A TEST OF THE PREDICTIVE VALIDITY AND A CROSS-VALIDATION OF THE NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA

by

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Abstract

The present investigation was primarily concerned with testing the predictive validity of the Neurosensory Center Comprehensive Examination for Aphasia (NCCEA). A total of 206 brain damaged subjects, diagnosed as either aphasic or non-aphasic were employed. 80 subjects were from Victoria, B. C., 38 from New York City, N. Y., and 88 from Iowa City, Iowa. Within the groups of aphasic and non-aphasic, Victoria and Iowa subjects were randomly assigned to Sample 1 or Sample 2, and Sample 5 or Sample 6, respectively. Multivariate analyses of variance indicated that there was a significant difference between the mean level of performance of aphasic and brain damaged non-aphasic subjects on the NCCEA for the following samples: Victoria Sample 1 + Sample 2, Victoria Sample 1, Victoria Sample 2, Iowa Sample 5 + Sample 6, and Iowa Sample 6. In addition, univariate analyses of variance indicated that in every sample, significant differences were observed for almost every subtest of the NCCEA. Data for the New York sample were not subjected to analysis because only two of the subjects in this sample were non-aphasic.

Stepwise discriminant analysis revealed that successful discrimination between aphasics and brain damaged non-aphasics, in terms of the percentage of total cases correctly classified (76.14% - 90.00%) could be attained by the use of a maximum of five and a minimum of three tests of the NCCEA for both Victoria and Iowa samples. The majority of misclassifications which occurred for these samples were subjects diagnosed as either minimally aphasic, or subjects for whom there was no indication of the severity of language deficits.

The second objective of the present investigation was cross-validation of the predictive equations derived by stepwise discriminant analysis on samples drawn from the same geographical and clinical setting, and samples drawn from different geographical and clinical settings. Cross-validation analyses were performed for every possible combination of samples. The loss in the predictive accuracy of the equations did not exceed the predicted maximum of 20% in any of the cross-validation analyses. However, the percentage of total cases correctly classified was higher for cross-validations within the same geographical and clinical setting, and for cross-validations on the New York sample, than for cross-validations between Iowa and Victoria samples.

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INTRODUCTION

A Historical Note on Aphasia

In a history of the early descriptions of aphasic behaviour, Benton and Joynt (1960), note that physicians of the Hippocratic school (circa 400 B.C.) provided the earliest documentation of deficits in language functioning. The fact that two labels were used - one referring to loss of articulation or "voicelessness", and the other to aphasia or "speechlessness", implies that both anarthria and aphasia were observed at the time. However, the inconsistency in the use of these labels for the description of aphasic or aphasic-like phenomena, makes it difficult to decipher whether a particular author was referring to anarthria or to aphasia in a specific case (Benton, 1964; Benton and Joynt, 1960). Although all forms of aphasia, with the exception of 'sensory' aphasia had been described and connected with cerebral dysfunction prior to the beginning of the nineteenth century, the connection between right hemiparesis, which had been observed by many of the early investigators, and aphasia was not made until the middle of the nineteenth century (Benton, 1964; Benton and Joynt, 1960).

Paul Pierre Broca, who defined aphemia in 1861 as "loss of the faculty of articulated speech in the absence of paralysis of the tongue, impairment of comprehension, or loss of intelligence", (Schuell, Jenkins and Jimenez-Pabon, 1964) has often been credited with localizing language functioning in the frontal lobes, and more specifically articulated language in the left, third frontal convolution (Joynt, 1964). However, Joynt (1964) notes that Gall was the first to localize language functioning in the frontal lobes and that this was further substantiated by Bouillaud in 1825 (Head, 1926). In his discussion of

Broca's contribution to the knowledge of aphasia, Joynt (1964) concludes that the most significant contribution made by Broca was his introduction of "scientific observation" into the field of aphasia, through his systematic collection, observation and description of cases.

The period of time between Broca's presentation of cases in 1861 and the first World War, was primarily characterized by attempts at the localization of language functioning, and a questioning of the validity of the localizationist approach by figures such as John Hughlings Jackson and Pierre Marie (Meyer, 1974; Osgood and Miron, 1963; Schuell et al., 1964). The localizationists basically attempted to correlate a specific deficit in language functioning with damage to a particular region of the cortex (Geschwind, 1967). However, as noted by Geschwind (1967), the degree of correlation attempted by each investigator varied greatly. Carl Wernicke's presentation of cases of sensory aphasia, or the inability to comprehend oral speech, in 1874 and his connection of these deficits with damage to the first and second temporal convolutions is considered by some authors (Osgood and Miron, 1963), to have marked the beginning of the period of the "diagram-makers" - a term initially employed in a derogatory fashion by Sir Henry Head. This proposition is refuted by Meyer (1974) who indicates that several investigators, namely L. Lichteim, H. C. Bastian and W. H. Broadbent had developed a localizationist point of view, without presenting actual diagrams prior to Wernicke's presentation of sensory aphasia and his subsequent development of diagrammatic schemes. Geschwind's (1967) interpretation of the contributions of Carl Wernicke, indicates that he considers Wernicke to be neither a strict localizationist, nor an anti-localizationist. Perhaps one of the best exemplaries of the strict localizationist view-point was Salomon Eberhard Henschen, who attempted to analyze approximately 1,500 cases of aphasia, which had been gathered from the literature (Geschwind, 1967; Schuell et al., 1964).

John Hughlings Jackson, was the first to question the localizationist theories that certain language functions such as the ability to comprehend oral speech, reading and writing were separate activities which could be localized in specific centers of the brain (Meyer, 1974; Schuell et al., 1964). Even though his theoretical contributions to the field of aphasia were of significant importance, they will not be considered in the present thesis. In terms of Jackson's contribution to the field of aphasia testing, his insistence on the need for accurately observing and recording facts, without making inferences from the observations, had a significant impact on the direction which was adopted by his successor, Sir Henry Head (Schuell et al., 1964).

Pierre Marie's criticism of the "diagram-makers" was based on his belief that the amount and type of information which was being collected to substantiate theories of localization of language functions, was inadequate, particularly with respect to the inferences which were drawn from the sectioning and examination of brains at autopsy (Head, 1926; Osgood and Miron, 1963). Not unlike Hughlings Jackson, Marie stressed the need for a more accurate description of aphasic symptomatology, adding that such descriptions could only be obtained with tests of graduated difficulty (Osgood and Miron, 1963).

A Review of the History of Examining for Aphasia

Early descriptions of aphasic behaviour, were largely dependent upon clinical observation. The development of Head's Serial Tests

(Head, 1926), in the early part of the twentieth century, represented the first attempt to systematically employ a battery of tests for the evaluation of and description of aphasic disorders (Schuell et al., 1964). Head, like Pierre Marie, emphasized the importance of constructing a series of tests of graduated difficulty, for the purpose of determining the extent to which a given individual could speak, read, write and/or comprehend (Head, 1926). At the same time, however, Head recognized that the level of difficulty of the tests he devised, was at times too great to elicit correct responses from normal individuals (Head, 1926). The basis for the development of and administration of Head's Serial Tests is partially reflected in the following quotation:

> " . . . It is not a sufficient test to hold up some object, and ask the patient to name it; at one time he may be able to do so, at another he fails completely. No conclusion can be drawn from one or two questions put in this way; his power of responding must be tested by a series of observations in which the same task recurs on two or more occassions." (Head, 1926, Vol. 1, p. 145)

In addition, Head (1926) states that the only possible way to draw conclusions from the variability in responses of a given individual is to arrange the tests in a sequence which would remain constant throughout the various methods of examination. However, each set within a subtest should be arranged in several different ways (Head, 1926). The brief summary for testing procedures offered by Head (1926) is presented in Appendix A.

Head's Serial Tests (Head, 1926) consist of six series of tests, each of which will be described briefly:

1. Naming and Recognition of Common Objects

Six common objects such as a pencil or a key are used in this test. The patient's task is to observe the six objects which are displayed in front of him; these objects are then screened from view while the examiner shows the patient a duplicate of one of the six objects. Once the screen is removed, the patient is requested to point to the object which had previously been displayed by the examiner. A total of eighteen observations are made.

The remaining tasks requested of the patient are, naming of the six objects, pointing to objects named by the examiner, selecting objects whose name appears on printed cards, writing the name of each object, and finally repeating the names of objects after they have been said by the examiner (Head, 1926).

2. Naming and Recognition of Colours

This series of tests is identical to the naming and recognition of common objects; however, eight colour strips are employed instead of six common objects (Head, 1926).

3. Man, Cat and Dog Tests

This series of tests employs three pictures - one of a man, one of a dog, and one of a cat. According to Head (1926) these tests were designed to evaluate reading and writing skills in their most elemetary form.

First, the patient is required to read the monosyllabic phrases aloud. He is then presented with a number of two-way combinations of the three pictures, which he is required to translate into words. For example, if a picture of a cat and a dog is presented simultaneously, the response required would be "the cat and the dog" (Head,1926). The patient is also requested to repeat phrases after the examiner, to write either to dictation or from the pictures, and to copy from print in cursive handwriting (Head, 1926).

4. <u>Clock Tests</u>

These tests make use of two clocks with movable hands. In the first task, one of the clocks is set by the examiner, and the patient is required to set the second clock to the same time. The patient is subsequently requested to set one of the clocks to oral commands, and also to printed commands. The patient's fourth task requires him to tell the time aloud, which has been set by the examiner; and finally, without speaking, the patient is requested to write down the time. In the task requiring the patient to set the time to printed commands, commands are presented both in numerical and alphabetic form (Head, 1926).

5. <u>Coin-Bowl Tests</u>

These tests require the patient to place a coin into one of four bowls according to a series of numerical commands (Head, 1926).

In front of each bowl is placed a penny; the patient's first task is to count the pennies from left to right. The patient is then requested to place the first into the fourth or the first penny into the fourth bowl. The form in which these oral and printed commands are presented, is left to the discretion of the examiner. The patient is also required to read printed cards aloud, and under the influence of his spoken words to perform the task (Head, 1926).

6. <u>Hand, Eye and Ear Tests</u>

The hand, eye and ear tests are the ones considered by Head to cause some difficulty even for normal individuals (Head, 1926).

Prior to imitating the examiner who touches either his eye or ear with one or the other hand, the patient is requested to name the hand as it is raised by the examiner, and then to raise his own corresponding hand. The patient's third task is to imitate the examiner's movements which are reflected in a mirror placed in front of the patient. Using a series of cards which depict various gestures in a simplified form, the patient is required to point to the card which depicts the gestures displayed by the examiner. He is then requested to point to cards in response to both oral and printed commands. Following this, the patient is required to read aloud from printed commands and to execute them, and finally to write down the movements or gestures which he observes in the examiner (Head, 1926).

By repeatedly administering the Serial Tests, Head studied the pattern of recovery from aphasia in twenty-six subjects, nineteen of whom had sustained gunshot wounds during the first World War. Head's second volume of Aphasia and Kindred Disorders of Speech (Head, 1926) is essentially an exhaustive account of each case studied, and the results obtained for each patient with successive administrations of the Serial Tests.

Head's Serial Tests have been criticized on various grounds. The primary objection, which was raised by Weisenburg and McBride (1935) is that the tests were not standardized. Consequently, while the simpler tests may have been used successfully in the description and evaluation of aphasic behaviour, the more difficult tests such as the Hand, Eye and Ear tests should not have been used, without prior knowledge of the performance of normal subjects (Weisenburg and McBride, 1935). The second criticism which has been directed at Head's use of the Serial Tests, is concerned with his sample size - a total of twenty-six patients. Schuell et al. (1964) indicate that Head may have been less impressed with the variability in the performance of the aphasics he observed, if his sample size had been increased. A third objection, raised by Eisenson (1973) concerns the amount of time and energy expenditure required of the patient, in addition to the judgment that the Serial Tests were both confusing and boring. Eisenson (1973) fails to mention that in Head's (1926) description of testing procedures, he repeatedly emphasized the importance of avoiding the creation of stress and fatigue in the patient through the administration of the tests. It is obvious that the latter objection to Head's Serial Tests can be directed at any Aphasia Battery, which takes a considerable length of time to administer.

Nevertheless, both Eisenson (1973) and Schuell et al. (1964) concede that Head's Serial Tests remain a major landmark in the history of aphasia testing. This is further attested to by the fact that immediately preceding and following the second World War, screening devices were constructed, which borrowed Head's idea for the use of common objects with, and several methods of eliciting responses from aphasic patients (Eisenson, 1973). The screening tests which are cited by Eisenson (1973) are Chesler's Test for Clinical Examination in Aphasia, The Wells-Ruesch Examination, and the Halstead-Wepman Screening Test for Aphasia. Although all three screening tests were published and widely used, the Halstead-Wepman Screening Test for Aphasia, which was published in 1949 (Schuell et al., 1964) is perhaps the best known of the three. This test, like the other two, was developed primarily to obtain an overall view of the language functioning of a given individual (Eisenson, 1973; Schuell et al., 1964). As screening instruments, they could not be expected to detect subtle aphasic symptoms; rather, their primary use was in the detection of obvious areas of impairment in language functioning or the absence of such impairments in brain damaged individuals. As stated by Eisenson (1973) only a good clinician may have been able to determine the presence of subtle aphasic symptoms while using a screening device.

This latter statement is true not only for the use of screening devices, but also for the use of comprehensive examinations designed to assess major areas of language functioning. It is evident that the information about the patient, obtained in a testing situation, is restricted by the number and types of questions posed by the test itself. Although standardized tests are commendable because they provide for: 1) objectivity in the scoring of and interpretation of responses; 2) quantification of the behaviours under study, and consequently the possibility of drawing comparisons among subjects and within subjects over time, and 3) economy in terms of time and money, their use alone in the assessment of aphasic disorders does not provide the type of information which can be obtained by clinical examination. Since many examinations for aphasia use a pass-fail dichotomy in the scoring of responses, the characteristics of speech are lost in the testing situation. In a clinical examination, these characteristics are noted, and form part of the basis for hypotheses developed by the clinician concerning the presence of and nature of deficits in language functioning. Unlike a test, it is possible for the astute clinician to detect not only deficits, but also the manner in which the patient circumvents his impairments. Since aphasics represent a relatively heterogeneous group within the brain-injured population, the use of one battery of tests may be inadequate for the assessment of a particular individual. In the clinical examination, the clinician is not restricted in his use of tests, he has the option of administering additional tests or of posing questions of his own which will either support or refute the hypotheses he has developed throughout the examination. In this sense, the clinical examination is more flexible than the testing situation with respect to individual differences among aphasic patients. It is obvious that in aphasia testing, clinical examination is not incompatible with the use of standardized tests. Moreover, the clinical examination completes the assessment of language functioning, which by its definition a standard test battery is unable to do. The laborious clinical examination of the latter part of the nineteenth century and the early part of the twentieth century has, in most instances out of necessity, been replaced by a shorter examination supplemented by standardized tests. However, more complete clinical examinations are still practiced today (Luria, 1966) where facilities permit.

Test Examination

The following methods to be described are more formally developed tests.

Aphasia. A Clinical and Psychological Study, presented by Theodore Weisenburg and Katherine McBride in 1935, is considered to be the second major landmark, both in the field of aphasia (Schuell et al., 1964), and in the history of aphasia testing (Eisenson, 1973). The study will only be considered as it relates to aphasia testing.

Weisenburg and McBride (1935) constructed a battery of tests for aphasia which consisted of ten series of tests, each test containing several subtests. The labels assigned to the series of tests were as follows: Speaking, Naming, Repeating, Understanding Spoken Language, Reading, Writing, Arithmetic, Language Intelligence Tests, Reproduction of Verbal Material, and Non-Language Tests. Weisenburg and McBride (1935) constructed this battery of tests by means of borrowing various tests and subtests from both standardized and unstandardized test batteries. Examples of such subtests are Henry Head's Hand, Ear and Eye Test, Gates Word Pronounciation and Primary Reading Tests, and the Stanford-Binet Vocabulary Test. The entire battery took approximately nineteen hours to administer (Weisenburg and McBride, 1935).

The value of Weisenburg and McBride's study does not lie in the actual battery which they constructed, for this was never widely used, nor does it lie in the results of the study itself; rather, as indicated by Schuell et al. (1964), its major contribution to the field of aphasia was in its methodology. The Weisenburg and McBride study (1935) was the first to have used a normal control group and a non-aphasic brain-damaged group in their comparison of aphasic and non-aphasic performance on a battery of tests for aphasia (Schuell et al., 1964; Weisenburg and McBride, 1935). The major shortcoming of the study, which invalidated their results to some extent, was Weisenburg and McBride's failure to discriminate between neurologically stable and neurologically unstable aphasics in their consideration of the performance of aphasic subjects (Weisenburg and McBride, 1935).

With the development of Head's Serial Tests (Head, 1926) and the construction of the Weisenburg and McBride (1935) battery of tests, the need for a standardized battery for aphasia became apparent. The subsequent development of various instruments for the assessment of aphasic behaviour paralleled changes and elaborations in the concepts of aphasia. Whereas the early workers of the 1920's and 1930's found it acceptable to employ screening devices in the detection of aphasic disorders, there has been a trend in more recent years towards the development of comprehensive examinations which permit an increasingly more complex description of language functioning (Schuell et al., 1964). As indicated by Benton (1967), a number of these examinations have the potential for recognition as a standard battery of tests for aphasia; however, not one has been adopted by a sufficiently large proportion of the workers in aphasia to be considered as such. The value of a standard battery of tests for facillitating communication among researchers, and more specifically for enabling direct comparisons among the results of studies, cannot be over estimated.

The lack of a standard battery for aphasia has been attributed to several factors. Some authors have suggested that the development of several examinations is a reflection of the diversity of opinions concerning both the nature of language and the nature of language disorders (Benton, 1967; Eisenson, 1973; Sarno, 1972). As noted by Osgood and Miron (1963) there exist two general approaches to test construction. The first approach is primarily concerned with designing a battery of tests which satisfy the requirements of some theoretical model; while the second approach concerns the development of a test battery based on systematic empirical observation.

With reference to the first approach to test construction, the test constructor's conception of the nature of the underlying disturbance in aphasia is a significant determinant of the type and number of tests considered necessary for an adequate assessment of language functioning. In this first category of tests, two tests are worthy of mention - the

Language Modalities Test for Aphasia, and the Boston Diagnostic Aphasia Test.

Jones and Wepman (1961) developers of the Language Modalities Test for Aphasia (LMTA), state that each language act consists of a stimulating situation, which may be externally produced or internally invoked (input), a central mediating process which serves to interpret the stimulus, and a response (output) which is attributable to both the stimulus and the central mediating process. This conception of the nature of language is reflected in the choice of stimuli employed, and the response required of the patient. In order to study the various input - output relationships, the LMTA samples behaviour in oral and graphic modalities, while stimuli are presented in both the visual and auditory modality. Since Jones and Wepman (1961) believe that maximal discrimination among brain damaged individuals will only be attained when the percentage of subjects passing a particular item is closer to fifty percent than to zero or one hundred percent, the level of difficulty of the items remains constant throughout the test battery.

Eisenson (1973) has indicated that the LMTA may be viewed as a psycholinguistic analysis of an aphasic's language production. The feature of this test which makes this analysis possible, and subsequently the classification of aphasics into one of five categories, is the scoring procedure. Unlike most comprehensive examinations for aphasia which use a pass - fail dichotomy for each item, each response to an item on the LMTA is scored as one of the following: correct, phonemic or orthographic, syntactic error, semantic error, jargon or illegible, no response (Eisenson, 1973; Jones and Wepman, 1961). A summary of the types of errors produced by an aphasic patient is used by the examiner to classify the patient into one of the following categories of aphasia - syntactic, semantic, pragmatic, jargon or global (Wepman and Jones, 1964). This form of classification is often used as a means of directing therapy for a particular individual. A brief summary of the language deficits which characterize the types of aphasia considered by Wepman and Jones (1964) is presented in Appendix B.

Although the LMTA is a structured instrument for assessing behaviour, it provides for the analysis of speech in a relatively unstructured situation by including in the visual stimuli a picture, about which the patient is required to tell a story.

Goodglass and Kaplan (Goodglass, 1972), developers of the Boston Diagnostic Aphasia Test (BDAT), beleive that certain types of language deficits are produced by injury to specific regions of the brain which are specialized for language functioning. Their examination for aphasia was designed to provide the examiner with enough information to make an accurate diagnosis of the type of aphasia, and to draw inferences about the localization of the lesion. Not unlike other comprehensive examinations for aphasia, the BDAT consists of subtests for various input and output modalities, for example auditory comprehension, oral expression, understanding written language, and writing. The items within each subtest become increasingly more complex, so as to obtain an estimate of the level of performance of a given individual on any one subtest. Since linguistic features such as syntactical organization, fluency, and type of paraphasia are expected to be major discriminating factors among types of aphasia, an analysis of free speech is considered to be essential for an adequate assessment of language functioning (Goodglass, 1972). Provision for an analysis of free speech is made in the first subtest of the battery, where the examiner's instructions are to provide the patient with open - ended questions, and a picture to describe (Goodglass, 1972).

An example of a test which was developed on the basis of systematic empirical observation is the Minnesota Test for Differential Diagnosis of Aphasia (MTDDA). It was developed by Hildred Schuell in 1948; however, the research edition of the test did not appear until 1955, following seven years of observation, exploration and revision (Schuell, 1957). The research edition underwent two subsequent revisions, so that in 1965 the final version or Form 8 of the test was published (Schuell, 1966).

The final version of the MTDDA consists of forty-seven subtests which are subsumed under the following categories: Auditory Comprehension, Visual and Reading Tests, Speech and Language Disturbance, Visuomotor and Writing Tests, and Numerical Relations and Arithmetic Processes.

In developing an examination for aphasia, Schuell considered it important to sample behaviour in all language modalities, with tests of graduated difficulty in each modality. Schuell's battery of tests were employed to answer two questions, both of which are related to the patterns of impairment observed on the performance of the MTDDA. Firstly, Schuell hoped to determine why an aphasic may not be able to perform beyond a certain level of difficulty within a particular modality; the second question was that of prognosis for a particular individual. Schuell (Sies, 1974), like Wepman and Jones, attempted to classify aphasics into one of five basic categories; however, each of Schuell's categories is also associated with a prognosis for recovery. For a brief summary of Schuell's classification system, refer to Appendix C.

A review on examining for aphasia would be incomplete without mentioning either the Porch Index of Communicative Ability (PICA) (Porch, 1967) or the Functional Communication Profile (FCP) developed by Martha Taylor-Sarno (Taylor, 1965).

The PICA, developed by Bruce Porch (Porch, 1967) has attained widespread use, particularly among speech pathologists in the United States of America. The PICA consists of eighteen subtests, which sample behaviours in the verbal, gestural and graphic modalities. The rationale for test selection was sampling of behaviour in various output modalities from which inferences could be drawn concerning a patient's input language and integrative abilities. Each of the subtests employs ten common objects, thus permitting the examiner to compare results across the three output modalities. Nine of the subtests require intact visual recognition for correct performance, six require understanding spoken language, while the remaining three test the patient's reading ability. A unique feature of the test, which is emphasized more than the content of the test itself, is the multi-dimensional scoring procedure (Porch, 1971). Each response to an item is scored on a sixteen point rating scale. Responses are scored for their accuracy, responsiveness - particularly in terms of the type and number of cues required to elicit a response, completeness in performing the task at hand, promptness in responding, and finally efficiency, or the facility with which a response is produced. This last factor takes into consideration impairments in motor functioning which may reduce the ease with which a particular task is performed. On the sixteen point rating scale, a score of 1 represents no response, a score of 9 is assigned to an accurate response elicited subsequent to repetition of instruction, while a score of 16 represents a response which was accurate, uncorrected, complete, immediate and efficient. The relative lack of direct testing of auditory-verbal abilities, for the purpose of determining where these abilities breakdown, has been cited as the major drawback in employing the PICA for the assessment of language functioning (Boone, 1972).

In comparison to the previously mentioned examination for aphasia, the FCP is an entirely different type of instrument which was designed to measure the functional dimension of language performance often ignored by aphasia batteries currently in clinical use. Taylor (1965) makes a distinction between clinical and functional measures of language performance. Clinical measures are obtained when the patient is presented with tests; functional measures can only be obtained when language performance is observed in an informal situation without the presentation of tests (Taylor, 1965). Taylor's primary objection to the clinical assessment of aphasic disorders is that aphasia batteries merely provide an indication of the patient's potential for language usage, they do not assess his actual use of language. For instance, there is no indication of the patient's spontaneous use of language in his interaction with others outside the testing situation, nor is the manner in which the patient attempts to circumvent his difficulties evaluated (Taylor, 1965).

The FCP consists of a list of fifty behaviours which are considered to be "common language functions of everyday", for instance, handling money, indicating the floor to the elevator operator, and writing one's own name (Taylor, 1965). The test is subdivided into five categories - movement, speaking, understanding, reading, and a miscellaneous category. An estimate is made of the patient's premordid level of language proficiency, against which his recovery of language functions can be compared. For each of the fifty items a rating is made by the observer, using an eight-point rating scale, ranging from 0 to normal. In the rating of a particular item, five factors are taken into consideration: speed, accuracy, consistency, voluntary control, and compensatory actions. A behaviour is rated as normal only when its performance matches the estimated premorbid level. A weighted score is assigned to each rating, which permits the calculation of percentages for each of the five modalities assessed by the FCP. The sum of the percentages for the five modalities represents the percentage of language functioning at a given time for a particular individual, in comparison to his estimated premorbid level of language proficiency. For example, an overall percentage of seventy-five indicates that the patient's overall language functioning is seventy-five percent of his premorbid level. The form sheet for the FCP is presented in Appendix D.

Since the present study investigates data of the <u>Neurosensory Center Comprehensive Examination for Aphasia</u> (NCCEA) (Spreen and Benton, 1969), a more detailed description of the examination and its development will be presented. The NCCEA represents a more current attempt to develop a battery of tests for aphasia on the basis of systematic empirical observation. It should be noted, that in addition to the English version of the NCCEA, both Italian and Spanish versions are currently being developed.

