[Present N33. Allow up to 30 seconds.] **A farmer had 10 acres of land. From each acre he harvested 6 tons of grain. He sold 1/3 to the government. How much did he have left?:** [____]		
(264)	Correct answer: (40 tons)	0 = correct 2 = incorrect	0 2
(265)	Response time: [____]	0 = 1-4 secs 1 = 5-30 secs 2 = 31 secs	0 1 2
	[Present N34. Allow up to 30 seconds.] **There were 18 books on 2 shelves. There were twice as many on one shelf as on the other. How many books were there on each shelf?:** [____]		
(266)	Correct answer: (6 and 12)	0 = correct 2 = incorrect	0 2
(267)	Response time: [____]	0 = 1-7 secs 1 = 8-30 secs 2 = 31 secs	0 1 2
	[Present N37. Allow up to 30 seconds.] **A pedestrian walks to the station in 15 minutes, and a cyclist rides there 5 times faster. How long does the cyclist take to get to the station?:** [____]		
(268)	Correct answer: (3 minutes)	0 = correct 2 = incorrect	0 2
(269)	Response time: [____]	0 = 1-4 secs 1 = 5-30 secs 2 = 31 secs	0 1 2

INTELLECTUAL PROCESSES SCALE TOTAL: [ ]

Luria-Nebraska Neuropsychological Battery

ADMINISTRATION & SCORING BOOKLET

Charles J. Golden, Ph.D., Thomas A. Hammeke, Ph.D., and Arnold D. Purisch, Ph.D.

Published by

WPS WESTERN PSYCHOLOGICAL SERVICES

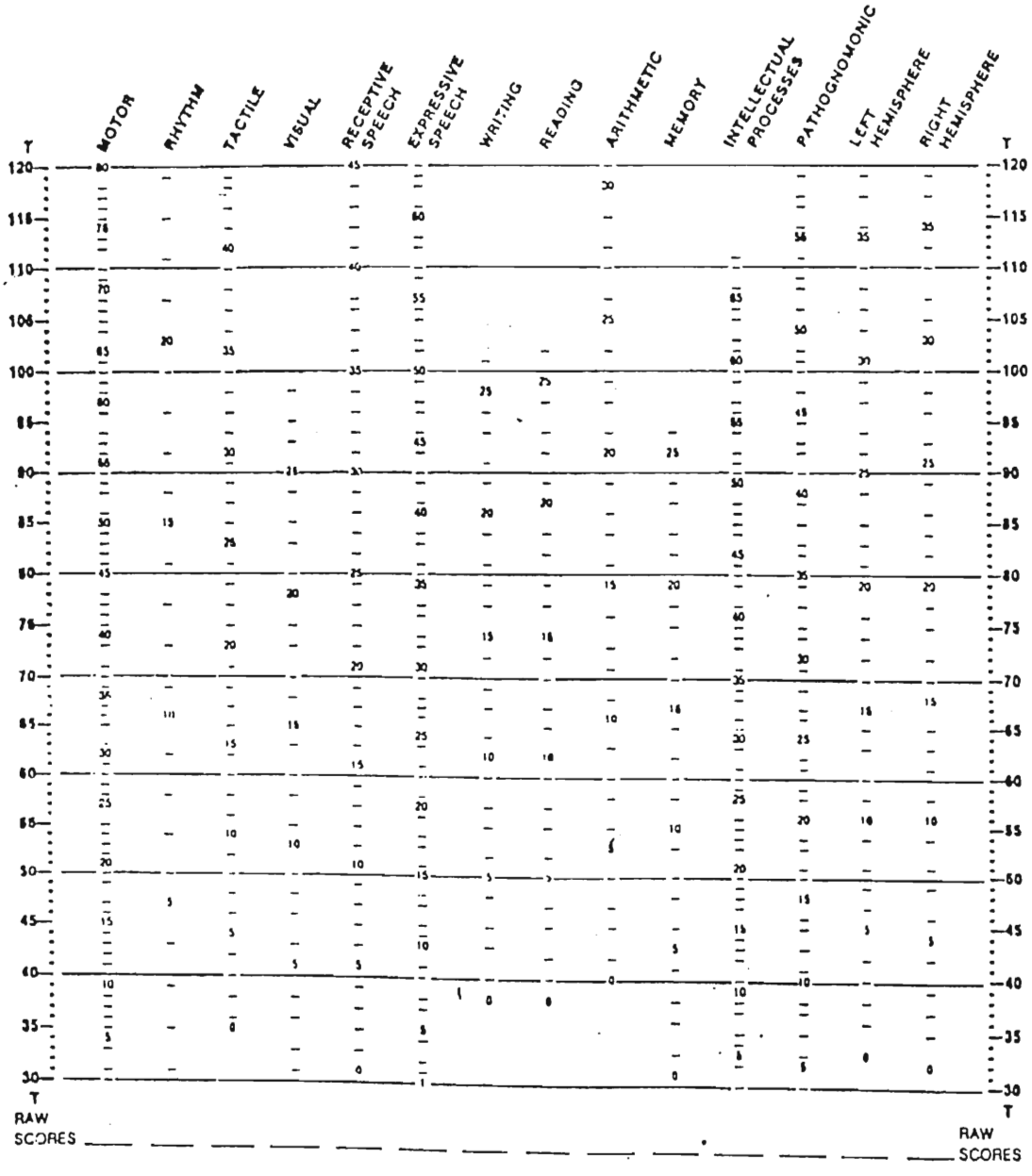
A DIVISION OF MANSON WESTERN CORPORATION