The development of the NCCEA was initiated by Spreen and Benton at the Neurosensory Center of the College of Medicine, University of Iowa, in 1962 (Benton, 1967). The authors' primary consideration was in the development of a clinically useful examination for aphasia; their second consideration was the development of an examination which could be employed for research purposes, for example in studying the nature of the pattern of recovery from aphasia (Benton, 1967; Spreen, 1976).

Four major factors were considered to be important in the development of a clinically useful examination for aphasia. The first factor to be considered was the development of tests which would essentially assess most areas of language functioning. A related factor was the construction of relatively detailed tests which would permit an accurate assessment of the level of performance attained by a given individual on any one test. The third factor concerned the possibility of making errors by attributing poor performance on certain subtests to language deficits. Consideration of this factor led to the development of four control tests designed to determine the presence of stereognostic defects, impairment in visual recognition, and visuoperceptive impairments. For example, a poor performance on tactile-naming tasks may be due to either an impairment in language functioning or to a stereognostic defect. The fourth factor to be considered was the development of scoring procedures, which would enable the researchers to standardize the tests and to make adjustments for age, education and sex, where such corrections were warranted.

Test selection was in accordance with the major objectives guiding the development of the NCCEA. In order to obtain a relatively complete assessment of major areas of language functioning, stimulus material was presented in the visual, auditory and tactile modalities. Tests were selected which would determine the patient's ability to understand both oral and written commands; his oral production of language in naming tasks, and in the generation of words and sentences; his ability to write to stimuli presented in visual and auditory modalities, as well as the accuracy of his writing; his reading and repetition skills, and finally, his level of articulation. Some subtests were primarily included for research purposes. For instance, Sentence Repetition was included to determine whether repetition defects occur in isolation (Benton, 1967).

The following is a brief description of each of the twenty tests comprising the nucleus of the battery:

1. Visual Naming (VN). Oral naming of common objects presented visually.
2. Description of Use (DU). Oral description of the function of common objects presented visually.
3. Tactile Naming - Right Hand (TNR). Oral naming of common objects presented tactually to the right hand. A poor performance warrants administration of control test C1 - Tactile Visual Matching - Right Hand (TMR).
4. Tactile Naming - Left Hand (TNL). Oral naming of common objects presented tactually to the left hand. A poor performance warrants administration of control test C2 - Tactile Visual Matching - Left Hand (TML).
5. Sentence Repetition (SR). Repetition of sentences varying in length

from one to twenty-six syllables. Sentences are presented on sound tape.

6. Repetition of Digits (DRF). Repetition of series of digits of increasing length, presented on sound tape.
7. Reversal of Digits (DRR). Reproduction of a series of digits of increasing length, in an order reversed to that presented on sound tape.
8. Word Fluency (WF). Oral retrieval of words (excluding proper nouns) beginning with the letters F, A and S. The subject is allowed one minute for each letter.
9. Sentence Construction (SC). Oral production of self-generated sentences employing a series of two and then three specified words.
10. Identification by Name (IN). Pointing to common objects named by the examiner.
11. Identification by Sentence (IS). A modification of the DeRenzi-Vignolo Token Test. The subject is required to perform a series of increasingly more complex commands.
12. Reading Names, Oral (RNO). Reading aloud nouns presented in print.
13. Reading Sentences, Oral (RSO). Reading aloud sentences presented in print.
14. Reading Names for Meaning (Pointing) (RNP). Reading names presented in print, then pointing to the appropriate object.
15. Reading Sentences for Meaning (Pointing) (RSP). Execution of twelve commands presented in print, making use of the material from the Token Test.
16. Visual-Graphic Naming (VGN). Written production of the names of common objects presented visually.

17. Writing Names (WN). Scoring of the responses to test number 16, with respect to accuracy of spelling.

18. Writing to Dictation (WD). Written production of a six and seven word sentence, dictated by the examiner.

19. Writing - Copying (WC). Copying a four word and a seven word sentence, presented in print.

20. Articulation (ART). Repetition of both real and nonsense words, presented on sound tape.

Standardization Procedures

The first edition of the NCCEA appeared in 1964. This was followed by the development of an experimental version in 1965. Prior to the publication of the first edition, the battery of tests was standardized on a group of thirty control subjects ranging in age from sixteen to sixty-four years, a group of fifty-seven brain damaged adults ranging in age from fourteen to sixty-five years, and a group of normal children ranging in age from two to twelve years.

Based on the performance of the various standardization groups, forty out of sixty items were selected for inclusion in the battery of tests. The criteria used in the selection of items were: 1) representation of a wide range of level of difficulty - the percentage of failures on the forty items ranged from 3.6% to 35.5% ($\bar{X}$ = 13.36%), while the mean age of aquisition for the forty items was 5.7 years; 2) appropriateness of items for both visual and tactile naming; and 3) ease in scoring responses as either correct or incorrect (Benton, 1967; Spreen and Benton, 1965). The forty items selected according to these criteria were subdivided into groups of ten items each. The level of difficulty represented by each subset of items was approximately equivalent. In the first edition of the test (Spreen and Benton, 1964) and in the experimental version (Spreen and Benton, 1965), the four groups of items were used throughout the battery of tests - for example, for Visual Naming, Description of Use and Tactile Naming Tests.

Administration of the battery of tests to the control group of subjects, allowed corrections for age and education to be made, where such corrections were indicated.

A third version of the NCCEA appeared in 1969 (Spreen and Benton, 1969). The major revision in Edition A was the elimination of eight items out of the forty which were selected for the first two editions. Two of the items which were eliminated presented the greatest difficulty to the original standardization groups, three items presented moderate difficulty, two items were passed by approximately ninety-five percent of the groups, while the eighth item posed the least difficulty for the standardization groups. Profile sheets were also revised, based on the performance on the NCCEA of a 're-standardization' group, consisting of a larger number of subjects.

Development of Profile Sheets

By converting raw scores into percentile ranks, a profile sheet was developed based on the performance of the control group used in standardization procedures. Since the performance of the aphasic standardization group fell below the lower limit for the normal control group, it was necessary to develop a second profile sheet based on the aphasic group's performance (Benton, 1967).

Plotting of a given subject's scores on the profile sheets enables the examiner to 1) compare the subject's performance with that of both normals and aphasics; 2) determine areas of language impairment, and 3) to compare within the individual's own performance his relative strengths and weaknesses in language functioning.

The manual of instructions for test administration, and the test booklet for Edition A of the NCCEA (Spreen and Benton, 1969) are presented in Appendix E.

Given the present state of knowledge about the nature of the underlying disturbance in aphasia, it may be difficult to secure a large amount of agreement regarding the specific tests necessary for an adequate assessment of language functioning. However, it should be noted that current researchers in aphasia testing have emphasized the importance of sampling behaviour in all language modalities (Eisenson, 1973; Goodglass, 1972; Schuell, 1966; Weigl, 1966). This procedure ensures that language deficits present in one modality, and not in another, are not overlooked. Schuell (1966) makes the additional qualification that an adequate examination for aphasia should provide sufficient information not only to describe the major deficits, but also to determine the reasons for language breakdown. For example, both prognosis and therapy may differ depending upon whether the impairment in reading ability is due to limitations in verbal retention span, or is the result of deficits in the visual system. Discriminations of a similar nature are possible with the use of the NCCEA (Spreen and Benton, 1969). The four control tests incorporated into the NCCEA allow the examiner to detect the presence of tactile and visual deficits. Since performance on, for example, a Visual Naming task requires both visual and language functioning, it is important to rule out the possibility of a major loss in visual recognition before a poor performance is attributed to an impairment in language functioning.

A second major factor contributing to the lack of a standard battery of tests for aphasia appears to be the technical inadequacy of the instruments developed to date (Benton, 1967). Benton (1967) states that many of the batteries of tests currently in use are not available in a form which could be used by workers outside the centers in which these tests were developed. More specifically, these tests have failed to provide standardization information, and explicit descriptions of administration and scoring procedures. Fulfilment of these, and the two standard requirements of reliability and validity will increase the probability that an examination will be accepted as a standard test battery for aphasia.

Although Benton (1967) has commented on the technical inadequacy of many of the clinical examinations for aphasia currently in use, it should be noted that at the present time experimental evidence for test-retest, inter-scorer, and split-half reliability of the NCCEA is not available.

Validity: A Basic Psychometric Requirement

Although there is some disagreement about the concept of validity, most authors agree that validity is an essential feature of any test (Anastasi, 1961; Brown, 1970; Guilford, 1954; Nunnally, 1967; Payne and McMorris, 1967; Yates, 1954). The type of validity required is dependent primarily upon the purposes for which the test was designed. Aphasia batteries are generally concerned with diagnosis and prediction. The Standards for Educational and Psychological Tests (APA, 1974) suggest that tests designed for diagnosis should provide at least one measure of criterion-related validity. Diagnostic prediction is often equated with classification into diagnostic categories, for example aphasic versus non-aphasic. Calculation of the percentage of correct classifications provides the test user with an indication of the confidence with which he can make decisions based upon the results. An aphasia battery designed to detect the presence of language deficits, and to describe the nature of these impairments, requires a demonstration of predictive validity. This can be measured by the correlation of performance on language tests with the presence or absence of a medical diagnosis of aphasia. Such diagnoses may be based upon clinical observation and the results of physical procedures such as angiography, which are designed to detect the presence of organic cerebral pathology.

General Purpose of the Thesis

The purpose of the present study is to demonstrate the predictive validity of the NCCEA. Associated with the determination of predictive validity, a discriminant functions analysis will allow the derivation of a prediction equation which will permit the classification of subjects into either an aphasic or non-aphasic category. From the prediction equation it will be possible to determine which of the subtests of the NCCEA maximally discriminate between subjects with a medical diagnosis of aphasia and those without. It will also be possible to determine which subtests correlate highly with each other and can therefore be considered unnecessary for a successful discrimination between groups. Since discriminant function coefficients provide optimum discrimination between groups for the particular sample from which they were derived, an attempt will be made to cross-validate the NCCEA on different samples of subjects. Wheeler (1963) and Wheeler and Reitan (1963) have strongly emphasized the need for cross-validation, particularly in tests designed to measure the presence or absence of deficits associated with cerebral damage.

The present study was designed to test the following hypotheses. The general hypothesis is stated first, followed in each case by the specific prediction of the outcome of the study.

I) i. Subjects with known organic cerebral pathology and a medical diagnosis of aphasia will perform significantly differently on a series of tests of language functioning than subjects with organic cerebral pathology and no diagnosis of language deficits.

ii. Performance on the NCCEA will successfully discriminate between subjects with a medical diagnosis of aphasia and subjects diagnosed as non-aphasic.

iii. The aphasic group will receive significantly lower mean scores on each of the subtests of the NCCEA than the non-aphasic group.

II) i. It will be difficult to differentiate between the performance of aphasics with minimal language deficits, and non-aphasics who show minimal performance deficits on individual subtests of the NCCEA.

ii. The use of a predictive equation for the classification of subjects into aphasic and non-aphasic categories is expected to yield a small percentage of misclassifications.

iii. The majority of misclassifications are expected to be subjects with a medical diagnosis of minimal aphasic symptoms.

III) i. The differences in performance on the NCCEA between aphasic and non-aphasic subjects in a second sample derived from the same geographical and clinical setting, are not expected to differ significantly from the first sample.

ii. The predictive equation derived from the first sample will successfully discriminate between aphasic and non-aphasic subjects in the second sample.

iii. The amount of loss in the predictive accuracy of the equation is expected to be in the order of ten to twenty percent.

IV) i. Differences between aphasic and non-aphasic subjects in a second sample, with respect to the range of and mean of scores on the NCCEA, are expected to be of the same order as those observed in the first sample within a particular geographical and clinical setting.

ii. The discriminant function derived from an analysis of the performance on the NCCEA of subjects in a second sample, is expected to be the same as that derived from subjects in the first sample.

iii. The absolute value of weighting coefficients will be expected to change minimally for a second sample. However, those subtests loading positively on the discriminant function derived from the first sample, will load positively on the discriminant function derived from the second sample of subjects.

METHOD

Tests

The twenty subtests comprising the nucleus of the battery of tests, designed by Spreen and Benton (1969) were employed in the present investigation (refer to Appendix E). Tests were administered by trained psychometricians, following the administration procedures of the NCCEA manual.

Subjects

Three groups of subjects were used in the present study. The first group consisted of eighty patients who were referred for neuropsychological assessment to: the Neuropsychology Laboratory of the University of Victoria, the Royal Jubilee Hospital, the Victoria General Hospital or the Gorge Road Rehabilitation Center, all of which are located in Victoria, British Columbia. The second group of subjects were assessed at the New York Rehabilitation Center, which is associated with the New York University Medical School. The total number of patients in this group was thirty-eight.* The eighty-eight patients who constituted the third group of subjects were all assessed at the Neurosensory Center of the School of Medicine, University of Iowa, Iowa City, Iowa.**

All the information concerning the New York and Iowa subjects selected for the present investigation, was available in the Neurofile at the University of Victoria, Neuropsychology Laboratory. Information concerning the Victoria group of subjects was also available in the Neurofile; however since the author had access to medical records for

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*Both the scores on the NCCEA and the medical information concerning New York subjects was provided by Dr. Martha Taylor-Sarno of the New York Rehabilitation Center.

**Medical information and scores on the NCCEA for Iowa subjects were provided by Drs. O. Spreen and A. L. Benton.

subjects tested at the Royal Jubilee Hospital, as much additional medical information was obtained as possible.

Since the amount of available medical information and personal data regarding sex, age, education and handedness was limited for the New York and Iowa groups, some of the criteria for the selection of subjects were modified to accomodate for these differences. A listing of the criteria used for subject selection is followed by separate descriptions of each of the three groups, and the samples which were drawn from the Victoria and Iowa groups.

Criteria for the Selection of Subjects

The following criteria were used in the selection of subjects, with certain modifications for New York and Iowa subjects where noted.

1. Performance on the NCCEA, with no more than three missing subtest scores.

   1) since Tactile Naming Right Hand, Tactile Naming Left Hand, and Articulation subtests are not routinely administered at the New York Rehabilitation Center, the criterion for the selection of New York subjects was performance on the NCCEA with no more than three missing subtest scores, excluding the three subtests mentioned above. For a New York subject the minimum number of subtest scores required was fourteen.

   11) for Iowa subjects, the Articulation subtest is not commonly administered, therefore the criterion for selection was performance on the NCCEA with no more than three missing observations, excluding the Articulation subtest. The minimum number of subtest scores required for an Iowa subject was sixteen.

2. In cases of the readministration of the NCCEA, the first administra-

tion which met the requirements specified above, was used.

3. Subjects were sixteen years of age or older at the time of test administration. Subjects who were older than fifteen years and six months were considered to be sixteen.

4. A medical diagnosis of organic cerebral pathology based upon the results of any number of the following: electroencephalogram, skull X-ray, angiogram, pneumoencephalogram, ventriculogram, echoencephalogram, brain scan, or the diagnosis established by a neurologist or neurosurgeon.

5. A statement made by either a neurologist or neurosurgeon, concerning the presence or absence of language deficits.

   1) in the case of New York subjects where such information was not available; the substitute criterion was a diagnosis of aphasia or absence of language deficits based upon the performance of the Functional Communication Profile (Taylor, 1965). It was felt that this substitution of criterion was justifiable since neurologists or neurosurgeons commonly base their diagnosis of aphasia on their interaction with the patient. In cases where aphasic symptomatology may not be obvious, the neurologist or neurosurgeon may use relatively simple tasks such as the naming of objects which are at hand, to determine the presence of aphasia (Heimburger and Reitan, n.d.). The Functional Communication Profile (Appendix D) evaluates a patient's language abilities in an informal setting, by means of casual conversation with the patient (Taylor, 1965).

6. Hospital medical records were searched for those Victoria subjects whose Neuropsychology Data File was incomplete with respect to an

indication of the laterality, locus, extent and etiology of the lesion.

1) hospital medical records for New York and Iowa subjects were inaccessible.

7. Where available, an indication of the laterality, locus, extent and etiology of lesion, was recorded.

Victoria Subjects

The Victoria group of subjects consisted of fifty-two males and twenty-eight females, ranging in age from sixteen to seventy-seven years ($\bar{X}$ = 49.71 years; SD = 16.23 years). The mean number of years of education completed was 10.34 (SD = 3.70 years) with a range of zero to nineteen years.

With respect to handedness, 92.5% of the entire group were manifest right handers, five percent were manifest left handers, and one subject was ambidextrous. Information concerning handedness was not available for one subject.

A medical data checklist was designed to facilitate the recording of medical information on each subject. This checklist is presented in Appendix F. Fifty-four of the eighty subjects in the Victoria group were diagnosed as aphasic by either a neurologist or a neurosurgeon. The remaining twenty-six subjects were diagnosed as non-aphasic; this diagnosis was usually in the form of a statement in the medical records, indicating the absence of language deficits. Since the diagnoses were made independently by neurologists or neurosurgeons, prior to the time of the present investigation, without knowledge of the investigation, and without access to behavioural test data, no biases are expected to exist. It should be noted that all eighty subjects suffered some form of organic cerebral pathology, eventhough 32.5% of the group were diagnosed as non-aphasic.

Information concerning lateralization, localization, and type of brain damage, was based on positive results obtained on any number of seven physical measures of brain dysfunction, craniotomy reports, and either a neurologist's or neurosurgeon's report. The seven physical measures most commonly employed to detect cerebral pathology were the: electroencephalogram, skull X-ray, angiogram, pneumoencephalogram, echoencephalogram, ventriculogram, and brain scan. The neurologist's or neurosurgeon's report, was based on positive signs on physical measures, clinical examination, and where performed - craniotomy. It is evident that in some cases, the information provided by the neurologist or neurosurgeon in his report, is redundant with the positive indicators of brain dysfunction mentioned above; however in cases where there was no access to hospital medical records, the neurologist's or neurosurgeon's report which was available in the University of Victoria, Neuropsychology Files, proved invaluable*.

The neurosurgeon's report concerning laterality, locus and type of brain damage was used as the primary source of information for cases where craniotomies had been performed. It should be noted that in almost all cases, positive signs on physical measures did not conflict with the neurosurgeon's report; however an exact count of conflicts was not recorded.

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*Collaborating neurologists and neurosurgeons were: Drs. C. Bertrand, G. S. Cameron, F. A. Hamdi, L. Harris, J. E. Harvey, A. H. Ibrahim, F. Kemble, R. M. Peet, and C. A. Simpson

As shown in Table I, the majority (70%) of the patients in the Victoria group suffered lesions restricted to the left cerebral hemisphere. An additional 13.75% suffered either bilateral of diffuse cerebral damage. The figures indicated that left cerebral hemisphere lesions were observed in 83.75% of the patients in the entire group.

With regard to locus of lesion, the most common site was the temporal lobes. 21.25% of the eighty subjects had temporal lobe lesions. Of this 21.25%, 82.35% suffered left hemisphere damage, 11.76% right hemisphere damage, and 5.89% suffered damage to both temporal lobes. Locus of lesion for the remaining subjects can be determined by examining Table I.

Of the twelve categories listed for type of brain damage (refer to Appendix E) only seven were applicable to the Victoria group. The two commonest types of brain damage which occurred within this group were vascular (32.5%), and traumatic (27.5%) resulting in some form of cerebral hemorrhage. The third commonest type of brain damage encountered was neoplastic lesions (15%). It is interesting to note that these three types of brain damage are most commonly associated with research in the field of aphasia.

In the Victoria group, the number of positive indicators of cerebral damage, ranged from 1 - 6 ($\bar{X} = 3.09$; SD = 1.24). In those cases where only one positive indicator of brain damage was recorded, this was the report of the neurologist or neurosurgeon.

Since the information was available, two other factors were considered with the Victoria group; these were the presence of complicating

TABLE I

Summary of Medical Data for the Victoria Group

	LATERALIZATION OF BRAIN DAMAGE			
	Right	Left	Bilateral	Diffuse
N	6	56	8	3
%	7.5	70	10	3.75

	LATERALIZATION OF BRAIN DAMAGE (cont'd		
	Subcortical	Undetermined	No Information
N	1	3	3
%	1.25	3.75	3.75

	LOCALIZATION OF BRAIN DAMAGE				
	Frontal	Temporal	Parietal	Fronto-Temporal	Fronto-Parietal
N	5	17	2	15	3
%	6.25	21.25	2.5	18.75	3.75

	LOCALIZATION OF BRAIN DAMAGE (cont'd)				
	Temporo-Parietal	Parieto-Occipital	Diffuse	Undetermined	No Information
N	8	3	15	4	8
%	10	3.75	18.75	5	10

	TYPE OF BRAIN DAMAGE			
	Traumatic	Vascular	Neoplastic	Infectious
N	22	26	12	3
%	27.5	32.5	15	3.75

	TYPE OF BRAIN DAMAGE (cont'd)		
	Degenerative	Undetermined	No Information
N	6	4	7
%	7.5	5	8.75

neurophysiological conditions, and the time interval between the onset of illness and the administration of the NCCEA. 75% of the Victoria subjects had one or more complicating neurophysiological conditions. These included motor and/or sensory impairments, visual field defects and/or diplopia, and under the category of other, conditions such as hypertension, epilepsy and diabetes insipidus.

Time interval data was available for only sixty-six of the eighty subjects. This was not unexpected since the onset of symptoms with neoplasms and degenerative disorders is most commonly insidious. The exact date and time can usually be specified with cerebrovascular accidents or traumatic head injuries. The time interval between the onset of illness, and administration of the NCCEA, ranged from 1 - 312 weeks, with a mean of 32.29 weeks and a standard deviation of 52.59 weeks. In eleven cases where the patient was tested within the first week following the onset of illness, the time interval recorded was one week.

It should be noted that the date of diagnosis of aphasia or absence of aphasia, corresponded closely to the time of test administration.

Victoria Subjects

The eighty subjects who constituted the Victoria group were sub-divided into aphasic and non-aphasic groups, according to their medical diagnoses. In the assignment of subjects to Samples 1 and 2, the aphasic and non-aphasic group were considered separately. This procedure ensured that an equal number of aphasics and non-aphasics would be assigned to each of the two samples.

Subjects were randomly assigned within their group to either Sample 1 or Sample 2 by means of Tables of Random Permutations (Moses and

Oakford, 1963). For example, each subject within the aphasic group received a number from the particular table of random permutations employed. Aphasic subjects with odd numbers were assigned to Sample 1, while those with even numbers were assigned to Sample 2. The same procedure was followed for the group of non-aphasic patients. Each of the two samples had a total of forty subjects, twenty-seven of whom had a medical diagnosis of aphasia, and thirteen with a medical diagnosis of absence of aphasia.

Victoria Sample 1

There were twenty-five males and fifteen females in Sample 1. They ranged in age from seventeen to seventy-five years ($\bar{X}$ = 46.53; SD = 15.41). The mean number of years of education completed was 10.58, with a standard deviation of 3.24 years. Information concerning education was not available for two of the subjects in the sample. Thirty-six of the forty subjects were manifest right handers, three were manifest left handers, while one was ambidextrous. With respect to the time interval between onset of illness and administration of the NCCEA, the range in weeks was from 1 - 312 ($\bar{X}$ = 31.58 weeks; SD = 57.77 weeks). Time Interval data was not available for ten percent of the subjects in the first sample.

Victoria Sample 2

The second sample consisted of twenty-seven males and thirteen females, ranging in age from sixteen to seventy-seven years ($\bar{X}$ = 52.9 years; SD = 16.58 years). In terms of the number of years of education completed, the mean was 10.10 years, with a standard deviation of 4.13 years. For one subject, this information was unavailable. There were thirty-eight manifest right handers, and one manifest left hander in the second sample. Information concerning handedness was not available for the remaining subject. The time interval between onset of illness and adminstration of the NCCEA ranged from 1 to 164 weeks ($\bar{X}$ = 33.13 weeks; SD = 46.58 weeks). Time Interval data was only available for seventy-five percent of the subjects in the second sample.

Medical Data Victoria Samples 1 and 2

A summary of the medical information available for subjects assigned to Samples 1 and 2 is presented in Tables II and III respectively.

Examination of both tables reveals that the majority of patients (70%) in each sample, sustained lesions to the left cerebral hemisphere. With respect to localization of lesion, the summary tables do not reveal any large percentages for any particular locus, with perhaps the exception of subjects assigned to Sample 2, where 27.5% sustained temporal lobe lesions. A more meaningful breakdown of laterality and locus of lesion will be attempted when aphasics and non-aphasics are considered separately. As far as type of brain damage is concerned, cerebrovascular accidents, traumatic head injuries and neoplastic lesions accounted for a large percentage (82.5% in Sample 1; 67.5% in Sample 2) in both samples.

Chi-square analyses could not be performed on the data concerning laterality, locus, and etiology of lesion for the following reasons: 1) the number of aphasics in each of the two samples was more than twice as great as the number of non-aphasics; 2) aphasia is most commonly associated with damage to the left cerebral hemisphere; 3) within

TABLE II

Summary of Medical Data for Victoria Sample 1

	LATERALIZATION OF LESION				
	Right	Left	Bilateral	Diffuse	Undetermined
N	5	28	5	1	1
%	12.5	70	12.5	2.5	2.5

	LOCALIZATION OF LESION				
	Frontal	Temporal	Parietal	Fronto-Temporal	Fronto-Parietal
N	4	6	1	8	1
%	10	15	2.5	20	2.5

	LOCALIZATION OF LESION (cont'd)				
	Temporo-Parietal	Parieto-Occipital	Diffuse	Undetermined	No Information
N	6	3	8	1	2
%	15	7.5	20	2.5	5

	TYPE OF BRAIN DAMAGE			
	Trauma	Vascular	Neoplasm	Infection
N	15	9	9	1
%	37.5	22.5	22.5	2.5

	TYPE OF BRAIN DAMAGE (cont'd)		
	Degenerative	Undetermined	No Information
N	1	4	1
%	2.5	10	2.5

TABLE III

Summary of Medical Data for Victoria Sample 2

	LATERALIZATION OF LESION			
	Right	Left	Bilateral	Diffuse
N	1	28	3	2
%	2.5	70	7.5	5

	LATERALIZATION OF LESION (cont'd)		
	Subcortical	Undetermined	No Information
N	1	2	3
%	2.5	5	7.5

	LOCALIZATION OF LESION				
	Frontal	Temporal	Parietal	Fronto-Temporal	Fronto-Parietal
N	1	11	1	7	2
%	2.5	27.5	2.5	17.5	5

	LOCALIZATION OF LESION (cont'd)			
	Temporo-Parietal	Diffuse	Undetermined	No Information
N	2	7	3	6
%	5	17.5	7.5	15

	TYPE OF BRAIN DAMAGE		
	Trauma	Vascular	Neoplasm
N	7	17	3
%	17.5	42.5	7.5

	TYPE OF BRAIN DAMAGE (cont'd)		
	Infection	Degenerative	No Information
N	2	5	6
%	5	12.5	15

the left cerebral hemisphere, damage to certain regions correlates more highly with aphasic symptomatology than damage to other regions; and 4) three types of brain damage, namely vascular, traumatic and neoplastic are most frequently observed in cases of aphasia.

In order to determine the presence of significant differences between the two samples in the distribution of laterality, locus and type of brain damage, it was necessary to adopt an alternate strategy for analysis. Laterality, locus and type of brain damage were analyzed individually. In addition, each category, for example frontal, parietal, temporal, occipital, was examined separately by means of cumulative binomial distributions (Beyer, 1968). The results of these analyses are presented in Table IV. Inspection of Table IV reveals that no significant differences were observed at $\underline{p} < .05$.

Victoria Samples 1 and 2 - Aphasics

The means and standard deviations for age, education, positive indicators of cerebral pathology, and the time interval between onset of illness and the administration of the NCCEA, are presented for both samples in Table V.

Aphasics in Sample 1 tended to be somewhat younger, had completed more years of education on the average, and had a higher mean number of positive indicators of cerebral damage, than aphasics assigned to Sample 2. However, the time interval between onset of illness and administration of the NCCEA, was longer for the aphasics in Sample 1. As demonstrated in Table V, the differences between aphasics in Sample 1 and aphasics in Sample 2 were non-significant for the age, education, and time interval variables. The difference in mean number of positive

TABLE IV

Cumulative Binomial Tests for Differences Between Victoria Samples 1 and 2 on Laterality, Locus and Type of Brain Damage

	Sample 1 N	Sample 2 N	P
Laterality			
Right	5	1	.109
Left	28	28	.552
Bilateral	5	3	.363
Diffuse	1	2	.500
Subcortical	0	1	-
Undetermined	1	2	.500
No Information	0	3	.125
Locus			
Frontal	4	1	.188
Temporal	6	11	.166
Parietal	1	1	.750
Fronto-Temporal	8	7	.500
Fronto-Parietal	1	2	.500
Temporo-Parietal	6	2	.145
Diffuse	8	7	.500
Parieto-Occipital	3	0	.125
Undetermined	1	3	.313
No Information	2	6	.145
Type of Brain Damage			
Trauma	15	7	.067
Vascular	9	17	.085
Neoplasm	9	3	.073
Infection	1	2	.500
Degenerative	1	5	.109
Undetermined	4	0	.063
No Information	1	6	.063

TABLE V

t-tests for differences between Victoria Aphasics in Sample 1 and Victoria Aphasics in Sample 2 on Age, Education, Time Interval between the Onset of Illness and Administration of the NCCEA, and Positive Indicators of Brain Damage

GROUPS		AGE (n)	AGE (years)	EDUCATION (n)	EDUCATION (years)	TIME INTERVAL (n)	TIME INTERVAL (weeks)	POSITIVE INDICATORS (n)	POSITIVE INDICATORS
Sample 1	$\bar{X}$	(27)	48.96	(25)	11.08	(25)	32.72	(27)	3.63
Aphasics	S.D.		13.90		3.04		65.28		1.11
Sample 2	$\bar{X}$	(27)	53.74	(26)	9.80	(22)	29.90	(27)	2.93
Aphasics	S.D.		16.54		3.86		45.69		1.07
	t=		-1.15		1.31		0.17		-2.37
	p=		0.255		0.197		0.866		0.021

indicators of brain damage was significant; however, this difference did not warrant the reassignment of aphasics, since the type of positive indicator was not taken into consideration in these preliminary analyses.

Tables VI, VII and VIII present information concerning laterality, localization and type of brain damage, respectively. If diffuse damage is taken as an indication that there is some involvement of the left cerebral hemisphere, then it is evident from Table VI, that for those aphasics for whom information concerning laterality of lesion was available, one hundred percent of the aphasics in Samples 1 and 2 sustained lesions to the left cerebral hemisphere - the hemisphere that is classically associated with aphasia, not only for right handed subjects, but also for the majority of left handed subjects (Penfield and Roberts, 1959).

Damage to the frontal and temporal lobes of the dominant (usually left) hemisphere is classically associated with aphasic symptomatology. However, as demonstrated by Benson (1967) and Russel (1963), aphasic symptoms may result from damage to any one of the following loci: frontal, temporal, parietal, temporo-parietal and parieto-occipital. Although diffuse is a term which is most frequently reserved for degenerative disorders affecting most areas of the cortex, in the medical reports referred to for the purposes of the present investigation, the term diffuse was also used to refer to damage in more than two areas within either the left or both cerebral hemispheres. For this reason, it will be included as a category or "locus", damage to which may result in aphasic symptomatology. When these eight categories of locus of lesion are considered, one hundred percent of the aphasics in Samples 1 and 2, for whom information was available, sustained lesions in one of

TABLE VI

Cumulative Binomial Tests for differences between Victoria Sample 1 Aphasics and Victoria Sample 2 Aphasics on Lateralization of Brain Damage

LATERALITY	SAMPLE 1		SAMPLE 2		p
	N	%	N	%	
Left	23	85.19	20	74.07	.380
Bilateral	4	14.81	3	11.11	.500
Diffuse	0	0	1	3.70	-
Undetermined	0	0	1	3.70	-
No Information	0	0	2	7.41	.250

TABLE VII

Cumulative Binomial Tests for differences between Victoria Sample 1 Aphasics and Victoria Sample 2 Aphasics on Localization of Brain Damage

LOCUS	SAMPLE 1		SAMPLE 2		p
	N	%	N	%	
Frontal	3	11.11	1	3.7	.313
Temporal	3	11.11	7	25.93	.172
Parietal	0		1	3.70	-
Fronto-temporal	7	25.93	7	25.93	.605
Fronto-parietal	1	3.70	2	7.41	.500
Temporo-parietal	4	14.81	2	7.41	.344
Parieto-occipital	2	7.41	0		.250
Diffuse	6	22.22	2	7.41	.145
Undetermined	0		1	3.70	-
No information	1	3.70	4	14.81	.188

TABLE VIII

Cumulative Binomial Tests for differences between Victoria Sample 1 Aphasics and Victoria Sample 2 Aphasics on Type of Brain Damage

TYPE	SAMPLE 1		SAMPLE 2		p
	N	%	N	%	
Trauma	8	29.63	6	22.22	.395
Vascular	9	33.33	13	48.15	.262
Neoplasm	8	29.63	2	7.41	.055
Infection	1	3.70	1	3.70	.750
Degenerative	0		4	14.81	.063
Undetermined	1	3.70	0		-
No information	0		1	3.70	-

these regions.

An examination of the percentage of anterior versus posterior lesions, could only be conducted for those aphasics in Samples 1 and 2 for whom laterality of lesion was left or bilateral. Frontal, fronto-temporal and fronto-parietal loci were considered to be anterior regions, while parietal, temporo-parietal and parieto-occipital were considered to be posterior regions. 64.71% of Sample 1, and 76.92% of Sample 2 suffered anterior lesions. When temporal locus was added to the posterior region category, 55% of Sample 1, and 50% of Sample 2 aphasics suffered anterior lesions.

Reference to Table VIII reveals that the majority (92.6%) of Sample 1 and 77.8% of Sample 2 aphasics suffered traumatic, vascular or neoplastic lesions.

<u>Victoria Samples 1 and 2 - Non-Aphasics</u>

There were eight male and five female non-aphasic subjects in each of Samples 1 and 2. All thirteen non-aphasics in Sample 1 were manifest right handers; twelve of the non-aphasic subjects in Sample 2 were manifest right handers, while one was a manifest left-hander. It is interesting to note that this subject suffered damage to the temporal lobe of the left hemisphere - an area which is frequently associated with Wernicke's or fluent (Benson, 1967) aphasia. The means and standard deviations for age, education, positive indicators of brain damage and the time interval between the onset of illness and the administration of the NCCEA are presented in Table IX.

The non-aphasics in Sample 1 were on the average approximately ten years younger than those in Sample 2, they had a lower mean number of years of education, the mean number of positive indicators of brain damage was slightly higher, and the time interval between onset of illness and administration of the NCCEA was shorter on the average in Sample 1. It is evident from Table IX that none of these differences were significant at $p < .05$.

Tables X, XI and XII present information concerning laterality, locus and etiology of lesion for non-aphasics in Samples 1 and 2.

Table X demonstrates that all non-aphasics, with the exception of one, who suffered lesions restricted to the right hemisphere, were randomly assigned to Sample 1. Cumulative binomial distributions (Beyer, 1968) were used to test the significance of differences in the distribution of non-aphasics for laterality, locus and type of brain damage. The inequality in the distribution of right hemisphere lesions proved to be non-significant at $p < .05$. None of the other testable differences between the samples, with respect to laterality of lesion proved to be significant.

Similarly, as demonstrated by Table XI, differences between non-aphasics in Samples 1 and 2, in terms of locus of lesion, all proved to be non-significant at $p < .05$. However, as indicated in Table XII, a significant difference was observed for type of brain damage. There were significantly ($p = .025$) more traumatic lesions in Sample 1 than in Sample 2. Since severity of lesion could not be accounted for in any of the cases, it was felt that the reassignment of non-aphasic subjects because of one significant difference, was unwarranted.

New York Sample (Sample 3)

The New York sample consisted of twenty males and eighteen females, ranging in age from twenty-two to seventy-seven years ($\overline{X} = 58.64$ years; $SD = 14.73$ years). The mean number of years of education completed,

TABLE IX

t-tests for differences between Victoria Non-Aphasics in Sample 1 and Victoria Non-Aphasics in Sample 2 on Age, Education, Time Interval between the Onset of Illness and Administration of the NCCEA, and Positive Indicators of Brain Damage

GROUPS		AGE (n)	AGE (years)	EDUCATION (n)	EDUCATION (years)	TIME INTERVAL (n)	TIME INTERVAL (weeks)	POSITIVE INDICATORS (n)	POSITIVE INDICATORS
Sample 1	$\bar{X}$	(13)	41.46	(13)	9.61	(11)	29.00	(13)	2.77
Non-Aphasics	S.D.		17.66		3.52		37.95		1.48
Sample 2	$\bar{X}$	(13)	51.15	(13)	10.69	(8)	42.00	(13)	2.62
Non-Aphasics	S.D.		17.19		4.73		51.02		1.33
	t=		-1.42		-0.66		-0.64		0.28
	p=		0.169		0.516		0.531		0.782

TABLE X

Cumulative Binomial Tests for differences between Victoria Sample 1 Non-Aphasics and Victoria Sample 2 Non-Aphasics on Lateralization of Brain Damage

LATERALITY	SAMPLE 1		SAMPLE 2		p
	N	%	N	%	
Right	5	38.46	1	7.69	.109
Left	5	38.46	8	61.54	.291
Bilateral	1	7.69	0		-
Diffuse	1	7.69	1	7.69	.750
Subcortical	0		1	7.69	-
Undetermined	1	7.69	1	7.69	.750
No Information	0		1	7.69	-

TABLE XI

Cumulative Binomial Tests for differences between Victoria Sample 1 Non-Aphasics and Victoria Sample 2 Non-Aphasics on Localization of Brain Damage

LOCUS	SAMPLE 1		SAMPLE 2		p
	N	%	N	%	
Frontal	1	7.69	0		-
Temporal	3	23.10	4	30.77	.500
Parietal	1	7.69	0		-
Fronto-temporal	1	7.69	0		-
Temporo-parietal	2	15.38	0		.250
Parieto-occipital	1	7.69	0		-
Diffuse	2	15.38	5	38.46	.227
Undetermined	1	7.69	2	15.38	.500
No information	1	7.69	2	15.38	.500

TABLE XII

Cumulative Binomial Tests for differences between Victoria Sample 1 Non-Aphasics and Victoria Sample 2 Non-Aphasics on Type of Brain Damage

TYPE	SAMPLE 1		SAMPLE 2		p
	N	%	N	%	
Trauma	7	53.85	1	7.69	.035
Vascular	0		4	30.77	.063
Neoplasm	1	7.69	1	7.69	.750
Infection	0		1	7.69	-
Degenerative	1	7.69	1	7.69	.750
Undetermined	3	23.07	0		.125
No Information	1	7.69	5	38.46	.109

was 13.23 years with a standard deviation of 3.06 years (range = 8 - 21 years). Thirty-five of the subjects were manifest right handers, one was a manifest left hander, and for the remaining two subjects information concerning handedness was not available. With respect to the time interval between onset of illness and administration of the NCCEA, the range was one to two hundred weeks ($\overline{X}$ = 30.54 weeks; SD = 52.50 weeks). A summary of the medical information available for the New York sample is presented in Table XIII. It should be noted that for most cases, laterality of lesion had to be deduced from information concerning symptomatology, more specifically subjects with right hemiplegia were judged to have sustained damage to the left cerebral hemisphere.

Thirty-six of the thirty-eight subjects constituting the New York sample were judged to be aphasic according to their performance on the FCP. There were nineteen male and seventeen female New York aphasics, ranging in age from twenty-two to seventy-seven years ($\overline{X}$ = 58.08 years; SD = 14.91 years). In terms of the number of years of education completed, the mean was 13.19 years, with a standard deviation of 3.11 years (range = 8 - 21 years). Information concerning the time interval between onset of illness and administration of the NCCEA, was available for thirty-five of the thirty-six subjects diagnosed as aphasic. The time interval ranged from one to two hundred weeks, with a mean of 31.91 weeks, and a standard deviation of 53.68 weeks. Thirty-three of the aphasic subjects were manifest right handers, one was a manifest left hander, and information concerning handedness was not available for the remaining two subjects. A summary of the medical data available for the New York aphasics, is presented in Table XIV.

TABLE XIII

Summary of Medical Data for the New York Sample

	LATERALITY OF LESION		
	Left	Bilateral	Unknown
N	35	1	2
%	92.11	2.63	5.26

	LOCALIZATION OF LESION	
	Temporal	No Information
N	2	36
%	5.26	94.74

	TYPE OF BRAIN DAMAGE		
	Vascular	Trauma	Neoplasm
N	29	3	2
%	76.32	7.89	5.26

	TYPE OF BRAIN DAMAGE (cont'd)		
	Infection	Undetermined	No Information
N	1	1	2
%	2.63	2.63	5.26

TABLE XIV

Summary of Medical Data for New York Aphasics

	LATERALITY OF LESION		
	Left	Bilateral	No Information
N	33	1	2
%	91.66	2.78	5.56

	LOCALIZATION OF LESION	
	Temporal	No Information
N	2	34
%	5.56	94.44

	TYPE OF BRAIN DAMAGE		
	Vascular	Trauma	Neoplasm
N	27	3	2
%	75	8.33	5.55

	TYPE OF BRAIN DAMAGE (cont'd)		
	Infection	Undetermined	No Information
N	1	1	2
%	2.77	2.77	5.55

Iowa Subjects

The Iowa group of subjects consisted of forty-four males, twenty-three females and twenty-one subjects for whom information concerning sex, was not available. The eighty-eight subjects ranged in age from sixteen to ninety-two years, with a mean of 54.9 years and a standard deviation of 16.58 years. With respect to the number of years of education completed, the range was from three to eighteen years ($\bar{X}$ = 10.64 years; SD = 3.16 years). It should be noted that the amount of personal and medical data available for the Iowa group of subjects, was limited; for instance no information concerning handedness or the time interval between onset of illness and the administration of the NCCEA was available for any of the subjects. Information concerning laterality, locus and type of brain damage was not available for the fifty subjects diagnosed as aphasic. The only medical information available for these fifty subjects was the diagnosis of aphasia based on hospital medical records (Spreen, 1976). For the thirty-eight subjects diagnosed as non-aphasic, information concerning laterality of lesion was available.

Iowa Aphasics

The group of Iowa subjects with a medical diagnosis of aphasia, consisted of twenty-eight males, sixteen females, and six subjects for whom information concerning sex was not available. They ranged in age from sixteen to eighty-seven years ($\bar{X}$ = 53.18 years; SD = 13.9 years), and in education from three to sixteen years ($\bar{X}$ = 10.4 years; SD = 3.01 years).

Iowa Non-aphasics

The Iowa group diagnosed as non-aphasic, consisted of sixteen males, seven females and fifteen subjects for whom information concerning sex was not available. They ranged in age from sixteen to ninety-two years ($\overline{X}$ = 57.15 years; SD = 19.52 years), and in the number of years of education completed, from four to eighteen years ($\overline{X}$ = 10.95 years; SD = 3.36 years). Of the thirty-eight subjects diagnosed as non-aphasic, 26.32% sustained left hemisphere lesions, 15.97% right hemisphere lesions, 26.32% bilateral or diffuse lesions, and for the remaining 31.58% of the non-aphasics, information concerning laterality of lesion, was not available.

Iowa Samples 5 and 6

The procedures employed in the assignment of Iowa subjects to Samples 5 and 6, were identical to those described for the assignment of Victoria subjects to Samples 1 and 2. Reference to Tables XV and XVI, will indicate that no significant differences for age and education were observed between aphasics assigned to Sample 5 and Sample 6, and non-aphasics assigned to Sample 5 and Sample 6, respectively.

As demonstrated by Table XVII, in the random assignment of subjects to either Sample 5 or Sample 6, within the group of non-aphasics, no significant differences with respect to laterality of lesion were observed between the two samples.

Tables XVIII, XIX, XX, XXI and XXII, present the significance of differences on age, education, and the time interval between onset of illness and administration of the NCCEA where such information was available, between the Victoria and Iowa group, the Victoria and New York group, the Iowa and New York group, Victoria aphasics and New York aphasics, and Iowa aphasics and New York aphasics, respectively. Several significant differences on age and education variables between

TABLE XV

t-tests for differences between the
Iowa Aphasics in Sample 5 and the Iowa Aphasics in Sample 6
on Age and Education

GROUPS		AGE		EDUCATION	
		(n)	(years)	(n)	(years)
Sample 5	$\bar{X}$	(25)	51.20	(25)	10.48
(Aphasics)	S.D.		15.28		2.93
Sample 6	$\bar{X}$	(25)	55.16	(25)	10.32
(Aphasics)	S.D.		12.37		3.15
	t=		-1.01		0.186
	p=		0.319		0.853

TABLE XVI

t-tests for differences between
Iowa Non-Aphasics in Sample 5 and Iowa Non-Aphasics in Sample 6
on Age and Education

GROUPS		AGE		EDUCATION	
		(n)	(years)	(n)	(years)
Sample 5	$\bar{X}$	(19)	53.37	(19)	11.16
Non-Aphasics	S.D.		17.20		3.15
Sample 6	$\bar{X}$	(19)	60.95	(19)	10.74
Non-Aphasics	S.D.		21.39		3.63
	t=		-1.20		0.38
	p=		0.247		0.710

TABLE XVII

Cumulative Binomial tests for differences between Iowa Sample 5 Non-Aphasics and Iowa Sample 6 Non-Aphasics on Laterality of Brain Damage

LATERALITY OF LESION	SAMPLE 5	SAMPLE 6	p
Left Hemisphere	6	4	.377
Right Hemisphere	2	4	.344
Bilateral-Diffuse	7	3	.172
No Information	4	8	.194

TABLE XVIII

t-tests for differences between Victoria Aphasics and Non-Aphasics and Iowa Aphasics and Non-Aphasics on Age and Education

GROUPS		AGE		EDUCATION	
		(n)	(years)	(n)	(years)
Victoria	$\bar{X}$	(80)	49.71	(77)	10.34
(Aphasics and Non-Aphasics)	S.D.		16.23		3.70
Iowa	$\bar{X}$	(88)	54.90	(88)	10.64
(Aphasics and Non-Aphasics)	S.D.		16.58		3.16
	t=		-2.05		-0.560
	p=		0.042		0.576

TABLE XIX

t-tests for differences between Victoria Aphasics and Non-Aphasics
and New York Aphasics and Non-Aphasics
on Age, Education, and Time Interval
between the Onset of Illness and Administration of the NCCEA

GROUPS		(n)	AGE (years)	(n)	EDUCATION (years)	(n)	TIME INTERVAL (weeks)
Victoria Group	$\bar{X}$	(80)	49.71	(77)	10.34	(66)	32.29
(Aphasics and Non-Aphasics)	S.D.		16.23		3.70		52.59
New York Group	$\bar{X}$	(38)	58.68	(38)	13.23	(37)	30.54
(Aphasics and Non-Aphasics)	S.D.		14.73		3.06		52.50
	t=		-2.89		-4.17		0.16
	p=		0.004		0.000		0.871

TABLE XX

t-tests for differences between
Iowa Aphasics and Non-Aphasics
and New York Aphasics and Non-Aphasics
on Age and Education

GROUPS		AGE		EDUCATION	
		(n)	(years)	(n)	(years)
Iowa	$\bar{X}$	(88)	54.90	(88)	10.64
(Aphasics and Non-Aphasics)	S.D.		16.58		3.16
New York	$\bar{X}$	(38)	58.68	(38)	13.23
(Aphasics and Non-Aphasics)	S.D.		14.73		3.06
	t=		-1.22		-4.27
	p=		0.227		0.000

TABLE XXI

t-tests for differences between
Victoria Aphasics and New York Aphasics
on Age, Education, and Time Interval
between the Onset of Illness and Administration of the NCCEA

GROUPS		(n)	AGE (years)	(n)	EDUCATION (years)	(n)	TIME INTERVAL (weeks)
Victoria Aphasics	$\bar{X}$	(54)	51.35	(51)	10.43	(47)	31.40
	S.D.		15.33		3.50		56.38
New York Aphasics	$\bar{X}$	(36)	58.08	(36)	13.19	(35)	31.91
	S.D.		14.91		3.11		53.68
	t=		-2.06		-3.79		-0.04
	p=		0.042		0.000		0.967

TABLE XXII

t-tests for differences between
Iowa and New York Aphasics
on Age and Education

GROUPS		AGE		EDUCATION	
		(n)	(years)	(n)	(years)
Iowa Aphasics	$\bar{X}$	(50)	53.18	(50)	10.40
	S.D.		13.90		3.01
New York Aphasics	$\bar{X}$	(36)	58.08	(36)	13.19
	S.D.		14.91		3.11
	t=		-1.57		-4.19
	p=		0.121		0.000

groups will be noted. However, both age and education factors are corrected for in the scoring of the NCCEA.

Procedure

A one-way multivariate analysis of variance (MANOVA) (Clyde, 1969) with two criterion groups was performed in order to obtain the multivariate test of the significance of the difference between the mean level of the performance of aphasic and non-aphasic brain damaged patients on the NCCEA. This was followed by univariate analyses of the differences between aphasic and non-aphasic brain damaged patients on the separate subtests of the NCCEA. A stepwise discriminate analysis programme from the Statistical Package for the Social Sciences (SPSS) (Nie, Hull, Jenkins, Steinbrenner and Bent, 1975) was also employed in order to assess the ability of the NCCEA to discriminate between aphasic and brain damaged non-aphasic patients on the basis of their performance on this battery of tests. The SPSS programme provided the following information: percentage of total cases correctly calssified, percentage of variance accounted for by the successive inclusion of discriminating variables in predictive equations, classification of ungrouped cases on the basis of a selected predictive equation, and standardized discriminant function coefficients.

Discriminant Analysis

The mathematical objective of discriminant analysis is the construction of a linear combination of the discriminating variables so that maximum differentiation between groups will be obtained (Klecka, 1975; Tatsuoka, 1970). Groups may be maximally separated by several methods. At the present time, there exists some controversy as to which method is the most powerful in differentiating between groups (Morrison, 1967). Since the MANOVA programme employs Wilks lambda, this method was also chosen for the SPSS programme in order to maintain consistency.

Discriminant analysis achieves maximum differentiation between groups by weighting each discriminating variable according to a pre-established criterion (in the present study - Wilks lambda). The linear combination of discriminating variables takes the form of:

$$Y = x_1 Z_1 + x_2 Z_2 + \ldots + x_p Z_p$$

where Y = the score on the discriminant function

x = the standardized discriminant weighting coefficient

Z = the standardized value on the particular discriminating variable

Standardized discriminant function coefficients, unlike unstandardized coefficients, report the relative importance of a particular discriminating variable. The absolute value of a standardized weighting coefficient represents the relative contribution of a particular discriminating variable to differentiation between groups (Klecka, 1975; Tatsuoka, 1970).

The percentage of correct classification of known cases serves as an indicator of the adequacy of the single discriminant function which is derived in the two group case. This may be viewed as analagous to testing the predictive validity of a battery of tests - in the present study, the NCCEA.

The Stepwise Procedure

The stepwise procedure was selected for discriminant analysis in order to determine the number and the variables necessary for successful discrimination between groups. In the present analyses, the stepwise procedure began by selecting the single best discriminating variable, in other words the variable which correlated most highly with the criterion. The second variable selected was the variable which provided the greatest improvement in the discrimination between groups, in combination with the first variable. Subsequent variables were selected in a similar fashion.

Deletion of Variables

In order to minimize the number of missing observations present in the Victoria, New York, and Iowa groups, the variables which contained the most missing observations were deleted from the analyses. Each group was considered separately, since for the New York subjects three subtests namely Tactlie Naming Right Hand (TNR), Tactile Naming Left Hand (TNL), and Articulation (ART), were not routinely administered. Similarly, the Articulation subtest was most commonly not administered to Iowa subjects.