Name:_____ Date:_____ Age:_____

Sex: M F Marital Status:_____ Race:_____

Occupation:_____ Education: _____ Hand Dominance: L R

Place of Examination: _____ Examiner: _____



CRITICAL LEVEL :

No. of Scales above CL : Not inc. Writ. & Arit. :

Estimated : VIQ= PIQ= FIQ=

Pathognomonic Scale*								Left Hemisphere Scale*					Right Hemisphere Scale*				
Item	Scale Score			Item	Scale Score			Item	Scale Score				Item	Scale Score			
(8)	0		2	(103)	0	1	2	(1)	0	1	2		(2)	0	1	2	
(9)	0		2	(108)	0	1	2	(3)	0	1	2		(4)	0	1	2	
(19)	0		2	(139)	0		2	(5)	0		2		(6)	0		2	
(37)	0	1	2	(157)	0	1	2	(7)	0		2		(8)	0		2	
(39)	0	1	2	(162)	0		2	(9)	0		2		(10)	0		2	
(42)	0	1	2	(166)	0	1	2	(11)	0		2		(12)	0		2	
(43)	0	1	2	(169)	0	1	2	(13)	0		2		(14)	0		2	
(45)	0	1	2	(175)	0	1	2	(15)	0		2		(16)	0		2	
(64)	0	1	2	(178)	0	1	2	(17)	0		2		(18)	0		2	
(77)	0		2	(184)	0	1	2	(19)	0		2		(20)	0		2	
(79)	0		2	(185)	0	1	2	(64)	0	1	2		(65)	0	1	2	
(82)	0	1	2	(187)	0	1	2	(66)	0	1	2		(67)	0	1	2	
(83)	0	1	2	(196)	0	1	2	(68)	0	1	2		(69)	0	1	2	
(85)	0	1	2	(211)	0	1	2	(70)	0	1	2		(71)	0	1	2	
(89)	0	1	2	(227)	0	1	2	(72)	0	1	2		(73)	0	1	2	
(101)	0	1	2	(241)	0	1	2	(74)	0	1	2		(75)	0	1	2	
(102)	0	1	2	(267)	0	1	2	(76)	0		2		(77)	0		2	
								(78)	0		2		(79)	0		2	
				Scale Total:				(80)	0		2		(81)	0		2	
								(82)	0	1	2		(84)	0	1	2	
								(83)	0	1	2		(85)	0	1	2	
									Scale Total:					Scale Total:			

*Scale scores for these three scales should be transposed from the previous pages and then summed

Clinical Observations:

COMPUTATION OF CRITICAL LEVEL

Table 1. Age Values

Age[a]	Age X .214
25	5.35
26	5.56
27	5.78
28	5.99
29	6.21
30	6.42
31	6.63
32	6.85
33	7.06
34	7.28
35	7.49
36	7.70
37	7.92
38	8.13
39	8.35
40	8.56
41	8.77
42	8.99
43	9.20
44	9.42
45	9.63
46	9.84
47	10.06
48	10.27
49	10.49
50	10.70
51	10.91
52	11.13
53	11.34
54	11.56
55	11.77
56	11.98
57	12.20
58	12.41
59	12.63
60	12.84
61	13.05
62	13.27
63	13.48
64	13.70
65	13.91
66	14.12
67	14.34
68	14.55
69	14.77
70	18.14

[a]For patients under age 25, use 5.35 as the age value.

Table 2. Education Values

Years Education	Education X 1.47
0	0.0
1	1.47
2	2.94
3	4.41
4	5.88
5	7.35
6	8.82
7	10.29
8	11.76
9	13.23
10	14.70
11	16.17
12	17.64
13	19.11
14	20.58
15	22.05
16 (BA)	23.52
18 (MA)	26.46
20 (MD, PhD, EdD)	29.40

Constant **68.8**

\+

Age Value (Table 1) _____

Total _____

\−

Education Value (Table 2) _____

Critical Level _____

Number of Scale Scores Above Critical Level: _____

Writing/Arithmetic Above Critical Level: Y N

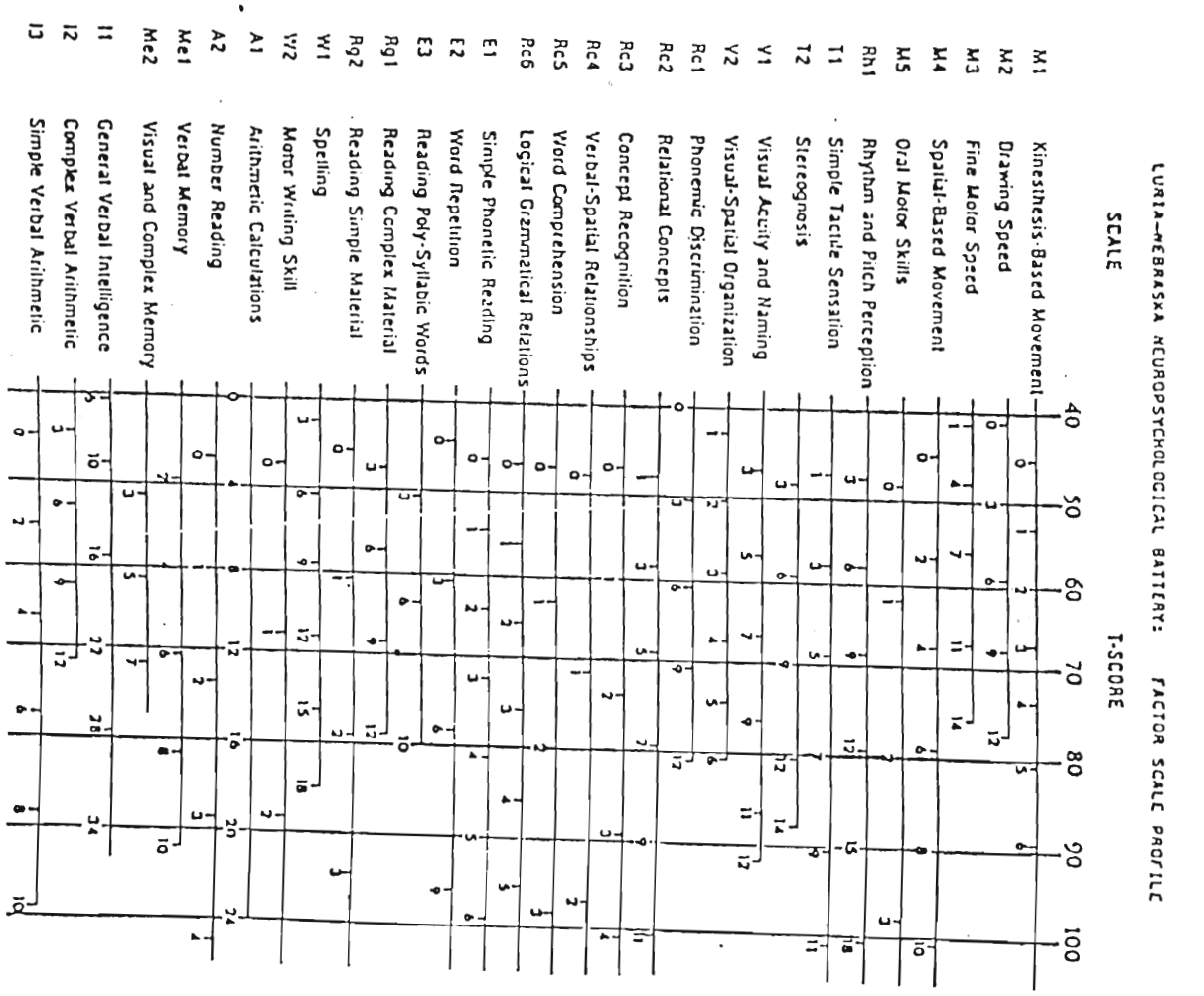
Pathognomonic Above Critical Level: Y N