For the Victoria group of subjects, the subtests of the NCCEA which contained the most missing observations were Tactile Naming Right Hand (TNR), Writing from Copy (WC), and Articulation (ART). Two other subtests were eliminated on the basis of lack of variability in the performance of aphasics and non-aphasics. These subtests were Identification by Name (IN) and Reading Names for Meaning (Pointing) (RNP).

The subtests eliminated prior to analyses for the New York group, were TNR, TNL, IN, RNP, and ART.

For the Iowa group of subjects, the subtests eliminated were TNR, TNL, IN, Identification by Sentence (IS), RNP, Writing Names (WN), and ART.

It is evident that in the cross-validation procedures from one group to another, only the subtests common to both groups could be employed in the analyses. For example, the cross-validation of Victoria samples on the New York sample employed fourteen variables, since TNL was eliminated in the New York sample. Similarly, in the cross-validation of Victoria samples on Iowa samples, only twelve subtests were common to both groups. These were: VN, DU, DRF, DRR, WF, SC, RNO, RSO, VGN, SRP, RSP, and WD.

Substitution of Means

Since the deletion of variables for the different samples of subjects did not eliminate the problem of missing observations entirely, some means were substituted for each sample. The percentage of missing observations requiring mean substitution was .833% in Victoria Sample 1, .833% in Victoria Sample 2, 4.66% in New York Sample 3, 1.22% in Iowa Sample 5, and 1.57% in Iowa Sample 6.

RESULTS

Hypothesis I

Hypothesis I was concerned with differences between aphasic and brain damaged non-aphasic subjects in their performance on tests of language functioning. It was predicted that patients with a medical diagnosis of aphasia would receive significantly lower mean scores on each of the subtests of the NCCEA, than non-aphasic brain damaged patients. The means and standard deviations for aphasic and non-aphasic subjects in the Victoria group, are presented in Table XXIII. Table XXIV summarizes the results of both the multivariate and univariate tests for the significance of differences in performance on fifteen of the subtests of the NCCEA, for the Victoria group. The multivariate test for the differences between the mean level of performance for aphasic and non-aphasic subjects was significant (F = 4.16, df = 15/64, $p < .001$), as were each of the univariate tests. These results indicate that aphasic subjects in the Victoria group, received significantly lower mean scores than non-aphasic subjects on each of the subtests included in the analyses.

Similar analyses were performed for the two samples drawn from the Victoria group. Table XXV presents the means and standard deviations for aphasic and non-aphasic subjects assigned to Sample 1. Table XXVI reveals that the difference between the mean level of performance of aphasic and non-aphasic subjects in Sample 1, was significant (F = 2.26, df = 15/24, $p = < .036$). This result supports Hypothesis I. In addition, all univariate tests, with the exception of Oral Reading (Names), Oral Reading (Sentences), Reading Names for Meaning (Pointing),

TABLE XXIII

Means and Standard Deviations for the
Total Victoria Groups of Subjects, on 15 Variables

VARIABLES		APHASICS (n=54)	NON-APHASICS (n=26)
Visual Naming	$\bar{X}$	9.72	15.58
	S.D.	5.87	1.10
Description of Use	$\bar{X}$	9.24	15.50
	S.D.	5.68	1.18
Tactile Naming, Left Hand	$\bar{X}$	10.28	15.54
	S.D.	5.91	1.36
Sentence Repetition	$\bar{X}$	11.30	17.00
	S.D.	4.97	2.87
Repetition of Digits	$\bar{X}$	5.00	8.69
	S.D.	3.10	1.52
Reversal of Digits	$\bar{X}$	4.19	6.89
	S.D.	2.69	1.90
Word Fluency	$\bar{X}$	15.02	31.27
	S.D.	10.20	12.00
Sentence Construction	$\bar{X}$	11.83	22.73
	S.D.	9.58	3.56
Identification by Sentence	$\bar{X}$	119.82	157.23
	S.D.	40.41	7.26
Oral Reading (Names)	$\bar{X}$	16.24	19.85
	S.D.	6.32	0.78
Oral Reading (Sentences)	$\bar{X}$	12.48	15.54
	S.D.	5.79	1.58
Readings Sentences for Meaning	$\bar{X}$	14.06	16.65
(Point)	S.D.	5.14	0.69
Visual-Graphic Naming	$\bar{X}$	5.02	7.77
	S.D.	3.24	0.99
Writing Names	$\bar{X}$	15.07	22.73
	S.D.	8.98	3.95
Writing to Dictation	$\bar{X}$	83.24	121.12
	S.D.	47.15	27.93

TABLE XXIV

Results of the Multivariate and Univariate Tests of the Significance of the differences between Aphasics and Non-Aphasics in the Total Victoria Group of Subjects, on 15 Variables

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN
1	4.16	15.00	64.00	0.001

UNIVARIATE F TESTS

VARIABLE	F(1, 78)	MEAN SQ	P LESS THAN
Visual Naming	25.27	601.57	.001
Description of Use	30.78	687.58	.001
Tactile Naming, Left Hand	19.95	485.69	.001
Sentence Repetition	29.35	570.94	.001
Repetition of Digits	33.00	239.26	.001
Reversal of Digits	21.10	127.89	.001
Word Fluency	39.68	4634.67	.001
Sentence Construction	31.38	2084.12	.001
Identification by Sentence	21.82	24569.03	.001
Oral Reading (Names)	8.36	228.13	.005
Oral Reading (Sentences)	6.96	164.01	.010
Reading Sentences for Meaning	6.55	118.48	.012
Visual-Graphic Naming	17.81	132.79	.001
Writing Names	17.22	1028.86	.001
Writing to Dictation	14.30	25174.98	.001

TABLE XXV

Means and Standard Deviations for Aphasics and Non-Aphasics in Victoria Sample 1, on 15 Variables

VARIABLES		APHASICS (n=27)	NON-APHASICS (n=13)
Visual Naming	$\bar{X}$	10.07	15.54
	S.D.	5.82	1.39
Description of Use	$\bar{X}$	9.59	15.15
	S.D.	5.31	1.57
Tactile Naming, Left Hand	$\bar{X}$	10.19	15.08
	S.D.	6.03	1.85
Sentence Repetition	$\bar{X}$	11.30	16.92
	S.D.	5.39	2.18
Repetition of Digits	$\bar{X}$	4.44	8.00
	S.D.	3.03	1.35
Reversal of Digits	$\bar{X}$	4.04	6.39
	S.D.	2.16	1.98
Word Fluency	$\bar{X}$	14.67	27.85
	S.D.	11.15	13.33
Sentence Construction	$\bar{X}$	12.59	22.62
	S.D.	9.32	3.93
Identification by Sentence	$\bar{X}$	123.59	155.54
	S.D.	32.26	9.53
Oral Reading (Names)	$\bar{X}$	16.59	19.69
	S.D.	6.29	1.11
Oral Reading (Sentences)	$\bar{X}$	12.74	15.31
	S.D.	5.65	2.21
Reading Sentences for Meaning (Point)	$\bar{X}$	14.22	16.62
	S.D.	5.58	0.87
Visual Graphic Naming	$\bar{X}$	4.82	7.54
	S.D.	3.45	1.39
Writing Names	$\bar{X}$	15.04	21.39
	S.D.	9.47	5.25
Writing to Dictation	$\bar{X}$	83.33	113.46
	S.D.	48.44	37.05

TABLE XXVI

Results of the Multivariate and Univariate Tests of the Significance of the difference between Aphasics and Non-Aphasics in Victoria Sample 1, on 15 Variables

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN
1	2.26	15.00	24.00	0.036

UNIVARIATE F TESTS

VARIABLE	F(1, 38)	MEAN SQ	P LESS THAN
Visual Naming	11.00	262.02	.002
Description of Use	13.53	271.39	.001
Tactile Naming, Left Hand	8.10	209.98	.007
Sentence Repetition	12.99	277.82	.001
Repetition of Digits	16.17	110.93	.001
Reversal of Digits	10.94	48.36	.002
Word Fluency	10.80	1524.21	.002
Sentence Construction	13.71	881.51	.001
Identification by Sentence	12.09	8955.27	.001
Oral Reading (Names)	3.07	84.31	.088
Oral Reading (Sentences)	2.47	57.82	.124
Reading Sentences for Meaning	2.34	50.26	.135
Visual-Graphic Naming	7.42	65.10	.010
Writing Names	5.05	353.56	.031
Writing to Dictation	3.91	7965.21	.055

and Writing to Dictation, support the predictions made in Hypothesis I.

The means and standard deviations for Victoria Sample 2, are presented in Table XXVII. This is followed by a summary of the results of both the multivariate and univariate tests for the significance of differences in performance between aphasic and non-aphasic subjects assigned to Sample 2. As demonstrated in Table XXVIII, both the multivariate test (F = 2.26, df = 15/24, $p < .036$) and all univariate tests were significant at $p < .05$. These results support the prediction made in Hypothesis I.

The performance of the Iowa group and the two Iowa samples, on the NCCEA, was tested in a similar fashion. Table XXIX is a presentation of the means and standard deviations for the Iowa group, on thirteen variables. As indicated in Table XXX, both the multivariate test (F = 4.49, df = 13/74, $p < .001$), and all the univariate tests for the significance of the difference in performance between Iowa aphasics and non-aphasics were significant at $p < .005$. These results are consistent with the prediction made in Hypothesis I.

The means and standard deviations for subjects assigned to Iowa Sample 5, are presented in Table XXXI. Table XXXII presents the results of the multivariate and univariate tests of the significance of the differences between Sample 5 aphasics and non-aphasics in their performance on thirteen subtests of the NCCEA. The multivariate test was non-significant (F = 1.94, df = 13/30, $p < .066$). This result does not support Hypothesis I. Since the multivariate test was non-significant, caution is indicated in the interpretation of the univariate F tests, because of the possibility of making a Type I error (Hummel and Sligo,

TABLE XXVII

Means and Standard Deviations for
Aphasics and Non-Aphasics
Victoria Sample 2, on 15 Variables

VARIABLES		APHASICS (n=27)	NON-APHASICS (n=13)
Visual Naming	$\bar{X}$	9.37	15.62
	S.D.	6.01	0.77
Description of Use	$\bar{X}$	8.89	15.85
	S.D.	6.10	0.38
Tactile Naming, Left Hand	$\bar{X}$	10.37	16.00
	S.D.	5.91	0.00
Sentence Repetition	$\bar{X}$	11.30	17.08
	S.D.	4.62	3.52
Repetition of Digits	$\bar{X}$	5.56	9.39
	S.D.	3.12	1.39
Reversal of Digits	$\bar{X}$	4.33	7.39
	S.D.	3.16	1.76
Word Fluency	$\bar{X}$	15.37	34.69
	S.D.	9.34	9.85
Sentence Construction	$\bar{X}$	11.07	22.85
	S.D.	9.95	3.31
Identification by Sentence	$\bar{X}$	116.04	158.92
	S.D.	47.52	3.59
Oral Reading (Names)	$\bar{X}$	15.89	20.00
	S.D.	6.44	0.00
Oral Reading (Sentences)	$\bar{X}$	12.22	15.77
	S.D.	6.02	0.44
Reading Sentences for Meaning (Point)	$\bar{X}$	13.89	16.69
	S.D.	4.76	0.48
Visual-Graphic Naming	$\bar{X}$	5.22	8.00
	S.D.	3.07	0.00
Writing Names	$\bar{X}$	15.11	24.08
	S.D.	8.64	0.95
Writing to Dictation	$\bar{X}$	83.15	128.77
	S.D.	46.74	11.20

TABLE XXVIII

Results of the Multivariate and Univariate Tests of the Significance of the differences between Aphasics and Non-Aphasics in Victoria Sample 2, on 15 Variables

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN
1	2.26	15.00	24.00	0.036

UNIVARIATE F TESTS

VARIABLE	F(1, 38)	MEAN SQ	P LESS THAN
Visual Naming	13.76	342.23	.001
Description of Use	16.63	424.74	.001
Tactile Naming, Left Hand	11.64	278.10	.002
Sentence Repetition	15.82	293.22	.001
Repetition of Digits	17.73	128.66	.001
Reversal of Digits	10.45	81.70	.003
Word Fluency	36.24	3276.03	.001
Sentence Construction	17.08	1216.06	.001
Identification by Sentence	10.42	16139.15	.003
Oral Reading (Names)	5.23	148.31	.028
Oral Reading (Sentences)	4.45	110.40	.042
Reading Sentences for Meaning	4.43	68.96	.042
Visual-Graphic Naming	10.52	67.71	.002
Writing Names	13.74	705.39	.001
Writing to Dictation	11.90	18263.25	.001

TABLE XXIX

Means and Standard Deviations for the Total Iowa Groups of Subjects, on 13 Variables

VARIABLES		APHASICS (n=50)	NON-APHASICS (n=38)
Visual Naming	$\bar{X}$	10.60	14.40
	S.D.	5.36	2.96
Description of Use	$\bar{X}$	11.58	15.11
	S.D.	5.78	2.82
Sentence Repetition	$\bar{X}$	12.34	15.58
	S.D.	4.86	2.31
Repetition of Digits	$\bar{X}$	4.86	6.71
	S.D.	2.96	2.04
Reversal of Digits	$\bar{X}$	4.44	5.97
	S.D.	2.38	1.92
Word Fluency	$\bar{X}$	14.02	27.24
	S.D.	8.88	10.56
Sentence Construction	$\bar{X}$	11.48	20.29
	S.D.	9.65	5.67
Oral Reading (Names)	$\bar{X}$	16.12	19.61
	S.D.	6.45	1.46
Oral Reading (Sentences)	$\bar{X}$	12.12	15.45
	S.D.	5.27	1.22
Reading Sentences for Meaning	$\bar{X}$	14.50	16.53
(Point)	S.D.	4.22	1.01
Visual-Graphic Naming	$\bar{X}$	3.96	7.29
	S.D.	3.16	1.14
Writing to Dictation	$\bar{X}$	79.18	116.58
	S.D.	48.28	28.74
Writing from Copy	$\bar{X}$	87.12	107.58
	S.D.	33.43	14.17

TABLE XXX

Results of the Multivariate and Univariate Tests of the Significance of the differences between Aphasics and Non-Aphasics in the Iowa Group, on 13 Variables

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN
1	4.49	13.00	74.00	.001

UNIVARIATE F TESTS

VARIABLE	F(1, 86)	MEAN SQ	P LESS THAN
Visual Naming	15.45	310.91	.001
Description of Use	11.97	268.32	.001
Sentence Repetition	14.38	226.51	.001
Repetition of Digits	10.93	73.94	.001
Reversal of Digits	10.57	50.79	.002
Word Fluency	40.61	3771.60	.001
Sentence Construction	25.07	1675.60	.001
Oral Reading (Names)	10.64	262.27	.002
Oral Reading (Sentences)	14.53	239.04	.001
Reading Sentences for Meaning	8.38	88.65	.005
Visual-Graphic Naming	38.28	239.34	.001
Writing to Dictation	17.94	30199.07	.001
Writing from Copy	12.50	9037.27	.001

TABLE XXXI

Means and Standard Deviations for Iowa Sample 5, on 13 Variables

VARIABLES		APHASICS (n=25)	NON-APHASICS (n=19)
Visual Naming	$\bar{X}$	11.28	14.11
	S.D.	5.09	3.73
Description of Use	$\bar{X}$	11.72	15.05
	S.D.	5.84	3.66
Sentence Repetition	$\bar{X}$	12.80	16.05
	S.D.	4.74	2.20
Repetition of Digits	$\bar{X}$	5.44	7.00
	S.D.	3.20	2.21
Reversal of Digits	$\bar{X}$	4.56	6.11
	S.D.	2.24	2.03
Word Fluency	$\bar{X}$	14.40	26.11
	S.D.	9.08	9.09
Sentence Construction	$\bar{X}$	13.84	21.21
	S.D.	9.67	5.14
Oral Reading (Names)	$\bar{X}$	15.44	20.00
	S.D.	7.12	0.00
Oral Reading (Sentences)	$\bar{X}$	12.08	15.37
	S.D.	5.18	1.38
Reading Sentences for Meaning	$\bar{X}$	14.40	16.68
(Point)	S.D.	4.73	1.16
Visual-Graphic Naming	$\bar{X}$	3.88	7.68
	S.D.	3.35	0.82
Writing to Dictation	$\bar{X}$	78.96	117.90
	S.D.	45.78	24.11
Writing from Copy	$\bar{X}$	85.64	106.84
	S.D.	33.52	12.83

TABLE XXXII

Results of the Multivariate and Univariate Tests of the Significance of the differences between Aphasics and Non-Aphasics in Iowa Sample 5, on 13 Variables

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN
1	1.94	13.00	30.00	.066

UNIVARIATE F TESTS

VARIABLES	F(1, 42)	MEAN SQ	P LESS THAN
Visual Naming	4.16	86.17	.048
Description of Use	4.75	119.90	.035
Sentence Repetition	7.65	114.21	.008
Repetition of Digits	3.30	26.27	.076
Reversal of Digits	5.58	25.78	.023
Word Fluency	17.91	1479.12	.001
Sentence Construction	9.06	586.46	.004
Oral Reading (Names)	7.74	224.48	.008
Oral Reading (Sentences)	7.23	116.74	.010
Reading Sentences for Meaning	4.22	56.33	.046
Visual-Graphic Naming	23.37	156.23	.001
Writing to Dictation	11.31	16365.11	.002
Writing from Copy	6.81	4852.91	.013

1971). However, all of the univariate tests, with the exception of Repetition of Digits, were significant at $p < .05$. This would support the hypothesis, if it were not for the non-significant multivariate F test.

Tables XXXIII and XXXIV present the means and standard deviations, and the results of the multivariate and univariate tests respectively, for the significance of the differences in performance between aphasic and non-aphasic subjects assigned to Sample 6. The multivariate test for the differences between the mean level of performance of aphasics and non-aphasics in Sample 6, was significant ($F = 2.45$, $df = 13/30$, $p < .021$). Twelve of the thirteen subtests were significant at $p < .05$; Oral Reading (Names) was non-significant. These results support Hypothesis I, and would be consistent with the predictions made in this hypothesis if it were not for the one non-significant univariate test.

<u>Hypothesis II</u>

In Hypothesis II, it was hypothesized that the predictive equation derived from a particular sample of subjects, would yield a small percentage of misclassifications. Furthermore, it was predicted that the majority of misclassifications would be subjects with a medical diagnosis of minimal impairment in language functioning. The percentages of correct classifications for the Victoria and Iowa samples are presented in Table XXXV. It is evident that the percentage of total cases correctly classified for all Victoria samples, was higher than that for the Iowa samples. Nevertheless, the results presented in Table XXXV support the hypothesis that a small* percentage of misclassifications

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* 30% has been adopted as the maximum percentage of misclassifications, in accordance with the results observed by Spreen and Benton (1965).

TABLE XXXIII

Means and Standard Deviations for
Aphasics and Non-Aphasics in Iowa Sample 6,
on 13 Variables

VARIABLES		APHASICS (n=25)	NON-APHASICS (n=19)
Visual Naming	$\bar{X}$	9.92	14.68
	S.D.	5.64	1.97
Description of Use	$\bar{X}$	11.44	15.16
	S.D.	5.82	1.71
Sentence Repetition	$\bar{X}$	11.88	15.11
	S.D.	5.03	2.38
Repetition of Digits	$\bar{X}$	4.28	6.42
	S.D.	2.62	1.87
Reversal of Digits	$\bar{X}$	4.32	5.84
	S.D.	2.55	1.86
Word Fluency	$\bar{X}$	13.64	28.37
	S.D.	8.84	12.00
Sentence Construction	$\bar{X}$	9.12	19.37
	S.D.	9.21	6.16
Oral Reading (Names)	$\bar{X}$	16.80	19.21
	S.D.	5.77	2.02
Oral Reading (Sentences)	$\bar{X}$	12.16	15.53
	S.D.	5.46	1.07
Reading Sentences for Meaning	$\bar{X}$	14.60	16.37
(Point)		3.74	0.83
Visual-Graphic Naming	$\bar{X}$	4.04	6.90
	S.D.	3.03	1.29
Writing to Dictation	$\bar{X}$	79.40	115.26
	S.D.	51.61	33.35
Writing from Copy	$\bar{X}$	88.60	108.32
	S.D.	33.96	15.72

TABLE XXXIV

Results of the Multivariate and Univariate Tests of the Significance of the differences between Aphasics and Non-Aphasics in Iowa Sample 6, on 13 Variables

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN
1	2.45	13.00	30.00	.021

UNIVARIATE F TESTS

VARIABLES	F(1, 42)	MEAN SQ	P LESS THAN
Visual Naming	12.34	245.03	.001
Description of Use	7.23	149.22	.010
Sentence Repetition	6.66	112.30	.013
Repetition of Digits	9.13	49.49	.004
Reversal of Digits	4.82	25.01	.034
Word Fluency	22.03	2341.82	.001
Sentence Construction	17.51	1133.85	.001
Oral Reading (Names)	3.02	62.73	.090
Oral Reading (Sentences)	6.98	122.34	.012
Reading Sentences for Meaning	4.07	33.76	.050
Visual-Graphic Naming	14.74	87.98	.001
Writing to Dictation	6.95	13884.83	.012
Writing from Copy	5.49	4196.36	.024

TABLE XXXV

Percentage of Correct Classifications

SAMPLES (*)	APHASIC % Correctly Classified	NON-APHASIC % Correctly Classified	TOTAL % of Cases Correctly Classified
1 + 2 (WF, DRF, SC, WD)	79.60	96.20	85.00
1 (DRF, SC, WD, VGN, WF)	85.20	92.30	87.50
2 (WF, DRF, DRR)	92.60	84.60	90.00
5 + 6 (WF, VGN, WD)	72.00	81.60	76.14
5 (VGN, WF, WD)	64.00	94.70	77.27
6 (WF, VGN, WD, DRF, DRR)	76.00	84.20	79.55

*Variables selected for discrimination between groups; presented in the order in which they were selected.

would occur for each sample.

The prediction that the majority of misclassified subjects, would be patients diagnosed as "minimally aphasic", cannot be fully evaluated because of the lack of specificity concerning the severity of impairments in language functioning contained in medical reports. Table XXXVI presents the percentage of misclassifications for aphasic and non-aphasic subjects according to severity of language deficits, and laterality of lesion, respectively for each sample. For the Victoria group, the majority of misclassified subjects, were aphasics with a medical diagnosis of minimal impairments in language functioning. The prediction made in Hypothesis II, was also supported by the results for Victoria Sample 1; however, the results for the remaining four sample of subjects were inconsistent with this prediction.

Hypothesis III

Hypothesis III was concerned with the successful discrimination of aphasics from non-aphasics, by means of a discriminant function derived from one sample of subjects from the same geographical and clinical setting, when it was applied to a second sample drawn from the same settings. More specifically, it was predicted that there would be a loss of 10 - 20 % in the predictive accuracy of the equation, when it was applied to the second sample of subjects. Table XXXVII summarizes the percentages of correct classifications derived from one sample, and the percentage of correct classifications obtained when the discriminant function from the first sample is applied to the second sample from the same geographical and clinical setting. The results presented in Table XXXVII support the hypothesis that successful discrimination between aphasics

TABLE XXXVI

Percentage of Misclassification of Aphasic Subjects
According to the Severity of Language Deficits,
and Non-Aphasic Subjects
According to the Laterality of Lesion

SAMPLE	APHASIC		NON-APHASIC			
	Minimal	No Indication	Left	Right	Bilateral or Diffuse	No Indication*
1 + 2	66.67	25.00		8.33		
1	60.00	20.00		20.00		
2	50.00			25.00	25.00	
5 + 6	9.52	57.14	14.29	4.76	9.52	4.76
5	10.00	80.00			10.00	
6	11.11	55.56	22.22	11.11		

*All Subjects for Sample 5 and 6 were over 70 years of age.

TABLE XXXVII

Cross Validations, for Victoria and Iowa Samples

SAMPLE	APHASIC % Correctly Classified	NON-APHASIC % Correctly Classified	TOTAL % of Cases Correctly Classified	CROSS-VALIDATION SAMPLE	APHASIC % Correctly Classified	NON-APHASIC % Correctly Classified	TOTAL % of Cases Correctly Classified
1 (DRF, SC, WD, VGN, WF)	85.20	92.30	87.50	2	66.67	100.00	77.50
2 (WF, DRF DRR)	92.60	84.60	90.00	1	85.19	46.15	72.50
5 (VGN, WF WD)	64.00	94.70	77.27	6	72.00	84.21	77.27
6 (WF, VGN, WD, DRF, DRR)	76.00	84.20	79.55	5	60.00	84.21	70.45

and non-aphasics can be obtained by the application of a prediction equation derived from one sample of subjects, and applied to a second sample of subjects, when both samples are from the same geographical and clinical setting. Furthermore, the prediction for the loss in the predictive accuracy of the equation derived from one sample when it is applied to the second sample, was substantiated in two of the four cross-validation analyses, namely Sample 1 on Sample 2, and Sample 2 on Sample 1. For the cross-validation of Sample 6 on Sample 5, the loss in the predictive accuracy of the equation was less than the predicted minimum of 10%; whereas there was no loss in the predictive accuracy of the discriminant function derived from Sample 5, when it was applied to Sample 6. These results support the predictions made in Hypothesis III.

Hypothesis IV

Hypothesis IV was primarily concerned with the nature of the discriminant functions derived from the different samples of subjects. It was predicted that for samples drawn from the same geographical and clinical settings, the absolute values of the weighting coefficients would change minimally; moreover, it was predicted that subtests loading positively on the discriminant function derived from one sample, would load positively on the discriminant function derived from a second sample of subjects drawn from the same geographical and clinical setting. Standardized discriminant function coefficients, and the percentage of variance accounted for by the successive inclusion of variables in the predictive equation for Samples 1, 2, 5, and 6 are presented in Table XXXVIII.

TABLE XXXVIII

Standardized Discriminant Function Coefficients and the Percentage of Variance Accounted for by the Successive Inclusion of Variables, for Victoria Samples 1 and 2, and Iowa Samples 5 and 6.

VICTORIA SAMPLE 1			VICTORIA SAMPLE 2		
Standardized Discriminant Function Coefficients		Percentage of Variance Accounted for by the Successive Inclusion of Variables	Standardized Discriminant Function Coefficients		Percentage of Variance Accounted for by the Successive Inclusion of Variables
DRF	-0.559	29.85	WF	0.895	48.82
SC	-0.691	41.33	DRF	0.432	50.96
WD	0.735	46.55	DRR	-0.307	52.71
VGN	-0.339	50.85			
WF	-0.278	53.06			

IOWA SAMPLE 5			IOWA SAMPLE 6		
Standardized Discriminant Function Coefficients		Percentage of Variance Accounted for by the Successive Inclusion of Variables	Standardized Discriminant Function Coefficients		Percentage of Variance Accounted for by the Successive Inclusion of Variables
VGN	-0.882	35.75	WF	-0.853	34.41
WF	-0.525	40.26	VGN	-0.465	38.68
WD	0.363	41.91	WD	0.345	40.90
			DRF	-0.471	42.73
			DRR	0.410	45.53

On the discriminant functions derived, Victoria Samples 1 and 2 had two variables in common - Word Fluency (WF), and Repetition of Digits (DRF). The absolute value for Repetition of Digits (DRF) was slightly smaller in the prediction equation derived from Sample 2 (0.432 vs. 0.559); however, the absolute value for Word Fluency (WF) was considerably larger in the second sample (0.895 vs. 0.287). The loadings of these two variables on the two discriminant functions were dissimilar. Both Word Fluency and Repetition of Digits loaded negatively on the discriminant function derived from Sample 1, whereas they had positive loadings on the discriminant function derived from Sample 2. These results are inconsistent with the predictions made in Hypothesis IV, with the exception of the minimal change in the absolute value for Repetition of Digits (DRF).

For Iowa Samples 5 and 6, three variables common to both samples were extracted for discrimination between aphasic and non-aphasic brain damaged subjects. The three variables were Word Fluency (WF), Visual-Graphic Naming (VGN), and Writing to Dictation (WD). In terms of the absolute values of the weighting coefficients, a small change was observed only for Writing to Dictation (0.363 vs. 0.345). The absolute value of the weighting coefficient for Visual-Graphic Naming was almost twice as large in Sample 5 as it was in Sample 6 (0.882 vs. 0.465); whereas the absolute value of the weighting coefficient for Word Fluency was smaller in Sample 5 than in Sample 6 (0.525 vs. 0.853). Nevertheless, Visual-Graphic Naming and Word Fluency loaded negatively, while Writing to Dictation loaded positively on both discriminant functions. These latter results are consistent with the predictions made in

Hypothesis IV concerning loadings on discriminant functions.

Additional Cross-Validation Studies

Cross-validation was performed for every possible combination of samples. The results of these analyses are presented in Table XXXIX. The largest percentage of correct classifications (94.74%) was obtained by applying the discriminant function derived from Victoria Sample 2 to the New York Sample (Sample 3). The next four largest percentages of correct classifications were obtained for Samples 1 + 2 predicting Sample 3, Sample 1 predicting Sample 3, Sample 2 predicting Sample 6, and Sample 6 predicting Sample 1. It is noted that for four of these five cross-validation analyses, Word Fluency was the first variable extracted by stepwise discriminant analysis for discrimination between aphasic and non-aphasic brain damaged subjects.

Table XL summarizes the percentage of misclassifications of aphasic and non-aphasic brain damaged subjects according to severity of language deficits and laterality of lesion, respectively. Inspection of Table XL reveals that for only eight of the twenty cross-validation analyses, the majority of misclassified subjects were diagnosed as minimally aphasic. For six of the twenty analyses, the majority of misclassified subjects were brain damaged non-aphasics.

TABLE XXXIX

Percentage of Correct Classifications for Cross-Validation Samples

SAMPLE(*)	Cross-Validation Sample	APHASIC	NON-APHASIC	% of Correct Classifications
1 + 2 (WF, DRF, SC, WD)	3	86.11	100.00	86.84
1 + 2 (WF, DRF, SC, WD)	5 + 6	78.00	60.53	70.45
1 (DRF, SC, WD, VGN, WF)	3	83.33	100.00	84.21
1 (DRF, SC, WD, VGN, WF)	5	64.00	73.68	68.18
1 (DRF, SC, WD, VGN, WF)	6	84.00	52.63	70.45
2 (WF, DRF, DRR)	3	94.44	100.00	94.74
2 (WF, DRF, DRR)	5	84.00	52.63	70.45
2 (WF, DRF, DRR)	6	92.00	68.42	81.82
5 (VGN, WF, WD)	1	51.85	84.62	62.50
5 (VGN, WF, WD)	2	48.15	100.00	65.00
5 (VGN, WF, WD)	3	72.22	100.00	73.68
6 (WF, VGN, WD, DRF, DRR)	1	74.07	92.31	80.00
6 (WF, VGN, WD, DRF, DRR)	2	48.15	100.00	65.00
6 (WF, VGN, WD, DRF, DRR)	3	75.00	100.00	76.32
5 + 6 (WF, VGN, WD)	1 + 2	57.41	92.31	68.75
5 + 6 (WF, VGN, WD)	3	75.00	100.00	76.32

(*) Variables selected for discrimination between groups; presented in the order in which they were extracted by stepwise discriminant analysis.

TABLE XL

Percentage of Misclassification of Aphasic Subjects
According to the Severity of Language Deficits,
and Non-Aphasic Subjects According to Laterality of Lesion,
for Cross Validation Samples

SAMPLE	CROSS-VALIDATION SAMPLE	APHASIC				NON-APHASIC			
		Minimal	Mild-Moderate	Moderate	No Indication	Left	Right	Bilateral or Diffuse	No Indication
1 + 2	3	100.00							
1 + 2	5 + 6	3.85			38.46	15.38	11.54	19.23	11.54
1	2	44.44			55.56				
1	3	100.00							
1	5	7.14			57.14	14.29		21.43	
1	6				30.77	7.69	23.08	7.69	30.77
2	1	27.27			9.09		45.45	9.09	9.09
2	3	100.00							
2	5				30.77	30.77	7.69	23.08	7.69
2	6				25.00	37.50	25.00	12.50	

TABLE XL (Continued)

SAMPLE	CROSS-VALIDATION SAMPLE	APHASIC					NON-APHASIC			
		Minimal	Mild-Moderate	Moderate	No Indication	Other	Left	Right	Bilateral or Diffuse	No Indication
5 + 6	3	77.78	11.11	11.11						
5 + 6	1 + 2	48.00			36.00	8.00[a]		8.00		
5	1	53.33			20.00	13.33[b]		13.33		
5	2	35.71			50.00	14.29[c]				
5	3	70.00	10.00	10.00		10.00[d]				
5	6	10.00			60.00		10.00	10.00		10.00
6	1	62.50			12.50	12.50[e]				
6	2	35.71			42.86	21.43[f]				
6	3	66.67	22.22	11.11						
6	5	7.69			69.23		7.69		15.38	

a = 1 subject was diagnosed as an "almost purely expressive aphasic"; the other "an obvious motor aphasic".
b = 1 subject was diagnosed as severely aphasic; 1 subject was diagnosed as an "almost purely expressive aphasic".
c = 1 subject was diagnosed as a severe expressive aphasic; the other was diagnosed as an "obvious motor aphasic".
d = This subject was diagnosed as having a severe expressive, and mild receptive aphasia.
e = This subject was diagnosed as an "almost purely expressive aphasic".
f = 1 aphasic was diagnosed as having a "marked receptive component";1 "an obvious motor aphasic; and the third as severely expressively aphasic.

DISCUSSION

A discussion of the results obtained in the present investigation will proceed according to the sequence in which hypotheses and predictions were presented.

Hypothesis I

It was hypothesized that subjects with organic cerebral pathology, and a medical diagnosis of aphasia, would perform significantly differently on a series of tests of language functioning, than subjects with organic cerebral pathology and no diagnosis of aphasia. This hypothesis was supported by five of the six samples tested.* Although the multivariate test for the significance of differences between the mean level of performance of aphasics and non-aphasics in Iowa Sample 5 was in the predicted direction, it was not significant at $p < .05$ ($F = 1.94$, $df = 13/30$, $p = .066$). Since the amount of personal information available for Iowa subjects was limited, and since no medical data were available for aphasics in Iowa samples, one can only speculate about the reasons for the failure to find significant differences.

Aphasic patients assigned to Sample 5 and to Sample 6 may have differed in terms of the severity of impairments in language functioning. A disproportionately large number of aphasics with minimal language deficits assigned to Sample 5 would account for the lack of a significant difference between the mean level of performance of aphasics in this particular sample.

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*The six samples were Sample 1 and Sample 2, Sample 1, Sample 2, Sample 5 and Sample 6, Sample 5, Sample 6.

It is conceivable, that both aphasic and non-aphasic patients assigned to Sample 5, differed with respect to their neurological stability. It may be that both aphasics and non-aphasics were tested within a short period of time following the onset of illness, or that they were tested after the period of time which is conventionally accepted as the period representing spontaneous recovery - three months following a cerebrovascular accident, and six months following traumatic head injuries. However, comparison of neurologically stable aphasics with neurologically unstable non-aphasics could mask any real differences in the performance of these two groups of patients. The problems most commonly associated with neurological instability are: disorientation in time and place, reduction of concentration, irritability or frustration following incorrect performance of a task which premorbidly could have been performed with ease, and fatiguability. These problems could be exaggerated if in addition to being neurologically unstable at the time of test administration, subjects in the non-aphasic group suffered severe brain damage. Absence of information prohibits the comparison of aphasics and non-aphasics in Sample 5, in terms of their neurological status at the time of test administration; however, it is possible that the non-aphasic group was neurologically unstable, and for the reasons cited above, did not perform as well as would be expected.

The prediction that the aphasic group would receive significantly lower mean scores on all subtests of the NCCEA was supported by three out of six samples. However, it should be noted that for two samples, non-significant univariate F tests were obtained for only one test each. For the third sample, four out of fifteen subtests did not discriminate significantly ($p < .05$) between aphasic and non-aphasic subjects. For each sample, on all subtests, the aphasic group received lower mean scores than the non-aphasic group, even though statistical significance at $p < .05$ was not obtained for a very small number of subtests analyzed. Oral Reading (Names) was the only subtest which did not discriminate significantly between aphasics and non-aphasics in two samples, namely Sample 1 and Sample 6. The other subtests which did not demonstrate significant discriminatory power were Oral Reading (Sentences), Reading Sentences for Meaning (Pointing), and Writing to Dictation for Sample 1, and Repetition of Digits for Sample 5. This minor inconsistency in the results obtained may be attributed to the random assignment of aphasic and non-aphasic subjects to samples, disregarding the distribution of the severity of language deficits in each sample.

Hypothesis II

Hypothesis II was stated as follows: "It will be difficult to differentiate between the performance of aphasics with minimal language dificits, and non-aphasics who show minimal performance deficits on individual subtests of the NCCEA." The use of a predictive equation for the classification of subjects was expected to yield a small percentage of misclassifications; the majority of these were predicted to be subjects with a medical diagnosis of minimal aphasic symptoms. The predictions made in Hypothesis II are a test of the predictive validity of the NCCEA. For six samples* the percentage of total cases correctly class-

*Sample 1 and Sample 2, Sample 1, Sample 2, Sample 5 and Sample 6, Sample 5, and Sample 6 ified, ranged from 76.14% to 90.00% ($\bar{X}$ = 82.57%). Both the highest and lowest percentage of total cases correctly classified were obtained with the use of only three variables (subtests). In Sample 2, where the percentage of total cases correctly classified was ninety percent, the variables selected for discrimination between aphasics and non-aphasics were Word Fluency, Repitition of Digits, and Reversal of Digits. The lowest percentage of total cases correctly classified was obtained for Iowa Sample 5 and Sample 6; discrimination was based on Word Fluency, Visual-Graphic Naming, and Writing to Dictation. It is interesting to note that the three highest percentages of total cases correctly classified were obtained for the Victoria group (Sample 1 and Sample 2), and the two Victoria samples. In light of the findings presented by Spreen and Benton (1965), and Wheeler (1963) who obtained eighty-two percent correct classification by using twenty-six variables from an aphasia screening test to discriminate between control subjects and brain damaged patients, it can be concluded that the NCCEA is a valid examination for the assessment of aphasic disorders. The results obtained are particularly remarkable, since aphasic and non-aphasic subjects were randomly assigned to samples.

The prediction that the majority of misclassifications would be subjects with a medical diagnosis of minimal aphasic symptoms was supported by the results for the Victoria group (Sample 1 and Sample 2), and Victoria Sample 1. Additional support for this prediction may have been obtained if the severity of language impairments had been known for the Iowa group (Sample 5 and Sample 6) and for aphasics in Samples 5 and 6. The only misclassifications which were inconsistent with the prediction made in Hypothesis II, were those in Sample 2. On the basis of the discriminant function derived from Sample 2, four subjects were misclassified. Two of the misclassifications were minimal aphasics, the remaining two were diagnosed as non-aphasic. One of the non-aphasic patients suffered diffuse damage in the right cerebral hemisphere, which was caused by a degenerative process. The second misclassified non-aphasic suffered diffuse damage as a result of a traumatic head injury. For the latter patient, memory deficits were noted in the medical report. The misclassification of this non-aphasic patient becomes obvious, when one considers the discriminating variables used in the classification of subjects in Sample 2 - Word Fluency, Repitition of Digits and Reversal of Digits. These last two subtests clearly assess short term memory functions. Word Fluency may also be considered a memory test in the sense that the patient is required to elicit previously learned material. Since Word Fluency is a timed test, memory deficits may interfere with the speed with which the subject is able to elicit words, thus lowering the subjects score on this particular test.

Although not mentioned in the neurologist's report, it is conceivable that the degenerative processes resulting in diffuse damage to the right cerebral hemisphere, for the first misclassified non-aphasic patient, may have resulted in some loss of memory functions also. This is only speculation, and the misclassification of this particular subject cannot be accounted for on the basis of the medical or personal data available.

The non-aphasic patient misclassified as aphasic in the Victoria group (Sample 1 and Sample 2) suffered from a right hemisphere lesion restricted to the temporal lobe, due to a degenerative process. This same patient was the only one misclassified in Sample 1. Since Repetition of Digits was selected as the best discriminating variable for Sample 1, and the second best for Sample 1 + Sample 2, it is possible that this patient suffered impairments in memory functioning, which are commonly associated with degenerative disorders. This factor cannot be ascertained and must therefore be considered speculation.

An attempt to evaluate misclassifications in the Iowa group and the two Iowa samples, will not be made since the only available medical information concerns laterality of lesion for most of the non-aphasic patients.

Hypothesis III

It was hypothesized that differences in performance on language tests would not be significant for two samples derived from the same geographical and clinical setting. More specifically, it was predicted that a discriminant function derived from one sample of subjects, would successfully discriminate between aphasics and non-aphasics in a second sample drawn from the same geographical and clinical setting. The loss in the predictive accuracy of the equation was expected to range from ten to twenty percent. The results obtained for the two Victoria samples and the two Iowa samples supported these predictions. Moreover, the loss in the predictive accuracy of the equations derived from the two Iowa samples was less than the predicted minimum of ten percent.

There was no loss in the predictive accuracy of the equation derived from Sample 5 when it was employed for discrimination between aphasics and non-aphasics in Sample 6. Although unexpected, the reasons for this result become apparent when the discriminating variables for both samples are considered. The three variables which were extracted by stepwise discriminant analysis for Sample 5 were Visual-Graphic Naming, Word Fluency, and Writing to Dictation. These three variables were also the first three extracted for Sample 6; however, the order of the first and second variables for Sample 5 was reversed for Sample 6. The additional extraction of Repetition of Digits and Reversal of Digits as the fourth and fifth discriminating variables, respectively, in Sample 6, probably accounts for the small loss (9.10%) in the predictive accuracy of the equation when it is applied to Sample 5. Examination of the predictive equation derived from Sample 5 suggests that Repetition of Digits and Reversal of Digits were not extracted because their contribution to the total discriminatory power of the equation was either negligible, or would have reduced the power of the equation by introducing error variance.

By applying the discriminant function derived from Sample 1 to Sample 2, an increase (15.4%) in the percentage of correct classfications was obtained for the non-aphasic group in Sample 2. Concomitantly, a decrease (25.93%) in the percentage of correct classifications was observed for aphasics. These results are attributable to the differences in the composition of the predictive equations derived from each sample.

Use of the predictive equation derived from Sample 2 for the purpose of discriminating between aphasic and non-aphasic subjects in Sample 1, resulted in a major loss (46.15%) in the percentage of correct classifications for the non-aphasic group. This loss can be attributed to the absolute values of the weighting coefficients derived from the two samples. In Sample 1, the absolute value of the weighting coefficient for Word Fluency was .278; whereas in Sample 2 it was .845. Word Fluency was the last variable included for discrimination between aphasics and non-aphasics in Sample 1; in Sample 2, Word Fluency was the first variable extracted by stepwise discriminant analysis, thus indicating that this was the single best predictor for Sample 2. An examination of the absolute values of the weighting coefficients for Word Fluency in the two Victoria samples, indicates that this variable contributed more than three times as much to the discrimination between aphasics and non-aphasics in Sample 2 than it did to discrimination between the two groups in Sample 1.

It is interesting to note that in all four samples (Sample 1, 2, 5, and 6) Word Fluency was included as one of the discriminating variables. Repetition of Digits, Writing to Dictation, and Visual-Graphic Naming were included in three of the four samples, not necessarily in the same three samples; while Reversal of Digits was included in only two samples. These results appear to be somewhat contrary to the popular belief that Sentence Repetition and the Token Test (Identification by Sentence) are clinically the most useful tests in detecting language deficits. However, since Identification by Sentence was eliminated from two of the four validation analyses, its power as a discriminating variable cannot be assessed for those two samples of subjects. For the Victoria samples, Identification by Sentence was not a significant discriminating variable in combination with all other variables included in the stepwise discriminant functions analysis. Alone, Identification by Sentence successfully discriminated between aphasic and non-aphasic subjects at $\underline{p} = < .003$.

Similarly, Sentence Repetition discriminated between aphasics and non-aphasics in all samples at $p < .01$. A possible explanation for the selection of Word Fluency as a discriminating variable in all validation analyses, is that maximal performance on the Word Fluency test requires the presence of several intact functions. It requires total comprehension of the task, intact memory functioning, and the ability to produce the types of words required within a given time period. Additionally, severity of language impairments will be reflected in the score obtained, particularly for aphasics whose deficits in the oral production of language are severe.

Since there is a considerable amount of overlap between the twenty tests comprising the nucleus of the NCCEA, the tests which did not contribute a significant amount of new information towards the discrimination between aphasics and non-aphasics were not included in the predictive equations derived. This does not imply that the subtests excluded from the predictive equation are not successful discriminators between aphasics and non-aphasics. As mentioned previously, in the discussion pertaining to Hypothesis I, with the exception of six subtests in separate analyses, all subtests alone discriminated successfully between aphasics and non-aphasics in all samples. By the inclusion of those variables which had to be excluded because of the number of missing observations, it may have been possible to obtain different sets of best predictors for each sample. Conversly, by the exclusion of some of the variables used in the present analyses, different sets of best predictor variables may emerge. Although some commonalities exist, it is obvious from the composition of the predictive equation derived from each sample in the present study, that the tests which are considered to be the best discriminators between aphasic and non-aphasic subjects are peculiar to the sample of subjects tested.

Hypothesis IV

Hypothesis IV was concerned with the composition of the predictive equations derived from samples of subjects drawn from the same geographical and clinical setting. It was predicted that the absolute values of the weighting coefficients would change minimally from one sample to the other. In addition, subtests loading positively on one discriminant function, were expected to load positively on the discriminant function derived from a second sample of subjects from the same geographical and clinical setting. As presented in a description of the results, these predictions were only partially supported. Both the discriminant functions derived from the two Victoria samples, and the discriminant functions derived from the two Iowa samples, differed with respect to the number of variables extracted by stepwise discriminant analysis. Moreover, the change in the absolute values of the weighting coefficients was more than that which can be considered minimal (.150) for most of the discriminating variables in both the Victoria and Iowa samples. For the discriminating variables common to both Iowa samples, loadings remained the same in both prediction equations. This result was not obtained for the Victoria samples. The lack of support, in two out of four samples, for the predictions made in Hypothesis IV can be attributed to the assignment of subjects to samples without matching for severity, laterality, location and etiology of lesion, and severity of impairments in language functioning. Although there were no significant differences between Victoria Samples 1 and 2 for laterality, locus and etiology of lesion, there may have been significant differences between the two samples in the type and severity of language deficits. These differences would account for the extraction of different subtests of the NCCEA as discriminating variables, since the various subtests of the NCCEA test for comprehension and production of language, retention of verbal material, and reading and writing abilities.

Additional Cross-Validation Studies

Sixteen additional cross-validation analyses were performed. The results of these analyses were presented in Table XXXIX. Since the samples for cross-validation were drawn from different geographical and clinical settings, no predictions were made about the percentage of total cases correctly classified or the nature of the misclassifications. Nevertheless, for all sixteen cross-validations, the loss in the predictive accuracy of the particular discriminant function employed did not exceed twenty percent. This is in accordance with the prediction made in Hypothesis III concerning a ten to twenty percent loss in the predictive accuracy of an equation derived from one sample when it is employed for discrimination between groups in a second sample drawn from the same geographical and clinical setting. The results of these sixteen cross-validations are even more compelling since each cross-validation was performed on samples drawn from different geographical and clinical settings.

A more accurate estimate of the power of the predictive equations derived for discrimination between aphasics and non-aphasics from different geographical and clinical settings is the percentage of total cases correctly classified. The range in the percentage of total cases correctly classified was 65% to 94.74%. For five of the cross-validation analyses, the percentage of total cases correctly classified did not exceed seventy percent. Four of these five cross-validation analyses concerned the application of discriminant functions derived from Iowa samples to Victoria samples; while the fifth was concerned with the application of a predictive equation derived from a Victoria sample to an Iowa sample. These results are suggestive of possible differences between the Iowa and Victoria samples of subjects.

Since no significant differences were observed between Iowa subjects and Victoria subjects for the information available, explanation of the results obtained remains speculative. It is conceivable that both Iowa aphasics and non-aphasics differed in comparison to Victoria aphasics and non-aphasics with respect to severity, laterality, locus and type of cerebral damage. There may have been differences between Iowa and Victoria aphasics in the nature and severity of language impairments, also. Differences in the nature and severity of language deficits would be reflected in different distributions of mean scores for the two groups of subjects, and consequently the extraction of different sets of best predictor variables.

Age may have made some contribution towards the low percentage of total cases correctly classified in the Victoria samples and the one Iowa sample, particularly with respect to the non-aphasic group. The range in age for Iowa non-aphasics was sixteen to ninety-two years, whereas for Victoria non-aphasics it was sixteen to seventy-one years. It should be noted that twelve of the thirty-eight Iowa non-aphasics were over seventy years of age. The corrections used for age in the various subtests of the NCCEA were derived from a standardization group ranging in age from sixteen to sixty-four years; therefore these corrections may have been inadequate for the non-aphasic subset of subjects who were over seventy years of age. It is possible that for Iowa non-aphasics who were over seventy years of age, a lower level of performance may have been attained on the NCCEA due to slowness in responding, possible deficits in verbal memory, and/or fatiguability.

Another possibility for differences between Victoria subjects and Iowa subjects is a cohort effect. Iowa subjects were tested approximately ten years earlier than Victoria subjects. Consequently, there may have been differences in the type of education received by both groups, more specifically, the emphasis on certain areas of learning may have differed. In addition, cultural differences may have been present between the two groups of subjects. Iowa subjects usually came from very small rural settings, as opposed to the urban setting of Victoria subjects. Another factor to consider is the difference in clinical settings. Victoria hospitals are most commonly associated with the treatment of all acute-care patients from the area, whereas the University of Iowa Medical Center accepts many cases with special problems which have been referred from local hospitals in regions within the state of Iowa, and from other states.

With respect to the percentage of misclassification, the majority of misclassifications which occurred were within the aphasic group for twelve of the sixteen cross-validation analyses. In nine of these twelve analyses the majority of misclassified subjects were diagnosed as minimally aphasic. For the remaining three, there was either no indication of the severity of language deficits, or subjects with specific diagnoses of either severity or type of aphasia were misclassified. The misclassification of subjects with specified language deficits can only be attributed to the random assignment of subjects to samples. This is also true for the misclassification of subjects diagnosed as non-aphasic.

General Discussion

The results of the present investigation demonstrated that the NCCEA is a valid instrument for discriminating between aphasic and brain damaged non-aphasic patients, even though several subtests had to be eliminated from the analyses because of the number of missing observations. It was also demonstrated that successful discrimination between aphasics and brain damaged non-aphasics could be attained by the application of discriminant functions derived from both samples from the same geographical and clinical setting, and samples from different geographical and clinical settings. These results demonstrate that despite any differences which may be attributable to factors specific to a particular geographical or clinical setting, the NCCEA retains its validity as a successful discriminator between patients diagnosed as aphasic and patients suffering from organic cerebral pathology, with no diagnosis of aphasia.

The extraction of only a few subtests from all subtests subjected to analysis in each sample, does not suggest that the subtests excluded from the predictive equations derived are not successful discriminators between aphasic and brain damaged non-aphasic subjects. On the contrary, each subtest analyzed proved to be a successful discriminator between aphasic and non-aphasic brain damaged subjects when used alone, with the exception of a few in separate analyses. These results suggest that, for the purposes of diagnosis, a relatively small number of tests comprising the nucleus of the battery of tests designed by Spreen and Benton (1969) will suffice. Diagnostic information concerning the presence or absence of aphasia may be useful to the neurologist or neurosurgeon requiring confirmation of a suspicion that language deficits are present, but it is of no use in terms of prognosis, therapy or rehabilitation of the patient. It is evident that the results of the present investigation do not negate the clinical usefulness of employing all subtests of the NCCEA subjected to analysis for the assessment of aphasic disorders.