LURIA-NEBRASKA FACTOR SCALES : ITEMS

M1	M2	M3	M4	M5	Rh1	T1	T2	V1	V2	R1	R2	R3	R4	R5	R6	E1
5	37	1	9	29	52	64	67	87	94	100	106	110	118	108	124	145
6	39	2	10	32	53	65	70	88	95	101	117	113	119	111	125	146
7	41	3	11	35	54	68	71	89	97	102	123	116	120	114	126	147
8	43	4	12		55	69	82	90		103	125					150
48	45	21	15		58	72	83	91		104	129					152
50	47	22	16		59	73	84	99		105	130					153
		23			60	74	85				132					163
					62	75										
					63	76										
						79										

E2	E3	R1	R2	W1	W2	A1	A2	H1	H2	I1		I2	I3
133	144	189	190	175	177	202	201	223	227	236	253	264	252
134	148	192	193	176	178	207	203	225	229	237	254	265	255
135	149	195	194	179	180	212	204	230	234	242	256	266	258
137	151	196	197	182	181	213	205	232	235	243	257	267	259
138	155	199		183		215	206	233		244	262	268	260
140		200		184		216	208			245		269	261
141				185		217	209			246			263
142				186		218	210			247			
				187		219	211			248			
						220	214			249			
						221				250			
						222				251			

LURIA-NEBRASKA NEUROPSYCHOLOGICAL BATTERY: FACTOR SCALE PROFILE

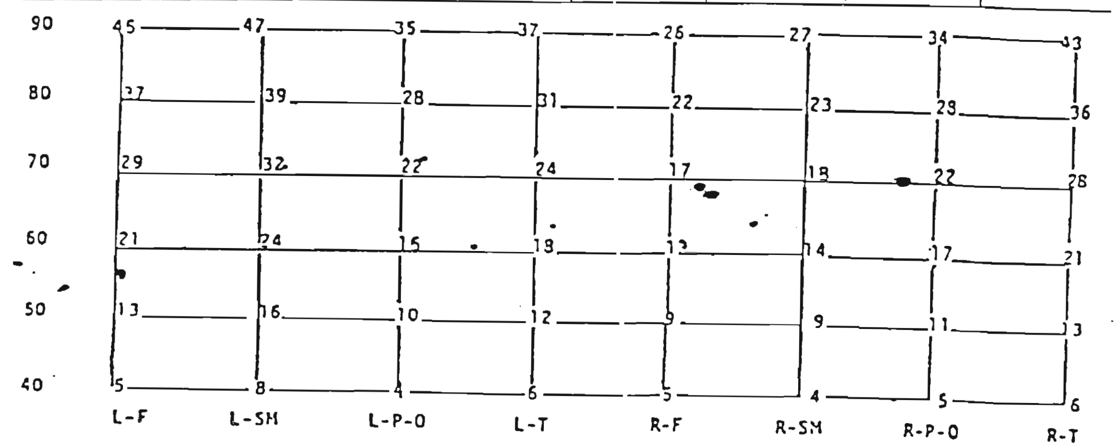


ERRORS:

1.	28.	55.	82.	109.	136.	163.	190.	217.	244.
2.	29.	56.	83.	110.	137.	164.	191.	218.	245.
3.	30.	57.	84.	111.	138.	165.	192.	219.	246.
4.	31.	58.	85.	112.	139.	166.	193.	220.	247.
5.	32.	59.	86.	113.	140.	167.	194.	221.	248.
6.	33.	60.	87.	114.	141.	168.	195.	222.	249.
7.	34.	61.	88.	115.	142.	169.	196.	223.	250.
8.	35.	62.	89.	116.	143.	170.	197.	224.	251.
9.	36.	63.	90.	117.	144.	171.	198.	225.	252.
10.	37.	64.	91.	118.	145.	172.	199.	226.	253.
11.	38.	65.	92.	119.	146.	173.	200.	227.	254.
12.	39.	66.	93.	120.	147.	174.	201.	228.	255.
13.	40.	67.	94.	121.	148.	175.	202.	229.	256.
14.	41.	68.	95.	122.	149.	176.	203.	230.	257.
15.	42.	69.	96.	123.	150.	177.	204.	231.	258.
16.	43.	70.	97.	124.	151.	178.	205.	232.	259.
17.	44.	71.	98.	125.	152.	179.	206.	233.	260.
18.	45.	72.	99.	126.	153.	180.	207.	234.	261.
19.	46.	73.	100.	127.	154.	181.	208.	235.	262.
20.	47.	74.	101.	128.	155.	182.	209.	236.	263.
21.	48.	75.	102.	129.	156.	183.	210.	237.	264.
22.	49.	76.	103.	130.	157.	184.	211.	238.	265.
23.	50.	77.	104.	131.	158.	185.	212.	239.	266.
24.	51.	78.	105.	132.	159.	186.	213.	240.	267.
25.	52.	79.	106.	133.	160.	187.	214.	241.	268.
26.	53.	80.	107.	134.	161.	188.	215.	242.	269.
27.	54.	81.	108.	135.	162.	189.	216.	243.	

Brain Lesion Localization Scales

L. Front.		L. S. Mot.		L. Par-Occ.		L. Temp.		R. Frontal		R. S. Mot.		R. Par-Occ.		R. Temp.	
1	166	5	78	5	199	31	130	6	47	4	84	10	87	29	217
59	168	11	82	7	203	63	131	7	53	10	89	24	90	62	227
62	192	17	86	8	204	100	155	13	63	14	92	39	91	65	233
104	196	21	87	90	207	101	156	33	93	36	172	53	94	69	235
105	202	22	88	95	215	102	176	39	94	46	175	59	97	55	237
123	207	38	99	96	221	103	183	40	117	51	179	60	103	95	239
125	208	40	145	149	222	109	186	44	125	54	202	65	153	117	247
134	219	41	150	151	233	120	199	45	169	56	218	75	215	127	254
138	225	44	221	175	243	121	214					77	225	157	255
140	230	46	228	179	251	122	232					79	236	172	262
143	237	52	229	187	255	126	238					81	239	173	264
144	248	55	240	191	263	129	239					83	257	174	
148	250	61	242	195								84	265	184	
157	257	70	249									85		195.	
161	259	71	259												
162	261														
164															
Totals LF		LSM		LPO		LT		RF		RSM		RPO		RT	



NAME ______________________ Date of Examination ______________

REFERENCE: Golden, C.J & McKay, S. Empirical derivation of experimental scales for localizing brain lesions using the Luria-Nebraska Neuropsychological Battery. Clinical Neuropsychology 1979, 1, #4, 19-23