Suggestions for Future Research

The first suggestion for future research on the validity on the NCCEA is directly related to the problems encountered in the present investigation. For future validation and cross-validation studies it is suggested that only subjects for whom scores are available on all twenty subtests of the NCCEA be used. In addition, a statement concerning the severity of language deficits is necessary in order to either match subjects according to the severity of their deficits or to explain any unexpected results which may be obtained. Complete medical data concerning severity, laterality, locus and etiology of lesion would allow correlations to be made between these factors and the nature of deficits in language functioning. In addition to medical data, it is suggested that information concerning sex, age, education, handedness, the time interval between the onset of illness and administration of the NCCEA, and the time interval between the administration of the NCCEA and the medical diagnosis of aphasia, be obtained for all subjects. Although matching of subjects for all variables mentioned above would reduce the loss in the predictive accuracy of the equations derived from different samples, in cross-validation analyses, the results of the present investigation suggested that matching of subjects is not necessary. However, the availability of medical and personal data would facilitate explanation of differences between samples in both validation and cross-validation analyses.

Additional validation and cross-validation studies are suggested for aphasic and normal control subjects, and aphasic and psychiatric, more specifically schizophrenic subjects. It would also be of interest to obtain the results of validation and cross-validation studies performed for aphasics and brain damaged non-aphasics on the Italian and Spanish versions of the NCCEA.

Other suggestions for future research are concerned with restandardization, reliability, and validity of the NCCEA in terms of discrimination between 'types' of aphasics.

It would be useful to perform a restandardization of the NCCEA on a new group of control subjects with a wide range in age and education, and also on aphasic patients for whom scores on the NCCEA are available in addition to those used in previous standardization procedures.

Another factor which would facilitate the adoption of the NCCEA as a standard test battery for aphasia, would be a check on the reliability of the instrument. Although inter-judge reliability is expected to be high because of the explicitness of administration and scoring procedures provided in the NCCEA manual, this has not been experimentally tested. Test-retest reliability would have to be performed on neurologically stable aphasics, since aphasics generally recover within the first few months following the onset of illness. The third reliability check which should be performed is split-half reliability.

Although the present study was not concerned with differentiation among aphasic patients according to patterns of language deficits, future research may address itself to the question of whether or not the NCCEA successfully discriminates between different 'types' of aphasics. This issue has been more widely pursued in the current literature on aphasia, than the question of the presence or absence of language deficits, since it pertains both to theories of aphasia and theories of prognosis and therapy for aphasia. Since discrimination among 'types' of aphasics would necessarily involve an examination of the theoretical bias of the typology used, it is suggested that initial validation analyses be restricted to discrimination between widely accepted 'types' of aphasics. To cite a few examples, discriminant analyses could be performed between fluent and non-fluent aphasics (Benson, 1967), among syntactic, semantic, pragmatic, jargon, and global aphasics (Wepman and Jones, 1964), and among Schuell's Groups 1 - 5 (Schuell et al., 1964). The predominant characteristics of non-fluent aphasia are: a low rate in the production of words, frequent mispronounciations, pauses and perseverations, and disturbances in the rhythm of speech. This type of aphasia is most commonly associated with lesions anterior to the Rolandic Fissure (Benson, 1967). Fluent aphasia is primarily characterized by impairments in comprehension, frequent paraphasias, an increased rate in speech production, and an inability to name common objects. Fluent aphasia is most commonly associated with lesions posterior to the Rolandic Fissure (Benson, 1967). A description of the primary deficits associated with the types of aphasia proposed by Wepman and Jones (1964) is presented in Appendix B; while a description of Schuell's (Schuell et al., 1964) Groups 1 - 5 is presented in Appendix C.

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Appendix A

A Brief Summary of the Testing Procedures for Head's Serial Tests

"... The patient must be examined alone, in a quiet room, apart from all distracting sights and sounds. It is of fundamental importance to record not only what he says or does, but also every remark or question of the observer. As soon as it is certain that the patient understands the task he is asked to perform, each series of tests must be carried out in silence; should this rule be broken, both sides of the conversation must be recorded. It is particularly important to write down at the moment any statement which throws light on the ideas or feelings of the patient with regard to the test, or to the difficulties he experiences in carrying it out. If it consists in executing some choice to oral commands, the observer must say the words once only in the simplest and most direct manner. Should it be necessary to repeat the order at the request of the patient, the fact must be noted, so that we may learn in how far his subsequent conduct is influenced by the repetition. Between any two series of tests, it is well to permit the patient to rest or to talk freely, but as soon as a fresh set of observations has been started, all conversation should be confined to the task at hand, and every word spoken on either side must be recorded.

It is extremely important to avoid all causes of fatigue or loss of temper. Some patients, especially the older aphasics, become depressed or angry, when they fail repeatedly to carry out tests which are childishly simple. The sequence of the various sets of observations must then be rearranged, so that the next series belongs to a group that can be carried out easily. It is remarkable how quickly this restores the patient's equanimity. In all work of this kind fatigue and disappointment must be avoided by every possible means, if necessary even by terminating the sitting." (Head, 1926, Vol. 1, p. 147)

"The order in which these serial tests are applied must be varied to suit the circumstances of the case. It is a mistake to begin with those which present the greatest difficulty and the length of the series must be adapted to the patient's capacity. For instance, the names of common objects can be written in capitals only, it is a mistake to insist on the whole eighteen tests; these may, however, be usefully employed in full to discover the extent to which the patient can make a choice to oral commands. With the older and more debilitated aphasics of civilian practice it is sometimes necessary to reduce the number of tests in the series throughout the whole of some particular examination, so as to avoid the disastrous consequences of fatigue or depression." (Head, 1926, Vol. 1, p. 149).

Appendix B

Primary Deficits associated with each of the

Five Aphasias proposed by

J. M. Wepman and L. V. Jones

Syntactic Aphasia	- marked inability to produce conventional sentences - underuse or ommission of function words - overuse of substantive words - ommission or misuse of inflection, tense and/or gender - telegraphic style of speech
Semantic Aphasia	- difficulty evoking once well known substantive words and proper nouns - substitution of circumlocutions and gestures for words which cannot be recalled
Pragmatic Aphasia	- use of substantive words inappropriate to the stimulus situation - substitution of neologisms and high-frequency words for substantive words - lack of awareness of the inability to communicate meaningfully
Jargon Aphasia	- unintelligible sound combinations, more commonly known as jargon - lack of awareness of the inability to communicate meaningfully
Global Aphasia	- severe impairment in both the production and comprehension of language - use of single automatized words, phrases, or neologisms - use of primitive gestures for communication

(Wepman and Jones, 1964)

Appendix C

A Brief Summary of Schuell's Classification System

Group 1 (Simple Aphasia)
- deficits in all language modalities
- absence of perceptual and sensorimotor impairments
- absence of dysarthria

Prognosis = excellent

Group II
- deficits in all language modalities, complicated by cerebral invovement of visual processes
- relatively mild neurological involvement
- absence of dysarthria

Prognosis = excellent

Group III
- severe deficits in all language modalities complicated by sensorimotor impairments
- massive lesion
- low incidence of complicating neurophysiological conditions, such as hypertension

Prognosis = dependant upon the extent and locus of lesion

Group IV
- some residual language functioning
- cerebral involvement of visual processes
- dysarthria
- generalized cerebral damage
- high incidence of complicating neurophysiological conditions, such as hypertension
- abnormal mental states, e.g. confusion

Prognosis = limited by the severity of the physiological condition and psychological status

Group V
- almost complete loss of all language skills
- severe neurological involvement
- massive lesion

- high incidence of complicating neurophysiological conditions
- abnormal mental states, e.g. confusion

Prognosis = poor

(Schuell, et al., 1964)

Appendix D

The Functional Communication Profile

FUNCTIONAL COMMUNICATION PROFILE

EVAL (Blue)	RE-EVAL (Red)	RE-EVAL (Red)	RE-EVAL (Red)
Date ______	Date ______	Date ______	Date ______
M ___ ___% (.)	M ___ ___% (.)	M ___ ___% (.)	M ___ ___% (.)
S ___ ___% (.)	S ___ ___% (.)	S ___ ___% (.)	S ___ ___% (.)
U ___ ___% (.)	U ___ ___% (.)	U ___ ___% (.)	U ___ ___% (.)
R ___ ___% (.)	R ___ ___% (.)	R ___ ___% (.)	R ___ ___% (.)
O ___ ___% (.)	O ___ ___% (.)	O ___ ___% (.)	O ___ ___% (.)
Overall __ __.__%	Overall __ __.__%	Overall __ __.__%	Overall __ __.__%

	NORMAL	GOOD	FAIR	POOR	0	
MOVEMENT						Ability to imitate oral movement
						Attempt to communicate
						Ability to indicate "yes" and "no"
						Indicating floor to elevator operator
						Use of gestures
SPEAKING						Saying greetings
						Saying own name
						Saying nouns
						Saying verbs
						Saying noun-verb combinations
						Saying phrases (non-automatic)
						Giving directions
						Speaking on the telephone
						Saying short complete sentences (non-automatic).
						Saying long sentences (non-automatic)
UNDERSTANDING						Awareness of gross environmental sounds
						Awareness of emotional voice tone
						Understanding of own name
						Awareness of speech
						Recognition of family names
						Recognition of names of familiar objects
						Understanding action verbs
						Understanding gestured directions
						Understanding verbal directions
						Understanding simple conversation with one person
						Understanding television
						Understanding conversation with more than two people
						Understanding movies
						Understanding complicated verbal directions
						Understanding rapid complex conversation
READING						Reading single words
						Reading rehabilitation program card
						Reading street signs
						Reading newspaper headlines
						Reading letters
						Reading newspaper articles
						Reading magazines
						Reading books
OTHER						Writing name
						Time orientation
						Copying ability
						Writing from dictation
						Handling money
						Using writing in lieu of speech
						Calculating ability

ESTIMATED TOTAL SPEAKING VOCABULARY: 0 1-50 50-100 100-500 500-1000 over 1000

DEPARTMENT OF PHYSICAL MEDICINE AND REHABILITATION, NEW YORK UNIVERSITY MEDICAL CENTER,
Speech Therapy Service, New York, New York

Appendix E

NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA

(NCCEA)

Edition A

MANUAL OF INSTRUCTIONS

and

TEST BOOKLET

NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA*

(NCCEA)

Edition A

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and

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University of Iowa

M A N U A L   O F   I N S T R U C T I O N S

Produced and distributed by
Neuropsychology Laboratory
Department of Psychology
University of Victoria

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The Neurosensory Center Comprehensive Examination for Aphasia consists of 20 tests of language performance and four control tests of visual and tactile function. The 20 language tests assess understanding and production of language, retention of verbal material, reading and writing. The four control tests are designed to detect the presence of visual or tactile deficits that might affect performance on the language tests and are given to a patient whenever his performance on certain tests (visual or tactile naming, reading) proves to be subnormal. The tests are numbered from 1 to 20 and from C-1 to C-4. Each test is also identified by an abbreviation indicating the performance assessed (e.g., VN = Visual Naming). Table 1 lists the tests by number and indicates the abbreviations used. Experimental versions of this test have been in use since 1962.

A distinctive feature of the examination is the provision for constructing a profile of directly comparable percentile scores, corrected for age and educational level, for any patient. This procedure enables the examiner to note at a glance specific dimensions of deficit as well as overall level of performance. Two profile sheets have been developed for this purpose. One is based on the performances of normal adults. A second profile sheet is based on the performances of a "reference" group of aphasic patients examined at the Neurosensory Center and is designed to provide an evaluation of a patient's performance in terms of the distribution of scores in this "reference" group. A number of other potentially useful profile sheets based on the performances of defined groups of patients (ostensibly non-aphasic brain-damaged patients, normal aged persons, mental defectives) are in preparation.

Procedures for administration, scoring and use of the profile sheets are described in this Manual.

TABLE I

Neurosensory Center Comprehensive Examination for Aphasia, Edition A

Language Tests

1.	VN	Visual Naming (Trays A & B)
2.	DU	Description of Use (Trays C & D)
3.	TNR	Tactile Naming, Right Hand (Trays A & B)
4.	TNL	Tactile Naming, Left Hand (Trays C & D)
5.	SRP	Sentence Repetition
6.	DRF	Repetition of Digits
7.	DRR	Reversal of Digits
8.	WF	Word Fluency
9.	SC	Sentence Construction
10.	IN	Identification by Name (Trays A & B)
11.	IS	Identification by Sentence (Token Test)
12.	RNO	Oral Reading (Names)
13.	RSO	Oral Reading(Sentences)
14.	RNP	Reading Names for Meaning (Pointing)(Trays A & B)
15.	RSP	Reading Sentences for Meaning (Pointing)
16.	VGN	Visual-Graphic Naming (Tray C)
17.	WN	Writing Names (Tray C)
18.	WD	Writing to Dictation
19.	WC	Writing from Copy
20.	ART	Articulation

Control Tests

C1	TMR	Tactile-Visual Matching of Objects, Right Hand (Trays A & B)
C2	TML	Tactile-Visual Matching of Objects, Left Hand (Trays C & D)
C3	VVM	Visual-Visual Matching of Objects (Trays A & B)
C4	FP	Form Perception (Matching Letters)

Test Materials

Eleven tests (Nos. 1-4, 10, 14, 16, 17, C1, C2, C3) use sets of common objects as stimuli. These objects are assembled in four sets of eight objects, each set being presented on a separate tray (A, B, C or D). The four sets of objects are essentially equal in difficulty level with respect to visual naming. For example, the mean percentage of success in naming in a group of 81 aphasic patients was found to be: Tray A - 63.1%; Tray B - 63.4%; Tray C - 63.1%; Tray D - 63.5%.

The objects on each tray are listed in Table 2. As will be seen, the sequence of presentation of the objects on each tray is ordered in terms of increasing difficulty, as defined by the number of errors made in naming each object by our group of 81 aphasic patients. Since performance on some tests might be influenced by the immediately preceding test if the same tray were used for both, trays are rotated for successive tests.

Tests 5, 6, 7 and 20 (Sentence Repetition, Repetition of Digits, Reversal of Digits and Articulation) are presented on sound tape.

Tests 11 and 15 (Identification by Sentence, Reading Sentences for Meaning) utilize the material (circles and squares of different sizes and colors) of the Token Test of De Renzi and Vignolo (Brain, 1962, 85, 665-678).

In Test 16, block letters, like those from a set of Scrabble blocks may be used if a patient has severe motor impairment of the writing hand.

Tests 3 and 4 (Tactile Naming) and Test C1 and C2 (Tactile Visual Matching) require a small box with a drop-curtain in front to screen the subject's hand from his view.

Other necessary material includes printed cards for the reading and copying tests and unruled paper and a sharp pencil for the writing tasks.

TABLE 2

Percentage Correct (Visual Naming) in a Group of Aphasic Patients

Tray A

Object	% Correct
comb	77
ring	75
key	74
cup	74
ashtray	59
thimble	58
padlock	47
paper clip	41
Mean % Correct	63.1

Tray B

Object	% Correct
knife	77
fork	73
bottle	71
shoe lace	63
brush	62
jar	59
can opener	58
tweezers	44
Mean % Correct	63.4

Tray C

Object	% Correct
pistol	77
plate	74
light bulb	68
screw driver	67
sponge	59
ruler	56
egg beater	55
spring	49
Mean % Correct	63.1

Tray D

Object	% Correct
watch	75
eye glasses	75
spoon	74
razor	67
matches	64
envelope	58
pen	53
tape	42
Mean % Correct	63.5

General Instructions

Seat the patient at a table. Explain to him that he will be given a series of tests to evaluate the status of speech and language functions. To insure cooperation from patients without obvious speech impairment, add that the tests are often given to patients without evident speech and language impairment for purposes of completeness of examination.

Begin by determining handedness on the basis of informal questioning or a standard handedness inventory *. Give the instructions for each test slowly and enunciate clearly. Present items in each test in the order listed on the answer sheets. Do not comment on the patient's performance, but encourage him with an occasional 'good' or 'fine' if he shows uncertainty. Allow ample time for responses and for spontaneous corrections unless otherwise specified in the test instructions. Repeat instructions if the patient does not respond. If he has difficulty in understanding instructions, make an attempt to instruct him by demonstration or gesture.

Recording :

Answer sheets for each test are provided in the answer booklet.

(a) Enter 1 or 0 (correct or incorrect) in the score column.

(b) Record all incorrect and/or mispronounced correct responses verbatim in the response column.

(c) Note any unusual features of performance, e.g., the subject's spontaneous alteration of his response, his uncertainty or delay in responding on the answer sheet. Any repetition of instructions, questioning of responses, instructing by gesture etc. by the examiner should also be noted.

* A sample inventory is available upon request.

(d) On all naming tests (1, 3 and 4), the type of error should be recorded in the "Error-type" column as follows:

"dk" for "don't know"

"nr" for no response

"Ø" for misnaming

"ØPP" for phonemic paraphasia

"ØSP" for semantic paraphasia

Profile Sheets

The scores on subtests 1 to 20 may be entered on profile sheets.* Before entering the scores, corrections for age and education level are applied for some of the tests. These corrections are applied even if the total raw score on a given test is 0. Raw scores obtained by partial testing on some tests (e.g., one set of eight items instead of the total of 16 items) are multiplied as indicated in the directions.

Profile Sheet A is based on a standardization group of normal adults. The corrected raw scores of each subtest can be transformed into the corresponding percentile rank of a normal population by reference to the left or right marginal column on the profile sheet. For most subjects without language disturbance a percentile rank of 40 or more can be expected. Ranks in the 30 to 40 range indicate minimal difficulties in performance; ranks in the 20 to 30 range indicate mild impairment, ranks below 20 indicate more severe dysfunction. Note, however, that subtests involving the handling of objects (tactile naming, tactile-visual matching, demonstration of use) may reflect a sensory or motor deficit rather than a language impairment. Occasionally, one or two individual errors on a given test may be of clinical significance even though the percentile rank is still above 30 or 40.

* Sample profile sheets for normal adults and for aphasic subjects are included in this manual (pp. 8 and 9).

Profile Sheet B is based on the performance of the "reference" group of aphasic patients. The percentile ranks on this profile indicate a patient's performance on a given subtest relative to the "average" performance of this reference group. This profile therefore is particularly designed to locate specific areas of strength and weakness in an individual patient.

NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA, EDITION A (1968)
PROFILE FORM A (NORMAL ADULTS)

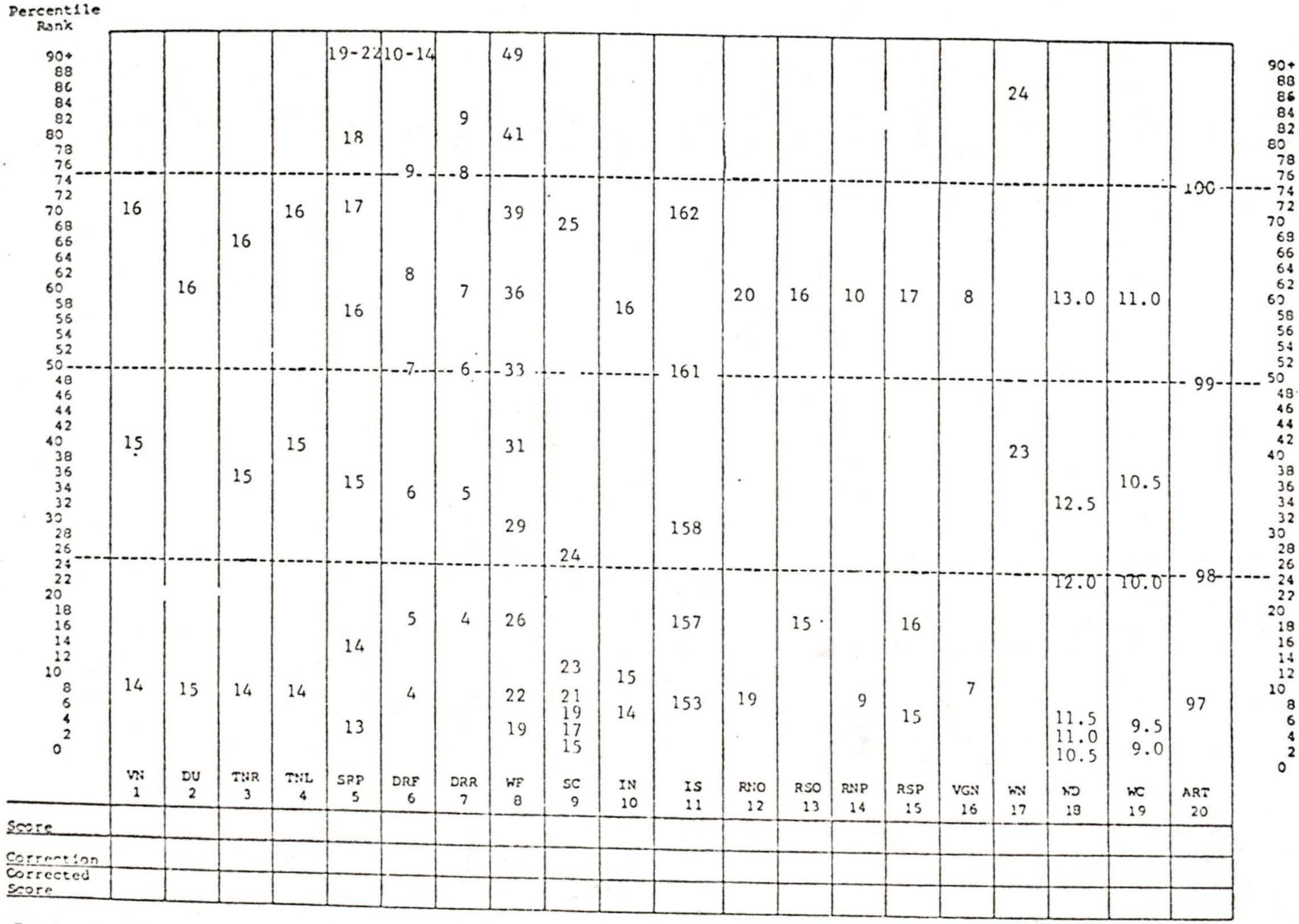

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Fig. 1

NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA, EDITION A (1968)
PROFILE FORM B (APHASICS)

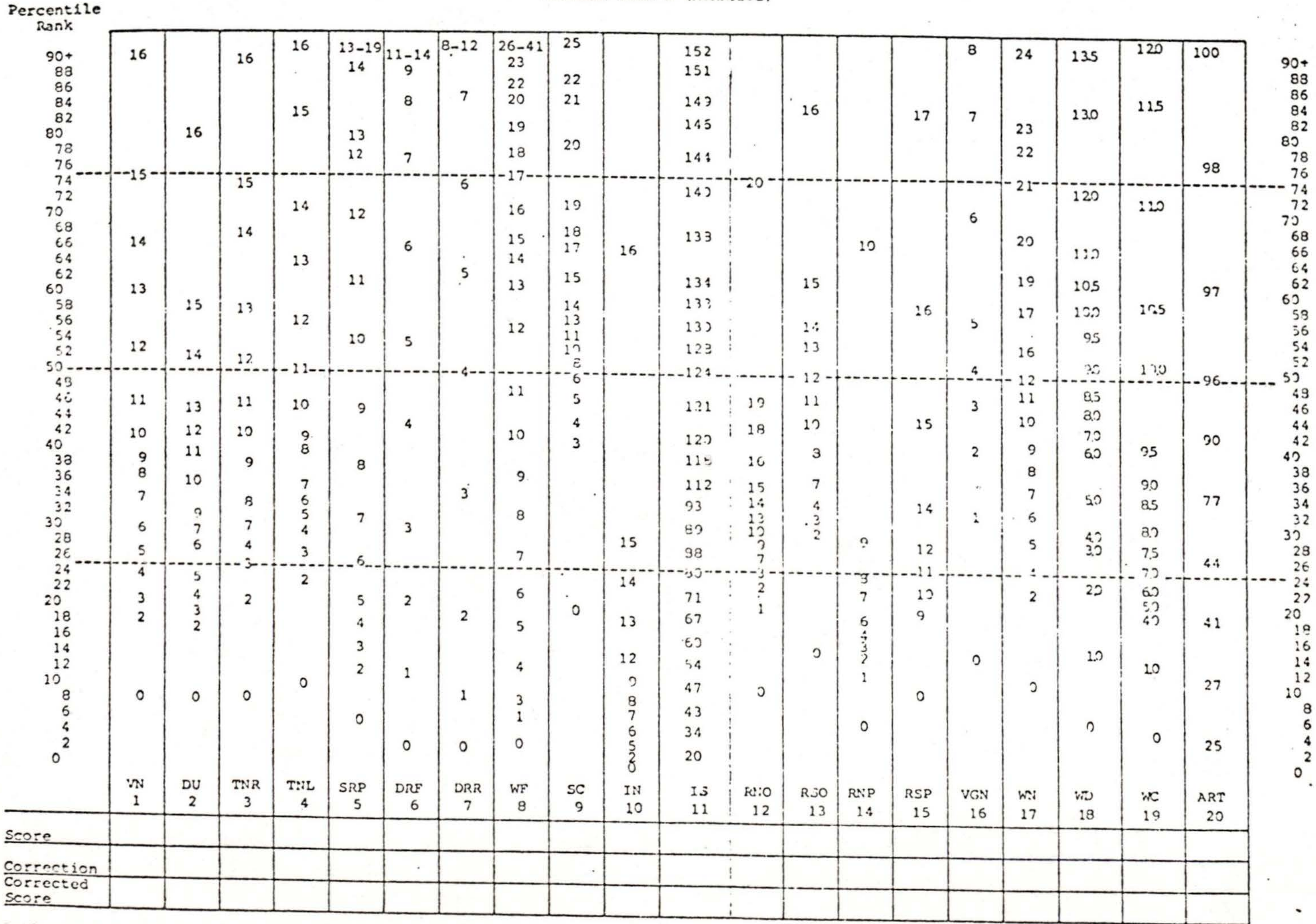

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Fig. 2

Test 1. VN VISUAL NAMING (TRAYS A AND B)

Administration

Present Tray A to the patient in such a way that he can see all of the objects without difficulty. Point to the first object (comb) listed on the answer sheet and say: "I WANT YOU TO TELL ME THE NAMES OF THESE OBJECTS. WHAT IS THIS? TELL ME THE NAME OF IT." If the patient shows any apparent difficulty in seeing the object, the examiner may take it out of the tray and hold it up for closer inspection. However, do not allow the patient to touch the objects.

If the patient responds by giving the use of the object (e.g., "for combing hair," "for eating"), repeat the instructions. If the patient responds with a generic term or a partically correct name (e.g., "silver" for spoon; "jewelry" for ring), ask him to give the exact name. In formulating the question, the examiner may utilize the information given in the patient's first response but must scrupulously avoid giving additional cues (e.g., he may say, "What is the full name of this? What kind of silver? What kind of jewelry?") Do not ask further questions if the patient fails to improve his response after the first question.

The eight objects of Tray A are presented. The test is terminated if the patient shows either complete success or complete failure, i.e., if he names all eight objects correctly or fails to name at least one object correctly. If the patient makes 1-7 errors in naming the objects of Tray A, the eight objects of Tray B are presented. Thus Test 1 may consist of eight or 16 items, depending upon the level of the patient's performance on Tray A.

Recording and Scoring

Detailed recording of the patient's responses is essential, especially in the case of spontaneous corrections. The criteria for scoring and the notations to be made on the answer sheet are as follows:

Give a score of 1 for each correct response, i.e., those names given on the record sheet. Slang or childish words (e.g., "pinchers" for tweezers) are generally not acceptable. Make a verbatim recording of any incorrect responses made before the correct name is produced. Make a notation, "d" if the response is delayed (i.e., produced only after five or more sec.). Spontaneously corrected misnamings are counted as correct responses. Poor articulation is disregarded as long as the word is clearly recognizable and offers no possibility for misinterpretation. E.g., "pate" for plate is acceptable but "pape" is not; "tweeser" for tweezers is acceptable but "stevers" is not. Incorrect responses of this type are noted as "PP" phonemic paraphasia). Admittedly there is a subjective element in the judgment of the examiner on this point. The guiding principle here should be whether or not a naive observer hearing the patient's utterance would immediately know which object is being named.

Give a score of 0 for each incorrect response (no response, unrecognizable response, "don't know" response, perseveration, misnaming). Misnamings that are semantically related to the object (e.g., shaver for razor; globe for light bulb; pencil for pen; hair for comb; knife for spoon) are noted as "SP" (semantic paraphasia). If the patient indicates recognition of the incorrectness of his response, write "No" after the misnaming.

If the patient misnames in response to questioning by the examiner of a partially correct response, score as a misnaming (e.g., patient says "wire" in naming the screen and, when questioned, responds with "brush").

If both a misnaming and a "don't know" response are given, score as a misnaming and write "No" after it.

Total score for Tray A is multiplied by two if only the first eight objects are presented. There are no corrections for age or educational level for performance on this test. Maximum score = 16.

Test 2. DU DESCRIPTION OF USE. (TRAYS C AND D)

Present the first object of Tray C. "WHAT DO YOU USE THIS FOR? WHAT DO YOU DO WITH IT?" Do not allow the patient to touch objects. If the patient does not understand the instructions, take an object which is not on the tray (e.g., button on the examiner's coat), give the correct answer and demonstrate its use at the same time (e.g., button the coat and say "For keeping the coat closed, for buttoning the coat", etc.). If the patient responds by giving a partially correct response (e.g., light bulb "on the ceiling") ask for more details; in formulating questions, the examiner may use the information given in the patient's response but he should avoid giving additional cues (e.g., he may say "What do you do with it on the ceiling?") Do not ask further questions if the patient fails to improve his response after the first question. Record verbatim.

The following responses and all responses which contain essentially the same information are scored as correct:

Tray C

(1) shooting, playing

(2) eating

(3) screw it in a socket, light a room, see with it

(4) turn screws

(5) wipe, clean

(6) measure

(7) mix food

(8) keep screen door shut

Tray D

(1) see what time it is, tell time

(2) to see, read

(3) eating

(4) shaving

(5) light fire, cigarette, etc.

(6) send letter in, mail

(7) write

(8) stick, glue together, patch up

All objects of Tray C are given. If 1-7 errors occur, all objects of Tray D are also administered.

Scoring:

Score 1 for every item for which a correct description of use is given. Grammatical errors are disregarded.

Multiply the score by 2 if only Tray C has been given. No corrections for age and educational level are applied in this test. Maximum score = 16.

Test 3. TNR TACTILE NAMING, RIGHT HAND (TRAYS A AND B)

Objects are presented by placing them firmly into the patient's hand under a rectangular box which is covered by a curtain on the side of the patient and which is open at the side of the examiner (see fig. 3, p.16). "NOW I WANT YOU TO PUT YOUR RIGHT HAND BEHIND THIS CURTAIN. I WILL GIVE YOU AN OBJECT AND I WANT YOU TO FEEL IT AND TELL ME WHAT IT IS. HANDLE IT AND FEEL IT FROM ALL SIDES BUT DO NOT TRY TO LOOK AT IT." With some apprehensive patients it is advisable to explain that the screen merely hides the object from view (demonstrate by showing the back of the box).

The eight objects of Tray A are presented. The test is terminated if the patient shows either complete success or failure, i.e., if he names all eight objects correctly or fails to name at least one object correctly. If the patient makes 1-7 errors in naming the objects of Tray A, the eight objects of Tray B are presented. Thus Test 3 may consist of eight or sixteen items, depending upon the level of the patient's performance on Tray A.

Recording and Scoring

Detailed recording of the patient's responses is essential, especially in the case of spontaneous corrections. The criteria for scoring and the notations to be made on the answer sheet are as follows:

Give a score of 1 for each correct response, i.e., those names given on the record sheet. Slang or childish words (e.g., "pinchers' for tweezers) are generally not acceptable. Make a verbatim recording of any incorrect responses made before the correct name is produced. Make a notation, "d", if the response is delayed (i.e., produced only after five or more sec.).

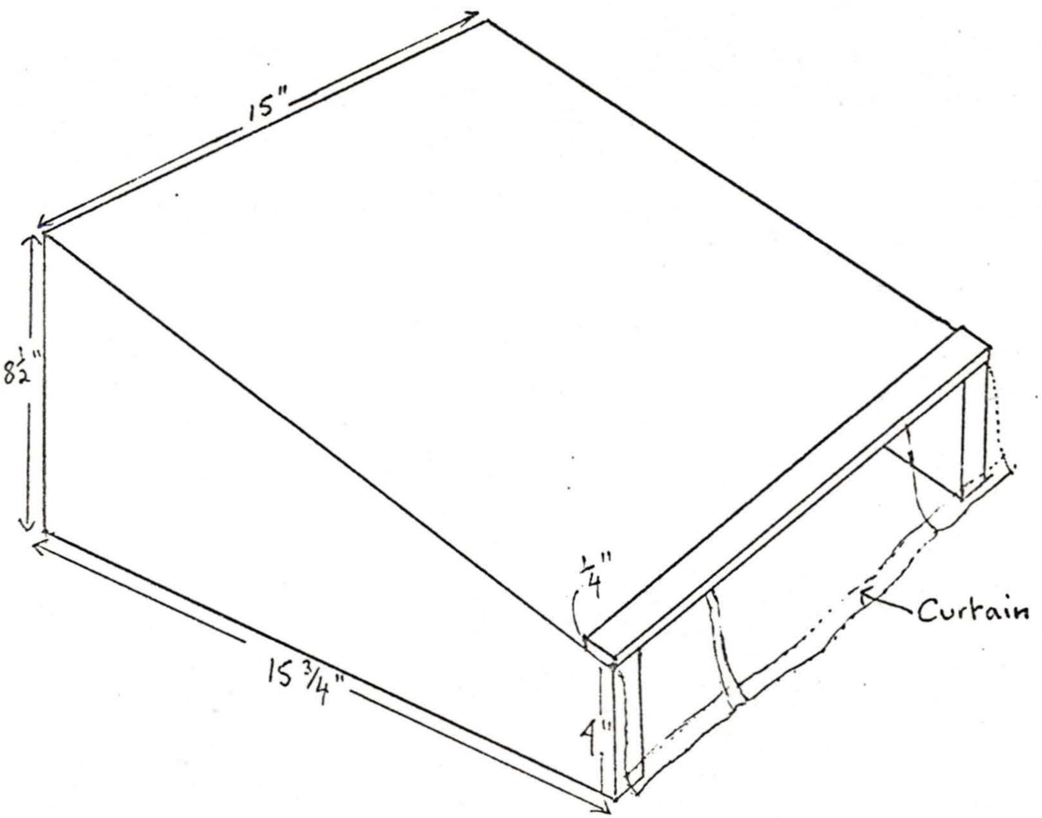

Fig. 3

Spontaneously corrected misnamings are counted as correct responses. Poor articulation is disregarded as long as the word is clearly recognizable and offers no possibility for misinterpretation. E.g., "pate" for plate is acceptable but "pape" is not; "tweeser" for tweezers is acceptable but "stevers" is not. Incorrect responses of this type are noted as "PP" (phonemic paraphasia). Admittedly there is a subjective element in the judgment of the examiner on this point. The guiding principle here should be whether or not a naive observer hearing the patient's utterance would immediately know which object is being named.

Give a score of 0 for each incorrect response (no response, unrecognizable response, "don't know" response, perseveration, misnaming). Misnamings that are semantically related to the object (e.g., shaver for razor; globe for light bulb; pencil for pen; hair for comb; knife for spoon) are noted as "SP" (semantic paraphasia). If the patient indicates recognition of the incorrectness of his response, write "No" after the misnaming.

If the patient misnames in response to questioning by the examiner of a partially correct response, score as a misnaming (e.g., patient says "wire" in naming the screen and, when questioned, responds with "brush"). If both a misnaming and a "don't know" response are given, score as a misnaming and write "No" after it.

If the patient fails to name an object correctly, but is able to identify the object clearly by a description of use, by "idiosyncratic" responses (e.g., "shaver' for razor, also "pencil" for pen <u>if this response was used in visual naming</u>) or by gestures, check under remarks and note the response verbatim. This additional score assesses tactile recognition and determines whether additional control tests (C 1 and C 2) should be given, as described later in this manual.

Incorrect responses or mispronunciations should be noted verbatim in the response column. Score should be multiplied by 2 if only the eight items of Tray A have been administered. No corrections for age or education are applied to this test. Maximum score = 16.

Test 4. TNL TACTILE NAMING, LEFT HAND. (TRAYS C AND D)

Repeat procedure for left hand with objects of Tray C. If errors occur, use objects of Tray D. Score as described for Test 3.

Test 5. SR SENTENCE REPETITION

The patient is seated about seven feet from a table with a playback loudspeaker contained in or connected with a tape recorder. Playback volume should be set at comfortable hearing level (approx. 70 db) and may be increased for hard-of-hearing patients.

"I AM GOING TO PLAY SOME SENTENCES (point to loudspeaker). LISTEN CAREFULLY, AND AFTER YOU HAVE HEARD EACH SENTENCE, REPEAT IT AS WELL AS YOU CAN. REMEMBER? LISTEN CAREFULLY, AND REPEAT THE SENTENCE RIGHT AFTER YOU HEAR IT." Repeat instructions if necessary and start tape recorder with Sentence Repetition Form A (Form B is an equivalent form used for repeated testing). Occasionally, the patient will not respond after hearing the first sentence. In this case, stop the tape and say "WOULD YOU REPEAT WHAT YOU HEARD?" If the patient responds, say "THAT'S RIGHT. DO THE SAME WITH EACH SENTENCE YOU HEAR." If the patient does not respond say "LISTEN CAREFULLY. THEN REPEAT WHAT YOU HEARD." Discontinue after five consecutive failures.

<u>Scoring</u>

A score of 1 is given for each sentence repeated correctly.* On sentences 1 through 10, failure on a single sentence is disregarded if the following five sentences are correctly repeated. Maximum raw score is 22.

Before the scores are entered into the profile sheet, the following corrections for age and educational level are applied:

Age:	< 35	0
	35 - 44	+1
	45 - 64	+2
	65+	+3
Educational level (successfully completed years of school or other formal education)	below grade 12	+2

MAXIMUM CORRECTED SCORE = 27

* Exception: Since "toward" in sentence 13, Form A, is often repeated as "towards", "towards" is accepted as correct.

Test 6. DRF REPETITION OF DIGITS

This test is administered according to the procedure of Blackburn and Benton (J. Consult. Psychol., 1957, 21, 139-143). Present the digits by tape. Start with Trial I of the 3-digit series for all subjects. "YOU WILL HEAR SOME NUMBERS ON THE LOUDSPEAKER. LISTEN CAREFULLY AND WHEN THE SPEAKER IS FINISHED, REPEAT THE NUMBERS JUST AS YOU HEARD THEM."

Give Trials I and II of each series, even if the patient passes the first trial. If the patient fails both trials of a series, proceed with the first trial of the next series. If he passes this trial, proceed with second trial and then with the next series accordingly. Discontinue after failure on three consecutive trials.

Scoring

Give a score of 1 for each trial passed. Maximum raw score is 14. Before entering these scores on the profile sheet, the following corrections both for age and educational level are applied, even if the raw score is 0.

Age:	40 - 55	+1
	56+	+2
Education:	16+	-2
	12 - 15	-1
	10 - 11	0
	6 - 9	+1
	5 or less	+2

MAXIMUM CORRECTED SCORE = 18

NOTE: The percentile ranks in the profiles are based on taped presentation. If digits have been presented orally, scores are not applicable. In general, scores from oral administration will be approximately 1 raw score point higher than from the taped presentation, as shown by a recent comparative study.

Test 7. DRR REVERSAL OF DIGITS

This test is also administered according to the procedure described by Blackburn and Benton. Present the digits by tape. Start with Trial I of the 2-digit series for all subjects. "NOW YOU WILL HEAR SOME MORE NUMBERS, BUT THIS TIME WHEN THE SPEAKER STOPS I WANT YOU TO SAY THEM BACKWARDS. FOR EXAMPLE, IF YOU HEAR "7-1" WHAT WOULD YOU SAY?" If the patient responds correctly, say "HERE ARE SOME OTHERS." If the patient fails the first example, correct him and give a second example saying, "REMEMBER, YOU ARE TO SAY THEM BACKWARDS: 4 - 9." After the patient's response, say "HERE ARE SOME OTHERS" and start the tape. Proceed as outlined for Test 6. Discontinue after three consecutive failures.

Scoring

Give a score of 1 for each trial passed. Maximum score is 14. Before entering the scores into the profile sheet, apply the corrections below.

Age:	40 - 55	+1
	56+	+2
Education:	16	-2
	12 - 15	-1
	10 - 11	0
	6 - 9	+1
	5 or less	+2

MAXIMUM CORRECTED SCORE = 18

Test 8. WF WORD FLUENCY

"I WILL SAY A LETTER OF THE ALPHABET. THEN I WANT YOU TO GIVE ME AS MANY WORDS THAT BEGIN WITH THAT LETTER AS QUICKLY AS YOU CAN. FOR INSTANCE, IF I SAY 'B', YOU MIGHT GIVE ME 'BAD, BATTLE, BED' .... I DO NOT WANT YOU TO USE WORDS WHICH ARE PROPER NAMES SUCH AS 'BOSTON, BOB, OR BRYLCREEM'. ALSO, DO NOT USE THE SAME WORD AGAIN WITH A DIFFERENT ENDING SUCH AS 'EAT AND EATING'. ANY QUESTIONS? (pause) BEGIN WHEN I SAY THE LETTER. THE FIRST LETTER IS F. GO AHEAD." Begin timing immediately after saying, "GO AHEAD."

Allow one minute for each letter. Say "FINE" or "GOOD" after each one minute performance. If the patient tends to discontinue before the end of the minute encourage him to try to think of more words. If there is a silence of 15 seconds repeat the basic instructions, and the letter.

Administer three letters: F, A, and S.

Scoring

The score is the sum of all admissible words for the three letters. Inadmissible words produced under these instructions are not counted as correct. Before entering this score into the profile sheet, the following corrections must be applied.

Age:	below 54	0
	55 - 64	+3
Education:	12 - 15	0
	8 - 11	+4
	below 8	+9

Test 9. SC SENTENCE CONSTRUCTION

"I WOULD LIKE YOU TO MAKE UP A SENTENCE USING THE TWO WORDS I WILL GIVE YOU. THE SENTENCE MAY BE SHORT OR LONG; JUST BE SURE IT CONTAINS EACH WORD I GIVE YOU. FOR EXAMPLE, IF I SAY 'WATER - POOL' YOU MIGHT SAY "THE WATER IS IN THE POOL. READY? 'SNOW - BOY.' GIVE ME A SENTENCE WITH THE WORDS 'SNOW' AND 'BOY'."

Repeat instructions if necessary, butgive no further demonstrations or help. Note time in seconds, beginning after the presentation of each set of words. If a patient's response does not contain both words, repeat the respective set once again. In this case, the time measurement includes the first and the second attempt as well as the repetition of the words.

1) snow - boy
2) hot - summer

After these tasks, say "NOW MAKE A SENTENCE WITH THESE THREE WORDS:"

3) bridge - walk - man
4) hair - water - girl
5) drive - street - car

Scoring

Any complete grammatically correct and meaningful sentence is given a credit of 3. The words need not be used in the order of presentation. Appropriate articles, prepositions and adjectives must be included. Change of tense or person is accepted as a correct response. "Grammatically correct" should be interpreted liberally. For example, "ain't", is generally accepted as is "good" for "well" in most instances, but omissions of essential parts of speech (telegram-style) is not. One point credit is added, if a sentence is completed within 20 seconds. Two points are added, if the sentence is completed within 10 seconds. No corrections for age or educational level are necessary. Maximum score = 25.

Test 10. IN IDENTIFICATION BY NAME (TRAYS A AND B)

Objects are presented on the tray, which is placed within easy reach of the patient. "I WOULD LIKE YOU TO POINT TO THE OBJECTS WHICH I NAME. WHICH ONE IS THE COMB? POINT TO THE COMB." If the patient has difficulty in understanding the instructions, guide his hand to the tray and point with index finger at objects (but do not point at a specific object), repeating "COMB". All words may be repeated once if the patient requests it or if he does not seem to understand the word. Do not allow the patient to handle the objects.

Administer all objects of Tray A. If 1 - 7 errors occur, present all objects of Tray B.

Scoring

A score of 1 is given for each item identified correctly. No correction for age or educational level is made. The obtained raw score is multipled by 2 if only one tray has been administered. Maximum score = 16.

IDENTIFICATION BY SENTENCE (TOKEN TEST)

Use questions on answer sheet and 20 tokens (white, yellow, blue, green, and red, large and small, circles and squares). Present tokens in the order shown in Fig. 4, and ask the first question "SHOW ME A CIRCLE"; pronounce clearly and slowly. Instructions for parts A and B may be repeated once. No other instructions may be repeated. If the patient makes no response he should be encouraged to make at least a partial response (e.g., if he says that he does not remember or asks for repetition of instructions, say "DO IT AS I SAID. DO AS MUCH AS YOU REMEMBER."). Discontinue after three consecutive failures (i.e., on sections A, B and C, if no part of the question received credit, on section D, if only one part, and on sections E and F if only two parts received credit).

The first section (questions 1 through 7) also provides a gross check on color-blindness affecting performance on this test. If difficulties in color recognition are noticed, further examination with the Ishihara plates or a similar test of color-blindness is necessary. If gross color-blindness is established both on this test and by a color-vision test, the test should be omitted.

Scoring

Give 1 point credit for each part of a question correctly performed. E.G., the correct performance of questions 1 to 7 receives 1 credit each, the correct performance of questions 12 through 15 ('small, white circle') receives 3 credits each. For questions 24 to 39 the verb and the preposition as well as the correct token receive credit (e.g., "Put the red circle on the green square" = 6 credits). Occasionally a preposition may be interpreted in several ways; e.g., item 25 'behind' may be viewed as away from the patient or as right of the yellow circle. In these instances any reasonable interpretation of the preposition is accepted and scored as correct. If the test has been discontinued, prorate the remaining items of that section on the basis of the patient's performance on the administered items. If all or most items of sections B, C, D, E and/or F have not been given because of previous failures, add a score of 3 for part B, of 5 for part C, of 6 for part D, of 9 for part E and of 18 for part F. No correction for age and eductional level is necessary. Maximum score = 163.

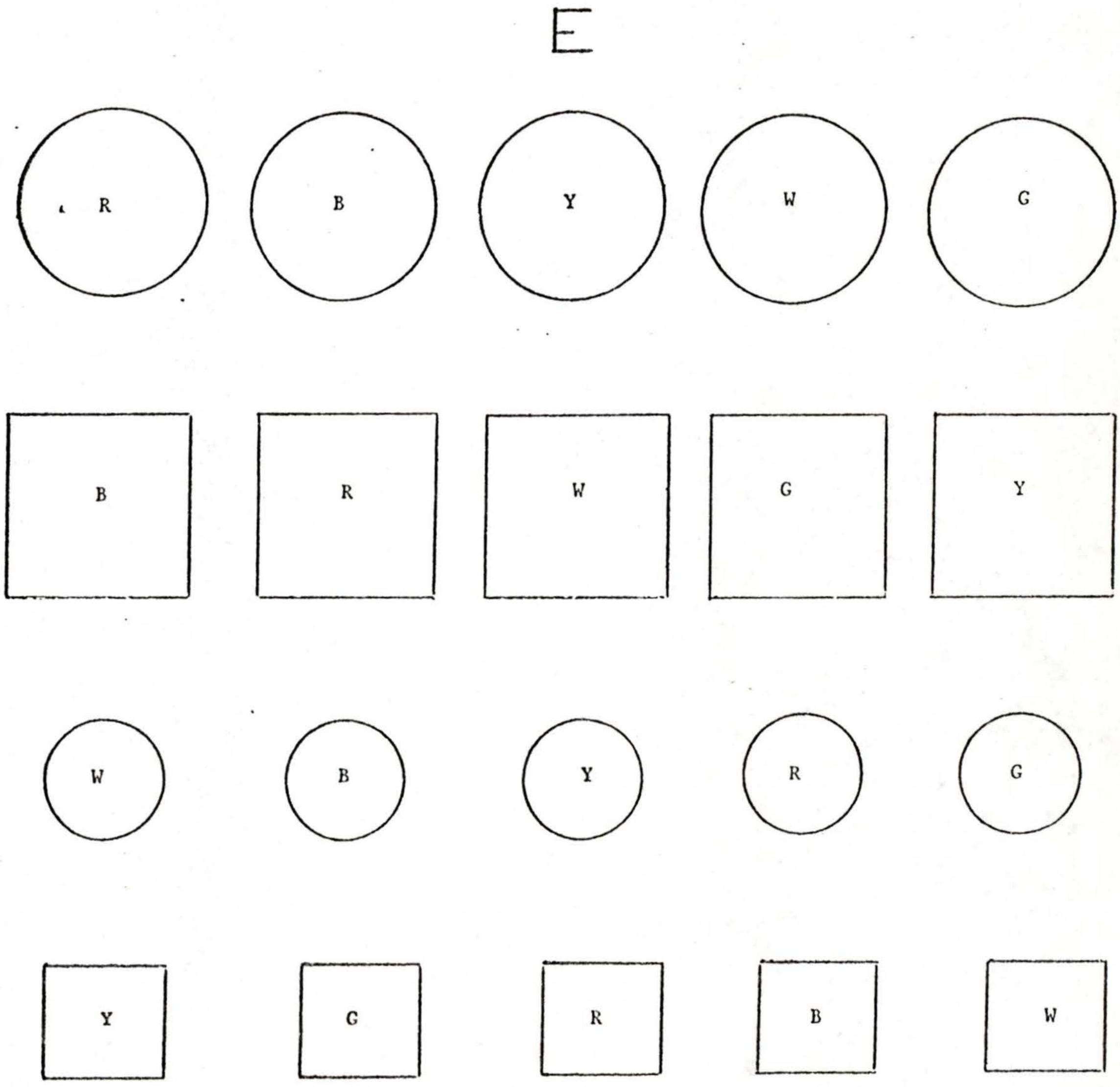

Figure 4

Test 12. RNO ORAL READING (NAMES)

Present the reading cards one at a time. "READ THIS ALOUD." Instruction may be repeated. This test does not have a simple pass-fail score and the 0-1-2 scoring must be applied during the actual administration.

If 1-4 errors occur on the first set of five cards, present the second set. The test may be discontinued after three consecutive incorrect responses.

Scoring

Score 2 for every word pronounced correctly. If the word is mispronounced but is intelligible, score 1. Score 0 for unintelligible or incorrect responses. If test has been discontinued because of three consecutive failures, the subsequent items receive a score of 0. Multiply the score by 2 if only one tray has been given. No correction for age or educational level is applied to this test. Maximum score = 20.

Test 13. RSO ORAL READING (SENTENCES) (Reading Cards, Tokens)

Test 15. RSP READING SENTENCES FOR MEANING (POINTING) (Tokens)

Test 13 and 15 are administered simultaneously. Display tokens in front of the patient in order shown in Fig. 4. Present the first reading card. "READ THIS ALOUD, THEN DO WHAT IT SAYS ON THE CARD." If necessary, this instruction may be repeated or elaborated during the course of the test. If reading aloud presents serious difficulties, the patient should be permitted to read silently and perform all commands first; cards may then be presented again with the instruction to read aloud.

Either test may be discontinued after three consecutive failures to make a response.

Scoring

Test 13: Score 2 for every sentence read correctly. Articulation errors are disregarded. A single misread word if spontaneously corrected, is not counted as an error. Score 1 if two or more mispronunciations and/or one other error (e.g., word substitution, unintelligible response, or omission) occurs. Score 0 for 2 or more errors other than spontaneously corrected misreadings. Maximum score = 16.

Test 15: The same answer sheet is used. Score 1 for each part of a question performed correctly, i.e., the correct performance of questions 1 and 2 receives 1 credit each, the correct performance of questions 9 through 12 ('small, white circle') receives 3 credits each. Maximum score = 17.

No correction for age and educational level are necessary for Test 13 and 15.

Test 14. RNP READING NAMES FOR MEANING (POINTING) (TRAYS A AND B)

For the convenience of the examiner, this test may be administered after Test 12. Display Tray A in front of the patient and present the five reading cards, one at a time. "SHOW ME THIS OBJECT." This instruction may be repeated once.

If 1-4 errors occur, all cards with names of objects on Tray B should be presented. However, the test may be discontinued at any time after three consecutive incorrect responses.

Scoring

Score 1 for every correct identification. If test has been discontinued, subsequent items receive a score of 0. Multiply the score by 2 if only 1 set of cards has been given. No correction for age or educational level is applied to this test. Maximum score = 10.

Test 16. VGN VISUAL-GRAPHIC NAMING (TRAY C)

Test 17. WN WRITING NAMES

Give the patient a sheet of unruled paper and a pencil. Present the first object of Tray C. Do not handle it in any way which would indicate its use. Do not let the patient handle it. "WRITE THE NAME OF THIS OBJECT." Encourage partial responses. If the patient wants to correct his response or if the word is completely illegible, instruct him to rewrite the word. Indicate the first attempts with brackets. Do not permit erasures. If the patient writes a word other than the first one given on the answer sheet, supply the preferred word and ask him to write it as well. Discontinue after three complete failures, i.e., 0 scores on Test 17.

If the patient does not respond within 30 sec. and name-finding difficulties are suspected, supply the name and ask the patient to write it. Note that the word was supplied.

If motor impairment does not permit the patient to write with his preferred hand, encourage him to use his non-dominant hand. If writing is impossible with either hand, the following substitute task may be given.

Block Letter Spelling: Present the following 13 block letters (from a set of "Scrabble") in alphabetical order: C E G I L N O P P R R S U. Present the ring, cup, sponge, ruler and spring from Trays A and C one at a time and ask the patient to spell the name of each. If he does not recall the name, supply it, recording this fact as described above. Restore alphabetical order of block letters after each response. Record response exactly. Spelling with block letters is a substitute task which does not produce a score comparable to the written naming score of this test. Interpretation of performance is on an impressionistic basis and should be done with caution.

Scoring

Test 16: A score of 1 is given for each object named correctly by writing. Spelling errors, reversal of letters and other writing errors are disregarded as long as the response is intelligible. Phonetic spelling ("scicer" or "sissors" for scissors, "ruller," "srw drive," etc.) is also accepted. Give no credit for words supplied by the examiner. No correction for age and education is made on Test 16. Maximum score = 8.

Test 17: This test is a rescoring of the graphic responses of Test 16 in terms of adequacy of writing. All eight items of Tray C are scored irrespective of whether the name was produced spontaneously or after prompting.

Score 3 for every correct name spelled correctly. Compound words, e.g. egg beater, screwdriver, etc. are acceptable if spelled as one or two words or with a hyphen. Score 2 for words containing one spelling error; score 1 for words with two spelling errors. Score 0 for words which are incomplete or unrecognizable, and for words with more than two spelling errors (a reversal of two letters is scored as two spelling errors). Maximum raw score is 24.

No correction for age is made. The following corrections for educational level should be made before the scores are entered into the profile sheet:

Educ.	8 and more years	0
Educ.	7 years	+2
Educ.	5 years or less	+4

MAXIMUM CORRECTED SCORE = 28

Test 18. WD WRITING TO DICTATION

Give the patient a sheet of unruled paper and a pencil. Ask him to write his name first. "WE WILL DO SOME MORE WRITING NOW. WRITE DOWN WHAT I SAY." Dictate the following text slowly. Repeat parts of the text (word by word, if necessary) if the patient requests it or if it becomes obvious that he has missed some of the text. Do not give any aid in spelling. If the patient says he does not know how to spell a given word, say, "JUST WRITE IT DOWN AS YOU HEAR IT. IT IS NOT IMPORTANT THAT THE SPELLING OF EVERY WORD BE CORRECT."

> Dictation Text:
>
> This is a very nice day.
> This brick building was built last year.

This test may be discontinued if the patient cannot write the first four words in a recognizable manner (i.e., 0-score).

Scoring

Score 1 for every word correctly spelled and legible. Legibility is judged generously, particularly in patients with motor disability. If the letter remains recognizable, disregard angular distortions, small additional movements, omission of i-dots, corrections, "dashing", i.e., almost straight lines for lower case letters with approximate allowance of space as in hasty writing, consistent "idiosyncratic" forms, i.e., looping, fancy strokes, failure to capitalize first letter of a sentence.

Score .5 for words which are correct except for one additional up-and downstroke and for words within a sentence beginning with a capital letter. These capitalizations should be scored as 1/2 point only if the capitalization is clearly recognizable. If all letters are capitalized, give a score of .5 for each word.

Score 0 for illegible, incomplete or otherwise incorrect words, e.g., letter reversals, additions and word substitutions.

Subtract 1 point for any duplicated or added words after all correctly written words are counted.

Maximum raw score is 13. Before the scores are entered into the profile sheet, the following corrections must be applied.

age	49 or less	50+
educ < 7	+2	+1
educ 7-8	+1	+1
educ > 8	0	+1

MAXIMUM CORRECTED SCORE = 15

Test 19. WC WRITING FROM COPY (Cards with text)

The patient may continue on the same sheet of paper used in Test 14. Present the first card. "I WOULD LIKE YOU TO COPY THIS. WRITE THIS SENTENCE." Encourage even fragmentary responses. Do not give aid.

Copying text:	
Card 1:	I am very hungry.
Card 2:	The color of the walls is green.

Test may be discontinued if he cannot copy the first sentence in a recognizable manner (i.e., 0-score).

Scoring

Score 1 for every word correctly spelled and legible. Legibility is judged generously, particularly in patients with motor disability. If the letter remains recognizable, disregard angular distortions, small additional movements, omission of i-dots, corrections, "dashing", i.e., almost straight lines for lower case letters with approximate allowances of space as in hasty writing, consistent "idiosyncratic" forms, i.e., looping, fancy strokes, failure to capitalize first letter of a sentence.

Score .5 for words which are correct except for one additional up- and downstroke and for words within a sentence beginning with a capital letter. These capitalizations within a sentence should be score as 1/2 point only if the capitalization is clearly recognizable. If all letters are capitalized, give full credit (in contrast to the scoring on Test 18).

Score 0 for illegible, incomplete or otherwise incorrect words, e.g., letter reversals, additions and word substitutions.

Subtract 1 point for each duplication after all correctly written words are counted.

Maximum raw score is 11. Before the scores are entered into the profile sheet the following corrections must be applied:

age	49 or less	50 +
educ < 7	+2	+1
educ 7-8	+1	+1
educ > 8	0	+1

MAXIMUM CORRECTED SCORE = 13

Test 20. ART ARTICULATION

The thirty-eight speech stimuli are presented by tape at a comfortable hearing level. "YOU WILL HEAR SOME WORDS. I WOULD LIKE YOU TO REPEAT EACH WORD LOUDLY AND CLEARLY." The first three words on the tape are presented with the carrier phrase "REPEAT THE WORD..."

After the first 30 words, i.e., after the stimulus "understand", the examiner should stop the tape briefly and say, "THE NEXT WORDS HAVE NO MEANING. JUST REPEAT THEM THE WAY YOU HEAR THEM."

Responses should be scoredduring the actual administration of the test.

Scoring

Score only the pronunciation of consonants and consonant blends listed on the record sheet.

Mark errors as follows:

0	circle	phoneme substitution (and note the substituted sound above the word)
/	slash	through omissions
X	cross	through distortions

Disregard spontaneously corrected errors.

The total score is the number of consonants and blends pronounced correctly. Before entering the score into the profile sheet, the following corrections are applied.

Educ.	8	+2
Age	56 - 65	+2

Maximum raw score = 100
MAXIMUM CORRECTED SCORE = 104

Test C 1 TMR TACTILE VISUAL MATCHING

Right Hand. (Tray A + B)

Administer this test if any errors occur on Tests 3 and 4 (Tactile Naming). Do not administer in cases of severe motor or sensory impairment of the right hand. No corrections for age or education are necessary. Mild sensory loss usually does not affect performance, but will have to be considered in the interpretation of test results.

Place objects firmly into patient's hand under a rectangular box covered by a curtain at the side of the patient as shown in Fig. 3 of this manual (p. 16). "PUT YOUR RIGHT HAND UNDER THE CURTAIN. I WILL GIVE YOU AN OBJECT. I WANT YOU TO FEEL IT AND THEN POINT TO THE SAME OBJECT ON THE TRAY (A second set of Tray B is placed on top of the box). HANDLE IT AND FEEL IT FROM ALL SIDES BUT DO NOT TRY TO LOOK AT IT."

Give all objects of Tray A. If 1-7 errors occur, present all objects of Tray B.

Scoring:

Score 1 for each object correctly matched. Multiply the obtained score by 2 if only Tray A has been given. Maximum score = 16.

Test C 2 TML TACTILE VISUAL MATCHING

Left Hand. (Tray C + D)

Have the patient place his left hand into the box. Proceed as directed in Test Cl, beginning with the objects of Tray C. If 1-7 errors occur, use Tray D.

Scoring

As directed in Test C 1. Maximum score = 16. No corrections for age or education are applied to this test.

Test C 3 VVM VISUAL VISUAL MATCHING

(Tray A + B)

Administer this test if any errors occur on visual naming (Test 1) or tactile visual matching (Test C 1 or C 2).

Place Tray A in front of patient and a second set of Tray A behind it. The position of the second tray should be reversed, i.e., the side marked "examiner" should be facing the patient, whereas the first tray is placed in standard position. "NOW I WILL POINT TO SOME OF THE OBJECTS ON THIS TRAY (point in the direction of second tray near the examiner) AND I WANT YOU TO POINT TO THE SAME OBJECTS ON THIS TRAY (point in the direction of the tray in front of patient). CAN YOU SHOW ME THE SAME OBJECT ON THE TRAY? Point to the first object (comb) on the tray next to the patient. If patient does not understand instructions, demonstrate by holding up one object and guiding patient's hand to the same object on the tray next to him.

If 1-7 errors occur on Tray A give Tray B.

Scoring

Score 1 for each object correctly matched. Multiply the obtained score by 2 if only Tray A has been given. No corrections for age or education are necessary. Maximum score = 16.

Test C 4 FP FORM PERCEPTION

Administer this test to all subjects who fail any item on the four reading tasks (Test 12: Reading Names, Oral; Test 13: Reading Sentences, Oral; Test 14: Reading Names, Point; Test 15: Reading Sentences, Point).

Display the upper half of the multiple-choice card of letters at reading distance. Present the first letter (T) on a separate card. "FIND THIS LETTER ON THIS CARD." If necessary, instructions may be given by gestures. Discontinue if no errors occur on the first eight items. If any errors occur, give items 9 through 16 (on reverse side of cards) displaying the reverse side of the multiple-choice card. Items 15 and 16 are not on the multiple-choice card.

Scoring

Give one point for every item correctly identified. Items 15 and 16 are scored as correct if S indicates that they are not on the card. Multiply by two if only the first part has been given. No corrections for age or education are necessary. Maximum score = 16.

NEUROSENSORY CENTER COMPREHENSIVE EXAMINATION FOR APHASIA

(NCCEA)
Edition A

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University of Victoria

and

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University of Iowa

ANSWER BOOKLET

Name					
Address					
Age		Handedness		File No.	
Education				Date	
Examiner					

Produced and distributed by
Neuropsychology Laboratory
Department of Psychology
University of Victoria

Test 1. VISUAL NAMING

(Give A. If between 1 and 7 errors occur, give B.)

Tray A	Response	Error Type	Score
comb			
ring			
key			
cup			
ashtray			
thimble			
padlock			
paper clip			
		TOTAL A	

Tray B	Response	Error Type	Score
knife			
fork			
bottle, baby bottle			
shoelace, shoestring			
brush			
jar			
can opener, bottle opener			
tweezers			
		TOTAL B	
		TOTAL A & B	

Test 2. DESCRIPTION OF USE

(Give C. If between 1 and 7 errors occur, give D.)

Tray C	Response	Score
shooting, playing		
eating		
screw it in a socket, light a room, see with it		
turn screws		
wipe, clean, & soap		
measure		
mix food		
keep screen door shut		
	TOTAL C	

Tray D	Response	Score
see what time it is, tell time		
to see, read		
eating		
shaving		
light fire, cigarette, etc.		
send letter in, mail		
write		
stick, glue together, patch up		
	TOTAL D	
	TOTAL C & D	

Test 3. TACTILE NAMING, RIGHT HAND

(Give A. If between 1 and 7 errors occur, give B.)

Tray A	Response	Error Type	Score
comb			
ring			
key			
cup			
ashtray			
thimble			
padlock			
paper clip			
		TOTAL A	

Tray B	Response	Error Type	Score
knife			
fork			
bottle, baby bottle			
shoelace, shoestring			
brush			
jar			
can opener, bottle opener			
tweezers			
		TOTAL B	
		TOTAL A & B	

Test 4. TACTILE NAMING, LEFT HAND

(Give C. If between 1 and 7 errors occur, give D.)

Tray C	Response	Error Type	Score
pistol, gun			
plate, saucer, dish			
bulb, light bulb			
screw driver			
sponge			
ruler			
egg beater, mixer			
spring			
		TOTAL C	

Tray D	Response	Error Type	Score
watch			
eyeglasses, glasses			
spoon			
razor			
matchbook, matches			
envelope			
pen, ballpoint			
scotch tape, tape			
		TOTAL D	
		TOTAL C & D	

Test 5. SENTENCE REPETITION

1.	Look	
2.	Come here.	
3.	Help yourself.	
4.	Bring the table.	
5.	Summer is coming.	
6.	The iron was quite hot.	
7.	The birds were singing all day.	
8.	The paper was under the chair.	
9.	The sun was shining throughout the day.	
10.	He entered about eight o'clock that night.	
11.	The pretty house on the mountain seemed empty.	
12.	The lady followed the path down the hill toward home.	
13.	The island in the ocean was first noticed by the young boy.	
14.	The distance between these two cities is too far to travel by car.	
15.	A judge here knows the law better than those people who must appear before him.	
16.	There is a new method in making steel which is far better than that used before.	
17.	This nation has a good government which gives us many freedoms not known in times past.	
18.	The friendly man told us the directions to the modern building where we could find the club.	
19.	The king knew how to rule his country so that his people would show respect for his government.	
20.	Yesterday he said he would be near the village station before it was time for the train to come.	
21.	His interest in the problem increased each time that he looked at the report which lay on the table.	
22.	Riding his black horse, the general came to the scene of the battle and began shouting at his brave men.	

TOTAL SCORE	
CORRECTION	
TOTAL CORRECTED SCORE	

Test 6. REPETITION OF DIGITS

(Record actual performance)

Digits forward	Score
5–8–2	3
6–9–4	3
6–4–3–9	4
7–2–8–6	4
4–2–7–3–1	5
7–5–8–3–6	5
6–1–9–4–7–3	6
3–9–2–4–8–7	6
5–9–1–7–4–2–8	7
4–1–7–9–3–8–6	7
5–8–1–9–2–6–4–7	8
3–8–2–9–5–1–7–4	8
2–7–5–8–6–2–5–8–4	9
7–1–3–9–4–2–5–6–8	9
SCORE	
CORRECTION	
CORRECTED SCORE	

Test 7. REVERSAL OF DIGITS

(Record actual performance)

Digits backward	Score
2–4	2
5–8	2
6–2–9	3
4–1–5	3
3–2–7–9	4
4–9–6–8	4
1–5–2–8–6	5
6–1–8–4–3	5
5–3–9–4–1–8	6
7–2–4–8–5–6	6
8–1–2–9–3–6–5	7
4–7–3–9–1–2–8	7
9–4–3–7–6–2–5–8	8
7–2–8–1–9–6–5–3	8
TOTAL SCORE	
CORRECTION	
TOTAL CORRECTED SCORE	

Test 8. WORD FLUENCY

	F	A	S
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Sum F________ Sum A ________ Sum S ________

TOTAL________

CORRECTION________

TOTAL CORRECTED SCORE________

Test 9. SENTENCE CONSTRUCTION

	Circle Obtained Score			
	greater than 20"		within 20"	within 10"
1. snow – boy	0	3	4	5
2. hot – summer	0	3	4	5
3. bridge – walk – man	0	3	4	5
4. hair – water – girl	0	3	4	5
5. drive – street – car	0	3	4	5
			TOTAL	

Test 10. IDENTIFICATION BY NAME

(Give A. If between 1 and 7 errors occur, give B.)

Tray A	Response	Error Type	Score
comb			
ring			
key			
cup			
ashtray			
thimble			
padlock			
paper clip			
		TOTAL A	

Tray B	Response	Error Type	Score
knife			
fork			
bottle, baby bottle			
shoelace, shoestring			
brush			
jar			
can opener, bottle opener			
tweezers			
		TOTAL B	
		TOTAL A & B	

Test 11. IDENTIFICATION BY SENTENCE (TOKEN TEST)

A. Present tokens as in Fig. 4.	Instructions may be repeated once	
1.	Show me a circle	
2.	Show me a square	
3.	Show me a yellow one	
4.	Show me a red one	
5.	Show me a blue one	
6.	Show me a green one	
7.	Show me a white one	
	TOTAL A(7)	

B. Present only large tokens.	Instructions may be repeated once	
8.	Show me the yellow square	
9.	Show me the blue circle	
10.	Show me the green circle	
11.	Show me the white square	
	TOTAL B(8)	

C. Present all tokens as in Fig. 4	Do not repeat instructions	
12.	Show me the small white circle	
13.	Show me the large yellow square	
14.	Show me the large green square	
15.	Show me the small blue square	
	TOTAL C(12)	

D. Present large tokens only.	Do not repeat instructions	
16.	Take the red circle and the green square	
17.	Take the yellow square and the blue square	
18.	Take the white square and the green circle	
19.	Take the white circle and the red circle	
	TOTAL D(16)	

E. Present all tokens as in Fig. 4.	Do not repeat instructions	
20.	Take the large white circle and the small green square	
21.	Take the small blue circle and the large yellow square	
22.	Take the large green square and the large red square	
23.	Take the large white square and the small green circle	
	TOTAL E(24)	

Test 11. (continued)

F. Present large tokens only. Do not repeat instructions.	
24. Put the red circle on the green square.	
25. Put the white square behind the yellow circle.	
26. Touch the blue circle with the red square.	
27. Touch the blue circle and the red square.	
28. Pick up the blue circle OR the red square.	
29. Move the green square away from the yellow square.	
30. Put the white circle in front of the blue square.	
31. If there is a black circle, pick up the red square.	
32. Pick up all squares except the yellow one.	
33. Put the green square beside the red circle.	
34. Touch the squares slowly and the circles quickly.	
35. Put the red circle between the yellow square and the green square.	
36. Touch all circles, except the green one.	
37. Pick up the red circle --no-- the white square.	
38. Instead of the white square, pick up the yellow circle.	
39. Together with the yellow circle, pick up the blue circle.	
TOTAL F(96)	
TOTAL A-F (163)	

Test 12. ORAL READING (NAMES)

(Give Set 1. If between 1 and 4 errors occur, give set 2.)

Set 1	Response	Score
pistol		
bulb		
screwdriver		
sponge		
spring		
	TOTAL SET 1	

Set 2	Response	Score
watch		
razor		
matches		
envelope		
scotch tape		
	TOTAL SET 2	
	TOTAL SET 1 & 2	

Test 13. ORAL READING (SENTENCES)

Test 15. READING SENTENCES FOR MEANING (POINTING)

	Test 13		Test 15	
1. Show me a circle.				
2. Show me a square.				
3. Show me a small circle.				
4. Show me a yellow square.				
5. Show me a white square.				
6. Show me a small white circle.				
7. Show me a large yellow square.				
8. Show me a small blue square.				
TOTAL				

Test 14. READING NAMES FOR MEANING (POINTING)

(Give Set A. If between 1 and 4 errors occur, give Set B.)

Tray A	Response	Score
comb		
ring		
cup		
ashtray		
padlock		
	TOTAL A	

Tray B	Response	Score
knife		
bottle		
brush		
shoelace		
tweezers		
	TOTAL B	
	TOTAL A & B	

Test 16. VISUAL-GRAPHIC NAMING

Test 17. WRITING OF NAMES

(S should write the first word listed. If S writes an alternate word, he should then be asked to write the first word.)

Tray C	Test 16	Check if Name Supplied	Test 17
gun, pistol, revolver			
plate, saucer, dish			
bulb, light bulb			
screwdriver			
sponge			
ruler			
egg beater, mixer			
spring			
TOTAL SCORE			
		CORRECTION	
		TOTAL CORRECTED SCORE	

Test 18. WRITING TO DICTATION

	Score
This is a very nice day.	
This brick building was built last year.	
TOTAL SCORE	
CORRECTION	
TOTAL CORRECTED SCORE	

Test 19. WRITING (COPYING)

	Score
I am very hungry.	
The color of the walls is green.	
TOTAL SCORE	
CORRECTION	
TOTAL CORRECTED SCORE	

Test 20. ARTICULATION

(Mark each of the listed consonants or blends with: / = omission, 0 = substitution, X = distortion.)

rain	r - n	remember	r - m - mb -
tall	t - l	suddenly	s - d - nl -
nose	n - z	together	t - / - th -
tree	tr -	one thousand	/ - th - s - nd
dance	d - ns	tomorrow	t - / - r -
leg	l - g	Washington	w - sh - ngt -
teacher	t - tsh	animal	a - / - / - al
notice	n - / - s	direction	d - / - ksh
report	r - / - rt	natural	n - tsh - / - al
daughter	d - t -	realize	r - l - z
listen	l - sn	understand	/ - / - st - nd
service	s - rv -	zaratan	z - r - t - n
flower	fl - r	ladanat	l - d - n - t
shoulder	sh - ld -	tafazas	t - f - z - s
beautiful	bju - / - / - l	fazalar	f - z - l - r
continue	k - nt - nju	nataraf	n - t - r - f
condition	k - / - sh - n	saladez	s - l - d - z
discover	d - sk - v -	dazafad	d - z - f - d
family	f - / - l -	ranasal	r - n - s - l

SCORE	
CORRECTION	
TOTAL CORRECTED SCORE	

Test C1. TACTILE-VISUAL MATCHING, RIGHT HAND

(Give A. If between 1 and 7 errors occur, give B.)

Tray A	Response	Score
comb		
ring		
key		
cup		
ashtray		
thimble		
padlock		
paper clip		
	TOTAL A	

Tray B	Response	Score
knife		
fork		
bottle, baby bottle		
shoelace, shoestring		
brush		
jar		
can opener, bottle opener		
tweezers		
	TOTAL B	
	TOTAL A & B	

Test C2. TACTILE-VISUAL MATCHING, LEFT HAND

(**Give C.** If between 1 and 7 errors occur, give D.)

Tray C	Response	Score
pistol, gun		
plate, saucer, dish		
bulb, light bulb		
screwdriver		
sponge		
ruler		
egg beater, mixer		
spring		
	TOTAL C	

Tray D	Response	Score
watch		
eyeglasses, glasses		
spoon		
razor		
matchbook, matches		
envelope		
pen		
scotch tape, tape		
	TOTAL D	
	TOTAL C & D	

Test C3. VISUAL-VISUAL MATCHING

(Give A. If between 1 and 7 errors occur, give B.)

Tray A	Response	Score
comb		
ring		
key		
cup		
ashtray		
thimble		
padlock		
paper clip		
	TOTAL A	

Tray B	Response	Score
knife		
fork		
bottle, baby bottle		
shoelace, shoestring		
brush		
jar		
can opener, bottle opener		
tweezers		
	TOTAL B	
	TOTAL A & B	

Test C4. FORM PERCEPTION

(Give to all Ss who fail any item of the four reading tests – 12, 13, 14, 15)

Part 1		Score
1	T	
2	W	
3	Y	
4	R	
5	E	
6	G	
7	K	
8	S	
	TOTAL SCORE	

Part 2 (Give only if any errors occur on Part 1)		Score
9	2	
10	1	
11	9	
12	3	
13	7	
14	5	
15	$	
16	!	
	TOTAL SCORE	
	TOTAL OF PART 1 & 2	

Appendix F

Medical Data Check List

A NA

Sample _______

Subject # ____________ Name ______________________

Sex M F Birthdate ____________ Education ______

Handedness R L A

Hospital/Referral ______________ Dr(s) ______________________

____

Hospital Record # ______________ Hosp. Date ______________ (1st.)

______________ (last)

Date of onset of illness ____________ 1st. NCCEA ______________

Retest Yes ____________ No

Brain Damage

No bd. questionable minimal definite severe

Lateralization	Localization	Type
1 no information	1 no information	1 no information
2 undetermined	2 undetermined	2 undetermined
3 right	3 frontal	3 congenital
4 left	4 temporal	4 trauma (hematoma)
5 bilateral	5 parietal	5 infection
6 diffuse	6 occipital	6 vascular (aneurysm)
7 subcortical	7 fronto-temporal	7 neoplasm
8 normal	8 fronto-parietal	8 degenerative
	9 temporo-parietal	9 metabolic
	10 temporo-occipital	10 toxic
	11 parieto-occipital	11 anoxic
	12 diffuse	12 normal
	13 normal	

Information based on

EEG	Skull X-ray	Angiogram	Pneumo.	Echo.	Ventriculo.	Brain Scan
+ -	+ -	+ -	+ -	+ -	+ -	+ -

Neurologist's / Neurosurgeon's Report ______________________

Complicating Neurophysiological Conditions

motor sensory visual & diplopia other ______________

Diagnosis / Type of Aphasia ______________________________

Comments:

VITA

Surname: LAWRIW Given Names: IRYNA

Place of Birth: BRADFORD, YORKS., ENG. Date of Birth: JUNE 26, 1951

Educational Institutions Attended, with dates of Entering and Leaving:

YORK UNIVERSITY, DOWNSVIEW, ONTARIO 1970 to 1974

UNIVERSITY OF VICTORIA, B.C. 1974 to 1976

Degrees, Diplomas, Etc., Awarded, with Dates and Names of Institutions:

B.A. (First Class Honours) 1974 York University, Downsview, Ont.

Honours and Awards:

University of Victoria Scholarships, 1974/1975 and 1975/1976

N.R.C. Grant, 1976/1977

Publications: