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I hereby recommend that the thesis prepared under my supervision by _____ Harold Goodglass

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CORRELATES OF ABSTRACT BEHAVIOR IN APHASIA

An Application of Objective Tests to the
Study of Correlates of Abstract
Behavior in Aphasic Speech Disorders

A dissertation submitted to the
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TO MY WIFE, ZELDA

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Chapter I

Purpose of the Study

A. Problems and hypotheses

It is observed in cases of aphasia that injuries to the cerebrum may result in varying patterns of impairment in the use of language symbols. This fact offers a unique opportunity for psychological research, for in these circumscribed losses of communication skills, we have direct access to physiologically isolated units of mental ability. However, the lines of cleavage along which language functions are observed to break down with brain damage are hard to define. They are only grossly related to the conventional four-fold subdivision of language skills into reading, writing, speaking, and understanding speech. Thus, an aphasic may be unable to read a word aloud by itself or even repeat it after hearing it spoken, yet he may use it spontaneously in reply to a question or read it aloud as part of a phrase. Another patient may read aloud or repeat difficult nouns, verbs, or adjectives yet be unable voluntarily to say "of" or "the". In a third case, the inability to articulate may be limited principally to nouns. Obviously the terms "expressive aphasia" or "impairment of speech" neither describes nor explains any of these disabilities accurately.

Goldstein (8,9) has suggested that a loss of

capacity for abstract behavior* accounts for part of the seemingly illogical patterning of successes and failures in the performance of aphasic individuals. This follows from his position that the abstract attitude is a mode of adaptation which is manifested in all the activities of an individual. The background and evidence for this viewpoint as it affects language behavior will be discussed in the next chapter.

The present study is an investigation of two related problems: -- First, it seeks to discover whether a relationship can be shown objectively between abstract behavior and the conditions under which familiar words are most readily spoken. Second, it seeks to discover whether the degree of aphasic speech loss determines the conditions under which familiar words are most readily spoken. A series of word association subtests is used to obtain measures of each aphasic subject's proficiency in word-speaking under controlled conditions. The stimulus situations in these subtests have been structured so that some make definite demands on one or more of the elements of abstract behavior, while others can be responded to in relatively concrete fashion.**

With respect to the first major problem, the subjects' standings in the several speech tests are compared with their ranks on three separate non-verbal tests of abstracting behavior. The finding of significant relationships between the

* "Abstract behavior," "abstract attitude," and "abstraction" are used here with approximately identical meanings. Please consult definitions of terms on page 9.

** See definition of concrete on p. 11.

verbal and non-verbal tests would tend to answer the first problem affirmatively. It goes without saying that such relationships must be in the direction which one would predict from the structure of the speech subtests involved. Significant relationships, other than those predicted by the hypothesis, would simply be equivocal.

The establishment of a correlation between certain language performances and non-verbal measures of abstract behavior may indicate either of two possibilities: First, that the abstract attitude is required in order to fulfill the language tasks involved; second, that a lesion severe enough to produce the given language loss is also likely to interfere with abstraction. In order to support the former hypothesis, we would have to show a similar relationship between abstraction and speech performance in a group of non-aphasics. For this reason, a control group of twenty persons with established cerebral lesions, but without aphasia is employed in this study. This point is most important, since Goldstein's hypothesis clearly holds that certain speech tasks are failed because they demand an abstract attitude.

Three controllable factors in speech-demanding stimuli are suggested directly by the definition of abstract behavior. The following subproblems concern the effect of these speech-stimulus-factors on the speech performance of individuals of known standing in non-verbal abstraction.

First: Do persons who stand low in abstracting

capacity perform relatively adequately in speech situations where a stereotyped lead to the response word is given, as compared to situations lacking this feature? Few language responses involve less in the way of symbolic behavior than the automatic completion of a well-known phrase or word-series, such as "The American flag is red, white, and" In order to support the basic hypothesis that loss of abstract behavior modifies both language and non-language behavior analogously, we would have to show that the individuals whose language performance is most improved by the possibility of responding in concrete fashion are the same ones who score poorly on a non-verbal test of abstraction.

Second: Do persons who have impaired abstraction perform relatively well under stimulus conditions which restrict the field of possible reactions, as compared to conditions in which more loosely controlled associations are required? This hypothesis follows from the statement that abstraction is demanded in making a choice of response from a number of possibilities. Studies in reaction time have shown that motor reaction time increases with the number of choices from which the reaction is to be selected and that reaction times for controlled word associations are less than for uncontrolled association. However, no attempt has previously been made to study the relation of these phenomena to the loss of abstraction in brain injuries.

Third: Is loss of abstraction correlated with relative

inadequacy of speech response under conditions where a specific stimulus is not supplied for each word to be spoken? This condition is represented by subtests in which the task is to name as many words at random as possible within a given time. This speech situation, more than any other word-association task, requires the subject to assume voluntarily one mental set after another, as he hunts for words.

Three variables of speech stimuli have just been defined. All of them have to do with the degree of structuring of the stimulus. A review of the foregoing theoretical analysis shows that the looser stimulus-structure corresponds, in each case, to a greater presumptive need for abstract behavior. If positive relationships with the non-verbal criteria of abstraction are found for all three speech-stimulus-factors, we are justified in considering "independence of stimulus structuring" to be a correlate of abstract behavior in speech-demanding situations.

Up to this point, we have considered the findings which relate to the hypothesis that abstract behavior is a mode of adaptation which characterizes both language and non-language behavior. The second, more limited problem to be considered is one which skirts the question raised by the above, more radical one. This problem concerns the breakdown of performance only within the area of speech behavior. It is the question of whether the structure of the stimulus-situation affects speech performance more or less, depending on the degree of

loss of function. Specifically, do the same three factors in stimulus-structure already described best distinguish the near-normal in speech from the more severely aphasic? If this question can be answered affirmatively, we have demonstrated something quite apart from the issue of whether this is the same abstract behavior as we measure in the non-language tests. We establish in this way a criterion for predicting the difficulty of speech situations to aphasic patients.

A practical need which can be answered by the solution of this last issue is that of determining the features which must be controlled to make a given speech test item as simple as possible for the kind of function tested. This is a problem in the diagnostic testing of aphasics. In order to explore the channels for eliciting speech which are intact or impaired, it is necessary to present stimuli of controlled difficulty. A purpose of this study is to determine specifically whether the variations in stimulus structuring, applied in the fourteen speech subtests used here, provide a practical means of pre-determining the level of difficulty of a test for speech in aphasics. For example, can we show that word-reading is an easier visual stimulus for speech than is object naming? This conclusion is possible if the greatest superiority in 'reading' over 'naming' scores occurs among the most severely aphasic.

B. Limitations of the study

A single type of language performance has been selected

for observation because of its relative ease of quantitative evaluation. The function under study here is efficiency in speaking single-word responses which are appropriate to their respective stimuli. Efficiency is measured in terms of (1) an arbitrary time limit for replying; (2) appropriateness of the meaning of the response word; (3) intelligibility of articulation; (4) the subject's awareness that he has given a response. The findings of this research will have specific application only to this one phase of speech behavior. However, they will also have a direct value for the support or rejection of the basic hypotheses whose predictions we are testing. While this research does not relate specifically to the effects of aphasia on other aspects of language performance (e.g., grammatical speech, reading, auditory comprehension), it illustrates an experimental approach which may be applied to each of them.

The nature of the tasks required in this investigation limits our choice of aphasic subjects to those who have sufficient speech to achieve scoreable responses within the range of difficulty of the subtests of this battery. It further eliminates as subjects those who have so severe a sensory aphasia that they do not understand the spoken stimuli. The selection of aphasic subjects is further limited to forty-one who happened to be available in the speech rehabilitation programs of three Veterans' hospitals -- certainly no guarantee of a representative sampling of types

of aphasia. It may legitimately be argued that the tendencies emerging from these data are artifacts of a biased selection of aphasics in which there is scant representation of those with predominantly sensory or amnesic symptoms.* This objection would hold that the effects on performance which result here from the changes in stimulus structure are not representative of the performance of the sensory aphasic. The only remedy to this limitation is to inspect the scores of the few subjects with distinctly sensory symptoms and see whether they show consistent deviations from the group tendencies.

Another major limitation on the scope of this investigation concerns the nature of the speech-stimulus-variables. While the factors to be varied systematically have been defined, the construction of speech tests which embody these factors is a task surrounded by serious pitfalls and one which we are never sure of having truly carried out. To mention only two sources of error, gross and irrelevant variations in item difficulty may be introduced by using uncommon words or else by making the response depend on the solution of a little reasoning problem (e.g. "My brother's child is my child's") Therefore, the results hinge not only on the validity of the hypotheses being tested, but on the validity of the particular test instruments used as true applications of the hypotheses.

It is stressed that the controlled speech-stimulus-variables in this study are not to be confused with exploratory

* See definitions of these terms on p. 11.

variations of the sensory channels through which a response may be elicited. For example, the use of written words as test items is commonly thought of as a test of word-blindness (or visual verbal agnosia) -- a relatively infrequent occurrence in partly recovered aphasics, and one which happened to be present to a severe degree in only one of our subjects. In this study, written word-reading is contrasted with picture-naming only because it is a stimulus which offers fewer possible responses. (This point is further discussed on p.42). To the extent that a specific form of sensory aphasia, such as word-blindness, interferes with a subject's performance, irrelevant variability is introduced which lowers the apparent significance of the results as a whole.

C. Definitions of terms

A number of terms, including those in the title of this research, are either unfamiliar to the average reader or are used here in a special sense. Those listed below are to be understood always in terms of the meanings assigned to them in this section.

Abstract attitude - In Goldstein's sense (8, pp. 5-8), a hypothetical active, self-conscious orientation to the environment which can be adopted by normal people whenever necessary for meeting new situations; the attitude which accompanies abstract behavior.

Abstract behavior - A mode of adapting which is accompanied by a high degree of awareness and voluntary control, as

represented by the following: (a) assuming a mental set deliberately or beginning a performance voluntarily or on demand; (b) keeping in mind simultaneously more than one aspect of a situation so as to make a choice between possibilities or react to more than one aspect at a time; (c) abstracting common properties and thinking or performing symbolically.

Abstraction - This term is used to represent the writer's reconciliation of the concept of abstract behavior with the conventional definition of abstraction. It is the capacity for or the act of

(a) differentiating attributes and relationships from things as immediately experienced; treating these attributes and relationships as things with attributes and relationships of their own. (e.g. to name and compare ideas, qualities, etc.)

(b) behaving in terms of as many simultaneous attributes of the perceptual field as one desires to attend to. (e.g. recognizing simultaneous possibilities and making a choice)

(c) assuming or relinquishing at will an orientation of attention towards any differentiated aspects of the perceived environment. (e.g. shifting, vicarious trial and error, assigning new meanings to symbols)

Anomia - Inability to evoke the names of things - common or proper nouns; an outstanding feature in some cases of aphasia.

Aphasia - Any loss in the ability to comprehend, formulate,

or express language symbols, resulting from a lesion of the cerebrum, provided it is not limited to a loss of coordination or sensation or a paralysis affecting the organs of communication.

Aphasia, amnesic - An aphasic syndrome in which the inability to recall or retain nouns (anomia) and sometimes verbs is the principal difficulty.

Aphasia, motor - an aphasic syndrome in which difficulty in recalling the articulation of speech is the outstanding characteristic.

Aphasia, sensory - A type of aphasia in which the outstanding feature is the patient's inability to understand spoken-and usually written-language. It usually involves more or less severe expressive disturbances of a typical kind - e.g. anomia, paraphasia, jargon.

Concrete behavior - That which consists of a stereotyped form of response to a single dominant aspect of the stimulus field; to be regarded as lying on the opposite end of a continuum from abstraction.

Objective test - One in which the content, the administration and the scoring procedures are so defined that the variability in results arising from these three factors is very small compared to the variability arising from the performance of the subjects.

Paraphasia - A failure of expression consisting of the involuntary substitution of jargon or inappropriate words during

an effort at meaningful speech.

D. Summary

Failures of speech in partly aphasic individuals follow patterns for which no systematic explanation has been established. One hypothesis, that of Goldstein, holds that aphasics who have lost the ability to behave abstractly fail in some speech situations more than in others because an abstract attitude is necessary in order to meet them. This study concerns the effect of specific variations in the structure of a speech stimulus on performance in giving one-word responses. The factors which are controlled in these stimuli are those which call for evidence of abstract behavior. The subjects' standings on the several speech tests are compared with their performance on four non-verbal tests of abstract behavior.

The problems under study are:

- I. Are there demonstrable correlates of abstract behavior in aphasic speech disorders?
 - A. Does a loss of abstract behavior correspond to relatively good word-association performance under conditions where a highly stereotyped response is possible?
 - B. Does a loss of abstract behavior correspond to relatively poor speech performance under conditions where the number of possible reactions is increased?

- C. Does a loss of abstract behavior correspond to relatively poor speech performance under conditions which require repeated spontaneous shifts in mental set for the choice of words?
 - D. In general, does a loss of abstract behavior correspond to increased dependence on stimulus-structuring for an adequate response?
- II. Is there a demonstrable relation between the degree of aphasic speech loss and the degree of difficulty of specific types of stimulus structuring?
- A. Does a severe loss of speech in aphasia correspond to relatively good word-saying ability under conditions where a highly stereotyped response is possible?
 - B. Does a severe loss of speech in aphasia correspond to relatively poor performance under conditions where the number of possible responses is increased?
 - C. Does a severe loss of speech in aphasia correspond to relatively poor speech performance under conditions which require repeated spontaneous shifts in mental set for the choice of words?

The first major problem and its sub-problems have a

bearing on the basic hypothesis that abstract behavior exists as a mode of adaptation which characterizes both language and non-language behavior. It also tests the validity of a number of specific speech subtests as applications of the definition of abstract behavior to the area of language performance. The second major problem is related to the basic hypothesis that there is a predictable order in which performances break down with increasing damage to the cortical bases of symbolic behavior -- that is, a factor over and above the simplicity and familiarity of the content of the responses.

Chapter V

Theoretical and Historical Background

A. Abstraction and tests of abstraction

The study of the process of abstraction has been pursued by psychologists investigating the processes of thinking and problem solving, by psychometricians, and by clinicians interested in pathological distortions of the thinking process. Abstraction, in the sense closest to its dictionary definition, refers to behavior in which one responds to certain chosen qualities or attributes of an experience, as distinct from the experience itself. Spearman (43) found that tests of abstracting similarities were the best indicators of his general intelligence factor, "g". Kelley (26) holds that if, in a very limited sense, there is a general factor in intelligence, it must be called a verbal reasoning factor because it consists of facility in abstract thinking with verbal problems. Tests of abstraction used by Spearman and later by Thurstone (46) consist of multiple choice items in which the subject must indicate his grasp of the common characteristic of a group of abstract designs, words, or pictures. The task may require the subject either to select another picture having the required characteristic or to exclude from the group the one picture which does not have a characteristic common to the rest. One of the tests used

in this study, the SRA Non-verbal test, devised by McMurry and King, is of this type.

Piaget (38) threw light on the genetic development of abstraction by showing that children first react to resemblances between things, later to differences. However, the child "acts" resemblance before thinking it. From the results of intelligence testing, we know that the ability to express the nature of differences precedes the ability to express the nature of similarities. Thus, in the Stanford Binet examination (44), we expect the average six year old to point out the differences between pairs of words, but do not ask for similarities until the next year-level in Form L and until the eight-year level in Form M. Moreover, the most common inadequate response to the request for similarities is the giving of differences. Thus, there is a great gap between 'acting' similarity and abstracting similarity. The former is nothing more than a manifestation of stimulus-generalization, and is often a sign of the failure to discriminate some quality of an experience from the experience itself. Thus, the child, frightened by a white rat who exhibited the same fear towards a fur coat was 'acting' similarity to the two objects because he was identifying the furry quality with the experience of the rat. (26)

The process of abstraction requires first a well-differentiated perception in which the individual is aware of

qualities or aspects of his experience and can retain these aspects as ideas independent of the unitary experience. At higher levels of abstraction, these qualities themselves become parts of a perceptual field and relationships between them are noted and abstracted. Failures or deficiencies in abstraction are of two sorts. In one case the individual cannot make the original differentiations between the fundament* and its various properties. In the second, he cannot voluntarily maintain his orientation to a given level of abstraction, but identifies ideas with their fundamentals. For example, a patient taking the Goldstein-Scheerer Cube test is given four blocks, each having a red side, and is told to build with them a design similar to the solid red square on a test card. In order to succeed, he must be aware of several different properties of the test design, namely, its color, its overall squareness, and its divisibility into four imaginary red quarters. A failure at this level of difficulty usually means that the patient has identified only one or two of these properties with the whole design, because he has not differentiated the third essential feature. Thus, he may place four red faces side by side, satisfied that he has reproduced the redness and met the requirement that he use four blocks. He has evidently failed to differentiate the squareness as an essential property of the

* Fundament is used, as Spearman (43) uses it, to signify the thing (or idea or experience) to which a quality or attribute belongs.

design. If he is not too badly impaired, he may acknowledge that there is a difference between his reproduction and the original, but be unable to say wherein it lies. Another form of failure may involve his constructing the design correctly with the exception that he uses the half-red, half-white face on one of the blocks instead of all red faces. In this case, the patient may have made the necessary differentiations but is unable to maintain his orientation to the requirement that each quarter of the design be red and square. By his incorrect substitution, he indicates that he tends to slip into the identification of "some redness" with the red, square block-faces that he has used in the rest of the design.

The Goldstein-Scheerer Cube test consists of a series of such designs of increasing complexity, but all of them made with four blocks. Each design is also presented in simplified form, if its original presentation is failed. Thus, if the patient cannot reproduce the drawing in half-scale he is shown a card with a full scale drawing; if he still fails, he is shown the design with lines drawn in to outline the four component blocks. With each step of simplification, his task of abstracting becomes easier, as more of the relevant characteristics are laid out where they can be copied by direct comparison. Nadel (35) and Goldstein and Scheerer (11) have described the errors most typical of the organic brain damaged and explained how each type of

error is a failure of normal abstraction or an attempt to solve the problem by resorting to concrete behavior. Goldstein and his associates designate as "concrete" the behavior which results from a failure of abstraction or when a stereotyped reaction is made thoughtlessly to some dominating feature of the stimulus which imposes a mental set on the individual.

The necessity of maintaining one's orientation to given properties of the environment also implies the ability voluntarily to assume or to change one's orientation, or mental set. This was brought out most clearly by Weigl (46), who in collaboration with Goldstein, originated the widely used Color-Form test. It consists of twelve cut out designs which can be sorted into four different color groups or three different shape groups. Brain-injured patients were typically unable to rearrange the pieces on the basis of shape after they had placed them according to color. Weigl's work also revealed that the person who is weak in abstracting tends to be dominated by concrete features of his environment without being able to account for his behavior and without being able to change his orientation. Thus, the brain-damaged patient often cannot separate the pieces even into color-groups. Instead, he lays them out in a compact rectangle, in which the columns are of similar color and the rows of similar shape or vice versa. He proceeds by placing each piece alongside the one to which it is attracted by virtue of a concrete similarity

of shape or color. There is no awareness of either shape or color as a criterion and the patient is bewildered when asked to separate the pieces into groups which belong together.

The Object-Sorting test, published by Gelb and Goldstein in 1924, consists of thirty objects which can be variously sorted into at least nine different categories. They include tools, toys, smoking equipment, edibles, and lend themselves to such categories as "elongated objects," "objects which occur twice," and so forth. The procedure involves the steps of having the patient select all the objects which can be classed with one which he has first selected himself, then with an object which the examiner selects. In each case, the basis of his choice must be explained. The patient then is asked to sort the entire group into as many categories as he wishes and when he has done this once he is asked to arrange them in some other way. The patient who is excessively concrete will make use of relatively few of the objects and form very few different groups spontaneously. Moreover the criteria for his groupings will tend to be arbitrary, situational factors, rather than logical categories. For example one of Weigl's patients grouped the pliers with the nail in the block of wood, because the pliers were needed to extract the nail.

Halstead (15, 16) has revised this procedure and set up different scoring criteria, including the number of objects recalled. He has used the test extensively with patients who have undergone brain surgery and found quantitative and

qualitative deviations in their performance. Of interest is the fact that the brains injured recall as many unsorted objects as they do sorted ones, while the normals are decidedly superior in their recall of the ones they have sorted. King (28) distinguishing three types of abstracting behavior, used a four-part adaptation of the object sorting test to measure separately the ability to "group", to "isolate" and to "shift." Kisker (30), and Lynn, Levine and Hewson (32) have also reported adaptations of this test. It was unfortunately not suitable for use in the present study because of its demands on verbalization.

The Stick test and the Color-Sorting test are two more simple procedures introduced by the Goldstein group which are revealing of the nature of the loss of abstract thinking and of the form which behavior takes in its absence. The first involves having the patient copy, then reproduce from memory simple geometric arrangements of small sticks, starting with one stick placed in different positions. Most of the arrangements are abstract configurations, but some resemble letters of the alphabet, or other familiar objects. Patients who have lost abstracting ability are typically unable to recall the simplest design unless they recognize it as a known "thing." They are unable to abstract the attribute of "direction" and use this concept to guide their reproduction of a slanting line. In order to comply with

instructions and appear adequate, such patients may erroneously perceive the given design as a familiar thing and then reproduce it so that it resembles what they have named. It is important to note that the tendency to distort perception and memory to bring it in line with what is familiar is a characteristic of all people. Carmichael, Hogan, and Walter (3) have demonstrated the change in memory of a perceived figure which is produced by the name one happens to attach to it. Thus, the mode of adaptation of the organic patient is in line with findings of normal psychology. His abnormality lies in the deficiency which forces him back on this ineffective compensation.

The Color-Sorting test is performed with a set of the Holmgren Wools -- about eighty skeins of wool of all hues and varying degrees of brightness. A person looking at the heap of skeins with a passive or concrete attitude may be struck by a configuration of skeins of outstanding brightness or by two or three skeins of nearly the same hue and brightness which stand out from the background. However, if asked to sort the wools by color, he must reorient himself to the abstract attribute of hue and ignore that of brightness. He must proceed to select, and place in groups, skeins of wool which are so unlike in brightness that there is no sensory cohesion between them at all. Weigl describes as typical the behavior of a patient who rejected all shades of green except a particular dark green skein, saying that only this

one was really "green." He then discovered a still more intense green and decided that now it was "green." He now rejected his first preference and tried to decide what color he ought to call it.

The Vigotsky test was used by its author (47) and by Hanfmann and Kasanin (18) to study abstract thinking in schizophrenia. It has since been used widely by clinicians as a test for organic brain damage. The task consists of solving the problem of sorting twenty-two blocks of different colors and shapes into four logically defensible categories. The problem is difficult, because it requires establishing a criterion based on a combination of two sensory characteristics: height and area, while ignoring the irrelevant features of color and shape. The procedure for administering the test is one which enables the examiner to follow the subject's reasoning in detail.

Abstract behavior, as Goldstein uses the term, includes the ability to shift from one mental set to another and to deal simultaneously with several aspects of a problem, as in making a choice. In a sense, both of these abilities are inseparable from abstraction, because many acts of abstracting are based on the deliberate selection, from a confused background, of specific features whose characteristics are then compared. Naturally, the greater the number of features which can be examined simultaneously, the more difficult the acts of abstract reasoning which can be performed. The same applies to ease with which one can shift one's mental

set, or retain it in the face of distracting features in the stimulus-structure. However, both of these abilities have a certain autonomy and, as Hunt (23) points out, can be measured independently. One of the tests devised by Lynn, Levine, and Hewson (32) is a direct measure of ability to bear in mind simultaneously progressively greater numbers of concepts. This is the "simultaneous concepts" test in which the subject is asked to select from groups of words those which meet given two-fold, three-fold, and four-fold criteria.

When we examine further the Gelb-Goldstein-Scheerer concept of abstract behavior, we find that it embodies a great deal more than what we can logically call abstraction. It takes on, rather, the character of a state of conscious alertness which is a prerequisite for abstraction, for initiating new activities, and for thinking rationally. This is almost identical in its implications with the term "vigilance" as used by Head to describe what the brain-injured person has lost.

B. Problems in understanding aphasia

Observing and explaining the phenomena of aphasia has been largely the province of neurologists who were directly concerned with problems of cerebral function and its localization. Broca, in 1861, demonstrated the constant association of lesions of the base of the third frontal convolution of the dominant cerebral hemisphere^{*} with the inability to recall

*The dominant cerebral hemisphere is the half of the brain which controls the side of the preferred hand. It is always on the side opposite the preferred hand.

the articulation of words, while understanding them was not necessarily impaired. Wernicke, in 1874, described a syndrome accompanying lesions of the first temporal convolution in which articulation remained normal, while the understanding of spoken or written language was impaired. Further observations of hundreds of individuals were accumulated during the years following Broca's and Wernicke's contributions; the apparent possibility of localizing centers for each of the sensory and motor functions connected with language was exploited energetically by Bastian, Kléist, and Henschen. They hypothesized centers for the storage of specific types of images or 'engrams,' together with a system of association pathways joining them together. They attempted to explain all the phenomena of aphasia in terms of the destruction or isolation of the several centers. The fruits of the work of these "structuralists" are summarized in Nielsen's authoritative volume on cerebral localization in aphasia. (36)

Some undeniable facts concerning localization have emerged and must be accepted in any theoretical approach to problems of aphasia. Isolated losses in each of the following language functions may occur as a result of brain injury: writing, recognizing written words; recognizing spoken words; finding and articulating words in general. When an isolated deficiency in one of the foregoing functions is found, the location of the causative lesion may be stated with fair accuracy. However, occurrence of such isolated

losses is extremely rare, not only because lesions usually involve two or more adjacent areas, but because a disturbance in one language function usually undermines other functions which have been learned in connection with it. Thus, a lesion primarily affecting the recall or understanding of spoken words may involve a serious disturbance in reading and writing as well.

The knowledge of specific areas crucial for the several sensory and motor functions of communication contributes to understanding only the grosser aspects of an aphasic symptom-complex. It is sufficient for approximately identifying the position of a brain lesion in the event of one of the specific language deficiencies mentioned above. Also, there is a type of paraphasic speech, consisting of a copious flow of confused words, jargon, or aimless sentences which is associated with the lesion of Wernicke's sensory aphasia. This is interpreted as a typical ineffective attempt to compensate for a sensory deficiency in which the patient barely grasps the meaning of his own words.

When a person survives the trauma which renders him aphasic, he usually shows retention or recovery of some of his communications skills. It is in the effort to account for the conditions under which a partly aphasic person succeeds or fails and to explain the nature of his wrong performances that the anatomic-functional approach proves inadequate. For example, some individuals can continue reciting any familiar

verse or word-series on which they are given a start, yet are unable to say a single word spontaneously otherwise. Others can speak many phrases and even short sentences with normal fluency, yet block completely on most nouns and even fail in attempts to repeat the noun when it is supplied for them. Still another group of aphasics, who tend to speak in telegraphic style, using chiefly nouns and the infinitive form of verbs, usually omit the "small words" of grammar when reading aloud and cannot even repeat them after hearing them spoken. Words which cannot be spoken voluntarily or repeated on request may be spoken almost automatically in answer to an appropriate question. Emotional stress may enable a nearly mute individual to speak a fluent sentence and then lapse into silence, unable to repeat his performance. Aphasics typically retain the ability to use certain interjections and swear-words, when almost all other speech is gone.

In the introduction to his most recent volume on language disturbances, Goldstein points out that the dominating concept of localization led to over-simplified examinations, over-schematized interpretations, and consequently to a flooding of the literature with inadequate protocols. "They produce a misconception of the facts because they neglect a finer analysis of symptoms or analyze them from a theoretic point of view which leads to the overlooking of many of the phenomena."

(8, p. x) Thus, patients presenting any of the characteristics

enumerated in the preceding paragraph might be categorized as having an "expressive aphasia" or "motor aphasia" with very little spontaneous speech and poor ability to repeat spoken matter. No theory of localized centers has explained why the words "the", "a", "of" should be harder to repeat aloud than the words "give", "breakfast", or "January", for some aphasics.

Parallel with the work of the anatomically oriented investigators is that of the men who stressed the psychological interpretation of aphasic phenomena, disputing even the best-supported facts concerning localization of speech centers. The first to set forth this position was the great English neurologist, J. H. Jackson. In dealing specifically with the phenomenon of occasional speech in aphasics, Jackson pointed out that the words and phrases which these patients retained were either stereotyped and meaningless or else represented an emotional attitude. The type of utterance most difficult for the aphasic was that which conveyed information - i.e., a "proposition." The latter function represents the highest development of symbolic behavior and hence requires the participation of the cerebral cortex of the dominant hemisphere -- the highest cerebral center. Emotional expression corresponds to a lower level of behavior and hence may be mediated by the subordinate hemisphere or subcortical brain centers. Sapir (38) in debunking the theory that speech is instinctive also points out that the near-involuntary expressions of pain and

joy are in a sense part and parcel of the emotion itself and in no way symbolic. They do not announce that a particular emotion is being felt.

This dichotomy between propositional or symbolic expression and non-propositional speech underlies the thinking of Head and Goldstein -- the foremost exponents, in the present century, of the psychological approach to aphasia. Head regarded the condition as a general defect of symbolic formulation and expression. In his two volume work on the subject he refers to Kleist, Bastian, and Wernicke as the "Diagram Makers" and rejects their concept of memory images. Head insists that the impairment of symbolic behavior is never confined to the use of words alone, but is reflected in other activities. His examination of patients therefore included a number of non-linguistic elements, some of which have since been shown to be quite difficult for normals. (See p. 36)

In rejecting the theory of sensory and motor image centers, Head also rejects the diagnostic classification based on it. He criticized especially such terms as "word deafness" or "word blindness." Instead, he offered a fourfold classification based on psychological-linguistic, rather than on anatomico-functional criteria. His first three categories of "verbal," "syntactic," and "nominal" aphasia correspond roughly to syndromes described by other writers and need not be discussed here. The fourth type, "semantic aphasia," is

is one which he associates most definitely with non-language deficiencies. This syndrome is characterized by the want of recognition of the ultimate significance of words and phrases, apart from their direct meaning. These patients' sentences tend to trail aimlessly, and they comprehend poorly what they read. These, too, are the individuals whom Head found most inadequate in recognizing relative values of numbers or of money and least able to draw or to use landmarks to orient themselves.

In contrast to Head, Goldstein accepts the basic fact that certain areas of the brain are crucial for specific sensory and motor functions of language, and that many specific lesions result in their own typical forms of aphasia. (8, p. 50) He delves more deeply than either Jackson or Head into the circumstances under which the partly aphasic person succeeds or fails. Goldstein enlarges on the Jacksonian notion of propositional and non-propositional speech and relates it to the broader concept of abstract and concrete behavior. Concrete language is that which corresponds to concrete behavior. It consists of automatisms, of word series, sentences, of "understanding language in familiar situations for which it has been conditioned" and of emotional speech. Abstract language is voluntary, propositional, and rational. It is often involved in the naming of objects. "Because the various speech performances, as voluntary speech, conversational speech, speaking of isolated words or of series, repetition, naming of objects, reading, etc., are in a different degree

dependent on the abstract attitude, the various performances may be damaged in different degrees." (8, p. 25) As a result, we are led to think of aphasic speech characteristics as determined by two distinct factors: first, the identity of the sensory or motor brain areas which are damaged; second, the capacity of the individual to meet the demands of the situation for an abstract use of language.

When we examine Goldstein's writings concerning the particular speech situations which demand abstraction, we find certain inconsistencies and arbitrary compartmentalization of facts. He sets forth the loss of object-naming in amnesic aphasics as an unquestionable manifestation of concrete behavior. These patients not only have difficulty in evoking specific nouns and verbs, but show an extremely concrete attitude to the names which they do supply, being unable to distinguish generic from specific nouns. One of his patients, when confronted with a knife and an apple called the knife an "apple-parer" (in German) and denied that it could also be considered as a "knife." (9) These patients also prove markedly defective in their handling of the non-language tests of abstraction. The inability to use names is held to require an abstract attitude towards the words, and as evidence, the simultaneous defect in non-language performance is cited. However, when confronted with protocols of patients who show naming defects precisely similar to amnesic aphasia without any defects in their non-verbal performance, Goldstein defends his position by saying that in order to be considered amnesic aphasics, these patients must also show a loss of abstract

attitude in their general behavior. He seems to ignore the fact that he can no longer claim that the naming defect is a manifestation of the general behavior change. Again, he cites the case of a young man who showed marked impairment of abstract behavior which did not improve, while the patient's early amnesic aphasia did improve. In this case, the patient's continuing inability to speak, read, or write the small words of grammar is referred to as evidence of his concreteness. (8, pp. 310-316) However, this latter defect is characteristic of a group of motor aphasics who do not necessarily have any general loss of abstract behavior. It seems illogical to cite it as evidence of concrete language behavior in the instance of a patient who happens to show concreteness in his non-language performances.

Head, like Goldstein, finds that naming things is an abstract act of relatively high order compared to describing them or showing what you do with them. Naming colors is particularly difficult because a color is an abstraction in itself. While his category of "nominal aphasics" have the most difficulty with nouns, he indicates that naming nouns is also relatively hard for the semantic and syntactic types, because they have all lost some of their capacity for symbolic formulation. The verbal aphasic is the only exception to this generalization.

Elsewhere, Goldstein indicates that a disturbance of abstract behavior in aphasics goes along with a loss in

spontaneous speech. These patients tend to remain silent until some external stimulus sets them off. When they attempt to initiate speech voluntarily, the results may be much poorer than they are in reactive speech, such as conversation. Typically, such a patient is said to be unable to initiate a series on command, as in counting or saying the days of the week. However, when given the first member of the series, he continues unaided. (8, pp. 56-57) The logical analogy between these language situations and the general definition of abstract behavior is easily seen. However, the real correspondence of any type of language performance to abstract behavior has yet to be demonstrated. Goldstein's evidence in support of such correspondences is not consistent, and the present investigation is intended as a systematic study of this very problem.

C. Tests of language and abstraction with aphasics

The conditions under which aphasia occur are largely responsible for the fact that only a handful of studies under anything like standardized conditions are reported in the literature. Except during war-time, there are no concentrations of subjects for controlled studies. Aphasia occurs in conjunction with cerebral vascular accidents, brain tumors, or brain injuries. Its victims are often senile and usually so acutely ill while in the hospital that little opportunity for examination by anyone but the physician is afforded, and he cannot take the time for extensive psychological testing.

The patients who recover enough to be given extensive tests pass through the neurological or medical wards of hospitals in small numbers. The first World War provided for the first time large numbers of otherwise healthy young victims of aphasia. Much of the work of Goldstein, Kleist, and Head was made possible by the necessity of studying and rehabilitating these wounded soldiers.

There is a tremendous literature based on individual case studies and collections of cases. In addition to the men already mentioned, Pick, Von Monakow, Marie, Liepmann, Isserlin made great contributions and the names of others are too numerous to list. The orientation of these writers is qualitative; their examination procedure involves trying out the various channels of communication in the patient, recording the functions which he performs, those in which he fails, and the abnormal "positive" symptoms, or incorrect performances which he makes. Their aim is diagnosing and their method is exploratory. Recently, under the impetus of the numbers of aphasic veterans of the last war, there has been a renewal of activity in the direction of retraining, and consequently in the direction of developing procedures for evaluating the disability and the amount of progress made. Eisenson (7) and Halstead and Wepman (17) have published inventory-type examinations for aphasia. Wells and Ruesch (53) suggest Cheshers' modification of Head's method (see below) and also provide lists of easy and hard stimulus words for use as a

word-association fluency test.

Head (11) is the first to report the use of a strictly controlled series of tests, along with more qualitative observations of his patients. The patients with whom he dealt were almost all of good intelligence and cultural background, and therefore not entirely typical in their reaction to aphasia. Head prescribes simple 'serial tests' for each of the sensory and motor channels of communication. Recognizing the great variability from moment to moment in the aphasic's performance, he uses repeated presentations of the same items in random sequence in order to average out some of the inconstancy. Objects are presented for naming from sight, reading from a card, writing from sight, writing from dictation, and repetition. Chesher (5) offers a very similar examination plan, pointing out the possibility of deriving from it a percent impairment score for each language function.

On a more complex level, Head offered three tests involving the following directions: A clock test, a coin-in-bowl test, and a hand-eye-ear-test. The coin-in-bowl test consisted in following a series of commands of the type, "Put the first coin into the third bowl," etc., while the hand-eye-ear test consisted of such commands as "Put your left hand to your right eye" and of mimicking movements of this type made by the examiner, when looking at him face to face. Head noted that the performance of the last named test

usually involved some subvocal speech because it is confusing to perform motions in the reverse direction from the ones that are to be copied. A number of subsequent investigators (Quadfasel, Gordon*) found that the hand-eye-ear test was not sufficiently discriminating between aphasics and non-aphasics and that many other factors besides internal speech affected performance.

Pearson, Alpers, and Weisenberg (37) undertook to give all of Head's tests to a series of 29 non-aphasic subjects, including some superior normals and some brain damaged patients. They too found the hand-eye-ear test useless for discriminating aphasics from the normal in speech. The Clock-setting test and the following of complex commands were also found to be of dubious value. The coin-in-bowl test, however, was one of those which was well done by normals but not by aphasics. In spite of the shortcomings of his procedures for measuring the milder forms of aphasia, Head should be credited with trying to meet the need for standard tasks of graduated difficulty which could be repeated so as to give a measure of improvement.

The work of Weisenberg and McBride (51) went further toward meeting the objective of quantitative measurement of language and non-language deficiencies in aphasics than any research before or since. They used a large battery of tests, including those of Head and portions of standardized intelligence and scholastic achievement tests. Most of these tests, for which adult norms had never been obtained, were standardized

* As cited by Goldstein (7)

on a group of normal individuals comparable to the aphasics in age and background. With respect to oral comprehension and reading, their final battery does provide well-graded series of tests. However, the puzzling problem of setting up a series of graded speech-eliciting situations was not attempted. The examination of expressive language was descriptive and exploratory, in that it involved a sampling of spontaneous speech, automatic serial speech, object and color naming, and repetition of words and phrases. These investigators found it impractical to offer a condensed examination which would be suitable for any case of aphasia. They held that after a preliminary examination to determine the areas of weakness it was necessary to select the particular detailed tests which would apply to the individual patient.

As a result of their studies, which included full neurological information, Weisenberg and McBride felt that it was futile to attempt any rigid classification of syndromes beyond calling them "expressive," "receptive," "expressive-receptive," and "amnesic." They found that similar lesions often produced very different functional effects and that there was little justification for believing in specific localization. While they did not use any tests directly comparable to the Goldstein tests of abstract behavior, their amnesic aphasics showed relatively little impairment in non-language performances.

Meyers' (34) study is unique in the literature in that it is the only reported controlled experiment in which a group

of selected aphasics is compared with a group of non-aphasics in a particular non-language task. Meyers tested the assumption that the loss of verbal cues in a group of aphasics would reduce their ability to learn the principle of a multiple choice button-pressing problem. He used eighteen aphasics having primarily receptive symptoms with deficiencies in word-finding ability and inner speech. There were no significant differences between the problem-solving ability of these individuals and that of a matched control group without aphasia.

D. Relevant studies with non-aphasic brain-damage cases

Studies of reasoning and abstracting ability in non-aphasic brain lesion cases are somewhat more numerous and indicate the use of both verbal and non-verbal instruments, although the former predominate. Nadel (35) compared a group of patients having frontal lobe lesions with a group of matched, neurologically normal people with respect to their performance on five tests for abstract behavior. He is the first to report the use of the modification of the Kohs Block Design test which has since been published as the Goldstein-Scheerer Cube Test. He also used the Color Sorting test, the Stick Test, the Rorschach, and the Feature-Profile assembly test. Nadel described concrete behavior as "restricted" and contrasted it with abstract behavior which is characterized by the "ability to choose a course of action and to shift." Nadel found that the subjects who tended towards "restrictive"

behavior performed with consistency in all of the test instruments.

More recently, King (29) studied changes in abstract behavior in 17 cases of partial frontal lobe ablation. He used the Weigl Color-Form test, the Object Sorting test and two verbal tests of abstraction which had been previously used by Wegrocki in the latter's study of schizophrenic reasoning (48); an Essential Differences test and an Analogies test. The first of these involves crossing out one word in a group of four, where three of the four have a common characteristic and the fourth is out of place. The second is a sentence completion test with questions of the type "Blow is to whistle as ring is to...." King rather arbitrarily differentiated abstract behavior into the functions of "grouping" things with similar properties, "isolating" things which lacked a common property, and "shifting" from one grouping criterion to another. He derived two verbal and two non-verbal scores for each of these factors, but in the analysis of the performance of operated and non-operated groups found no significant differences in their abstract behavior, as measured.

Halstead (14), in addition to elaborating on the Object-Sorting test, has used a large battery of performance tests on a population of brain-operated patients whose lesions were well known. By means of factor analysis, he has isolated four factors to which he has assigned names without, as yet,

being able to state clearly what each of them means. He has introduced the term "biological intelligence," which he uses analogously to Goldstein's "abstract behavior" and has shown that his tests may be used to derive an "impairment quotient" which turns out to be highly correlated with frontal lobe damage.

Lynn, Levine, and Hewson (32) found they could discriminate between diffuse organic brain damage patients and normal controls by means of the Object Sorting test. One of Thurstone's tests for his "Factor A", the ability to hold a closure against distracting stimuli, failed to discriminate between these two groups. This test had previously been found to show significant deviations in the performance of patients with focal brain lesions. A number of reports of pre- and post-testing of frontal lobotomy patients with tests of abstraction fail to show any differences. Kisker's (30) and Hunt's (24) findings concur in this respect. It is generally agreed that these results are influenced by the fact that the subjects were psychotic to begin with and the loss of abstraction in schizophrenics is very much like that in organics.

Of the studies of organic brain damage using verbal test material, that of Capps (2) is most relevant to the present study. In his investigation of vocabulary changes in deteriorated epileptics he used oral word naming tests similar to those employed here. The ability to name words at

random for a three minute period was found to be strongly correlated with clinical estimates of deterioration (Coefficient of correlation .65). Capps also found that the more deteriorated patients had more trouble with identifying synonyms than antonyms. This fact seems to be related to Bolles' finding that deteriorated patients are unable to overlook differences between words when asked to give the similarity between them. The bearing of this on the genetics of abstraction has already been discussed. (p.16)

E. Word association and reaction time experiments in the light of the abstract behavior concept

It has been pointed out that capacity for abstracting inevitably involves the ability to direct the attention to selected aspects of the environment. In choosing between possibilities, or in deliberately making a particular response when there are several conflicting impulses, a person is exercising a capacity that is closely associated with abstraction if not identical with it. In everyday life a good deal of our activity is of a habitual nature and calls for a comparatively low level of conscious thought. We "stop to think" when we are confronted with a choice for which no habitual response is available. This observation was brought into the laboratory by Wundt, Donders, Lange, Exner, and those who followed them in differentiating between simple reactions on the one hand and choice and discriminatory reaction on the other. (55, pp. 302 ff.) The simple fact which emerges from laboratory studies is that choosing takes more time than

responding where no choice is necessary. Merkel* showed that as the number of possible choices increases, so does the reaction time.

With respect to word-association tests, Woodworth and Wells (53) compared the reaction-times for highly restricted and less restricted associations and found a reliable difference in favor of the former. Cattell* published reaction times for various types of controlled word associations. In general, the associations which are partly restricted are slower than those which are completely restricted. We may interpret this in terms of abstraction by saying that the more completely the mental set for a particular response is determined by the stimulus, the less demand there is for a deliberate choice and, therefore, the less is abstraction involved. Now, let us examine Lund's finding on having normal subjects name colors serially from a color chart and then read the color names serially. In this case, the mean reaction time for naming colors was approximately fifty percent longer than for reading the names (560 ms. versus 360 ms.) Woodworth (p. 356) offers this explanation. "About the only response to a seen word is to read it, whereas there are many possible responses to a seen color, form, or object." He also suggests that the difference may be due to practice, because every time we see a printed word we read it, but we do not necessarily name a color when we see it. However, the objection to the "practice"

* Cited by Woodworth (55)

explanation is that the number of times that we have spoken a color name in connection with its written representation is probably much smaller than the number of times we have spoken it in connection with seeing it. Wells and Card (52) also report that school children elicit spoken words in response to written ones more easily than in response to pictures or actual objects.

It may well be argued that it is not reasonable to call color naming more abstract than color reading because the normal person can do both without conscious deliberation. On the other hand, the difference in reaction times and the logic by which this difference is explained have been taken as sufficient reason for testing the hypothesis that a relative deficiency in color naming (as compared to color reading) is related to a general loss of abstracting ability.

F. Summary of background in terms of present study

1. The relation between 'abstract behavior' and the process of abstraction in the conventional sense has been explained and the currently used clinical tests of abstraction have been discussed. Of the tests mentioned, only the Goldstein-Scheerer cube test and the SRA Non-Verbal dispense with spoken language entirely, and these two are consequently chosen for use in this investigation, where many of the subjects are nearly without speech. Two other non-verbal procedures have been devised for this study and will be described in the chapter on procedure.

2. Aphasic phenomena are only partly explained in terms of the disruption of the neurological substrate for the various sensory and motor functions needed for language communication. A number of neurologists have stressed the relation of aphasia to a general loss of symbolic behavior (Head) or to a loss of abstract behavior (Goldstein). The loss of naming ability, reduction in spontaneity, and over dependence on stereotyped speech have been cited as corresponding to a deficiency in abstract behavior. However, the evidence so far is based on individual case material which is full of inconsistencies. It has been shown that the speech situation of naming objects or colors, as contrasted with reading their names involves a choice of reactions and may thus be usable as another measure of abstraction. This investigation is the first reported effort to verify the correspondence of abstraction to certain types of speech performance.

3. A survey of tests for aphasia reveals that the approach to the examination of expressive language is descriptive, and exploratory because there seems to be no basis for grading the difficulty of stimuli for speech. One of the aims of this study is to ascertain whether such a grading of tasks is possible, among the subtests which are used.

Chapter III

Procedure

A. Outline of the Experimental Design

The first and principal problem of this study requires the application of both verbal and non-verbal tasks to a group of aphasics and to a control group of non-aphasics. The purpose of the non-verbal tests is to rank the members of the two groups with respect to their capacity for abstraction, as measured by the tests. The speech-test scores are, in turn, grouped with respect to three factors, so that the relationship of each factor to abstraction can be studied. Separate aphasic and non-aphasic groups are used because the relationships sought here were suggested by clinical case studies of aphasics only. It is necessary to subject them to parallel study in non-aphasics in order to conclude whether there is a direct relationship between abstraction and the speech variables in question.

Each of the speech-test scores represents the effect of a given speech-stimulus-factor on performance. The scores are derived from the discrepancy between performances of the subjects in given pairs of subtests, where each pair presents a contrast between a high degree and a low degree of a particular speech-stimulus-factor. The fourteen speech subtests used in this study were so chosen that a number

of such contrasting pairs could be selected for each of the following speech-stimulus-factors: (1) presence or absence of a highly stereotyped stimulus-response link; (2) degree of restriction of possible responses as determined by the stimulus; (3) presence or absence of a specific stimulus for each response word.

In terms of experimental variables, the design for the first problem takes the following form. With respect to one phase of the problem, the independent variable is the subjects' capacity for abstraction; the dependent variables are the effects of each of three speech-stimulus-factors upon the subjects' performance. The second phase of the problem relates to the implicit question, "Are these findings characteristic only of aphasics?" It requires that we deal with a second set of experimental variables. Now the independent variable is presence or absence of aphasia, and it is controlled by using two groups. The dependent variable is the kind of relationship discovered between the subjects' abstraction and speech performances.

Since the speech tests cover a considerable range of difficulty, only a portion of the aphasic population is adequately tested by each one, and only eight of the subtests are applicable to the non-aphasics. The findings obtained from the twenty non-aphasics are compared with those obtained from an equal number of the aphasics who have usable scores in the same eight subtests of the speech battery. The non-aphasic controls are matched with their aphasic counterparts

for (a) Goldstein-Scheerer Cube test scores, (b) age, and (c) years of schooling. This means that many combinations of test pairs (i.e. sixty-two) are available for studying the first phase of the problem. A much smaller number of test pairs (twenty-three) will be used for comparing the control group with the twenty matched aphasics.

The second problem concerns relationships only among the speech test performances of the aphasics, and no comparison with a control group is required. The independent variable is the overall severity of aphasic speech impairment, represented by the mean of a subject's ranks in all of the speech subtests. The dependent variables are the same as those in the first problem. The principle of concomitant variation is applied here.

B. Time and Place of the Study

The testing of aphasics for this research was carried out by the investigator during the period from June 10, 1950 to January 19, 1951 at four different hospitals which provided speech rehabilitation for aphasic veterans. The first three months of this period were spent at the Veterans' Aphasia Center at Cushing Veterans' Hospital, Framingham, Massachusetts, where twenty-one subjects were obtained. During this period five additional subjects were seen at the Veterans' Language Clinic at Massachusetts General Hospital in Boston. During the latter four months of the research period, nine aphasic subjects were tested at the Veterans' Administration Hospital

Fort Thomas, Kentucky, five at the Dayton Ohio Veterans' Administration Center, and one at the Cincinnati General Hospital. During the same period, seventeen non-aphasic patients with organic brain damage were tested at Fort Thomas and twelve more at Dayton, as candidates for the control group.

The average time spent with each aphasic patient for a single administration of both language and non-language batteries was two and one half hours. In all but eight cases, the complete administration required two or more separate sessions. The average time spent with each non-aphasic patient was one and one half hours. All but two of these administrations were completed in a single session. The total number of hours spent in testing was approximately two hundred hours, including the time for retesting twenty-four of the aphasics.

C. Subjects

1. Aphasics

The criteria for selecting subjects for the aphasic group were (1) that the individuals bear a medical diagnosis of aphasia, attributed to a cerebral lesion; (2) that they have sufficient speech to make some acceptable responses on the easiest of the subtests of the battery; (3) that they be physically capable of sitting at a desk with the examiner for testing sessions of at least forty-five minutes without fatiguing noticeably before the end of a session; (4) that they show no bizarreness of behavior or silliness of responses; (5) that their understanding of the spoken stimuli be sufficient

to eliminate failures obviously due to inability to grasp the stimulus; (6) that they be literate and have an English speaking background, either from birth or a very early age; (7) that they be no older than sixty years of age.

The criteria have been set as loosely as it is possible to have them and still be sure that the variations in subjects' performances under the different experimental conditions are due to the effect of brain injury on their speech. The numbers of aphasics available for a study on the scale of this one is so limited that more restricting criteria would leave too few subjects for a quantitative analysis of results. On the other hand, the inclusion of diverse forms of aphasic speech impairments in a single study tends to obscure the emergence of statistical tendencies. The justification for placing all aphasics in a single experimental group is that each individual is his own control with respect to the comparison of performances under the contrasting conditions represented by any pair of subtests.

The fact that subjects were chosen from among persons receiving speech rehabilitation reflects a preliminary screening which eliminated the very old, those of below average intelligence, the psychotic, the illiterate, and those who were too feeble or fatiguable.

A summarization of the data on age, years of schooling, occupation, cause and duration of aphasic condition, and a brief description of the aphasic picture for each subject is

given in Table I. In this and subsequent tables, each subject is referred to by the first three letters of his last name. The forty-one aphasics range in age from twenty-four to sixty years, with a mean of forty-two years. In education, the subjects range from a low of five grades to a high of graduation from law school, with a mean of eleven years of schooling.

The physical causes of the subjects' aphasic conditions fall into eight categories. The largest of these is the blockage of a major cerebral blood vessel, in most cases, the left middle cerebral artery, which accounted for seventeen of the cases. Next in frequency were open head injuries, involving laceration of cerebral tissue, which accounted for seven more. Six subjects had suffered cerebral hemorrhages associated with hypertension, while four had hemorrhages resulting from ruptured aneurysms. Four suffered closed head injuries followed by subdural or intracerebral hemorrhages, and the last three cases followed operation for a fronto-temporal tumor, a frontal lobe abscess, and a cyst in the third ventricle. All of the aphasics were originally right handed and most of them had a partial right-sided paralysis.

Table I
 Summary of Data on Background and Disabilities of Aphasic Subjects .

Subject	Age	Educ.	Occup.	Onset	Cause	Description of aphasia
AHE	40	10 gr.	Salesman	7 yrs.	Lt. fronto-parietal abscess	Slight expressive aphasia. Speech slightly slowed, but vocabulary and sentence formulation normal. Reading retarded.
BON	30	13 gr.	Lab. techn.	5 yrs.	Ruptured aneurysm	Slight expressive aphasia. Speech broken by frequent blocks, but vocabulary and sentence formulation normal.
BYR	33	12	Chauffeur	3 yrs., 3 mos.	Closed head injury	Slight expressive-receptive aphasia. Speech now fairly fluent with occasional word hunting and wrong usage. Occasionally requires repetition of a word or phrase.
CAD	56	11 gr.	Florist	5 mos.	Cerebral hemorrhage	Expressive aphasia. Articulation very defective but vocabulary and word-finding near normal. Sentence forms are simplified, but spontaneity of speech not affected.
CAM	38	16 (Coll)	Production manager	2 yrs., 5 mos.	Oper. for cyst of third ventricle	Moderate Expressive aphasia. Speaks in rapid bursts with slight slurring; simple but correct grammatical patterns. Frequently blocks completely in word hunting and never speaks spontaneously.

(continued on next page)

Table I(continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of aphasia
CLI	28	10 gr.	Oil-burner repair	3 yrs.	Thrombosis, lt. middle cer. art.	Moderate expressive aphasia. Fair vocabulary, but speech is telegraphic and word-finding difficult for all parts of speech. Articulation of familiar words is good, but cannot easily repeat new words.
CRA	28	10 gr.	Factory machine operat.	6 yrs.	Shrapnel wd., lt. parieto-occipital	Slight expressive aphasia. Speech fairly fluent with rare word hunting. Occasionally blocks between phrases.
CRO	27	13 gr.	Punch press operat.	5 yrs. 8 mos.	Probable vasc. occl. following bullet wd. in neck.	Moderate expressive aphasia. Has large vocabulary, but constant difficulty in word finding. Speech is grammatical, but formulation of sentences and articulation done with much effort and deliberation. Frequent telegraphic speech.
CSO	37	6 gr.	Unkn.	6 yrs.	Lt. frontal gunshot wound	Very severe expressive-receptive aphasia. Can use some one-word phrases; occasionally very short complete sentence. Cannot repeat voluntarily except words already relearned. Does not grasp long phrases.

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Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of aphasia
CUS (Female)	48	12 gr.	Clerk	1 yr.	Hemorrhage following closed head injury	Moderate receptive-expressive aphasia. Hazy grasp of words spoken out of context. Very severe word finding defect, especially anomia. Spontaneous speech well-articulated, but sentences tend to ramble. Voluntary repetition poor.
FEA	51	12 gr.	Hotel manager	4 mos.	Cerebral hemorrhage	Severe expressive aphasia. Articulation very defective and vocabulary somewhat restricted, and sentence forms simple, but grammatical. Spontaneity somewhat reduced.
FER	49	19 (Law)	Lawyer	1 yr. 5 mos.	Cerebral hemorrhage	Moderate predominantly receptive aphasia. Conversation rambling and repetitious, devoid of jargon, but marked by anomia and circumlocution. Comprehension impaired. Cannot name words out of context.
FRA	33	10 gr.	Laborer	8 mos.	Depressed lt. temporal fracture	Mild expressive aphasia. Copious spontaneous or conversational speech with many stereotyped phrases used repetitiously and grammatical forms very defective. Articulation and repetition good.

(continued on next page)

Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of aphasia
FUL	24	11 gr.	None	4 yrs. 2 mos.	Ruptured aneurysm	Moderate expressive aphasia with slight com- prehension defect. Speech generally in brief phrases, grammatically incomplete, but occasional full sentences. Better in con- versation. Reading and writing poor.
GAU	50	8 gr.	Factory foreman	2 yrs.	Cerebral hemorrhage	Moderate expressive- receptive aphasia. Fre- quent, severe word-hunt- ing difficulty and inability to formulate phrases. Speaks in phrases, grammatically complete. Repetition and articulation slightly awkward.
GOF	30	6 gr.	Labor	3 yrs. 9 mos.	Depress- ed parie- tal fracture	Mild expressive aphasia. Speech is slow, with long interruptions for word finding or organizing phrases. Articulation fre- quently awkward or slurred. Vocabulary and grammatical usage near normal.
GRA	42	13 gr.	Carpenter	1 yr. 2 mos.	hemorrhage after closed head injury	Mild expressive aphasia. Speech is slow, with fre- quent blocks for word hunting, but grammatical- ly normal and well articulated

(continued on next page)

Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of aphasia
HAL	25	7 gr.	Farmer	2 yrs.	Post-oper. thrombosis after ligation of int. carotid art.	Severe predominantly expressive aphasia, with some sensory loss. Small vocabulary of one word phrases or very short sentences. Spontaneous efforts as good as reactive speech. Artic. laborious.
HEA	56	5 gr.	Unknown	4 yrs.	Cer. thrombosis due to meningovasc. syphilis	Severe expressive-receptive aphasia. Very poor articulation and almost no spontaneous speech. Has small vocabulary of words when given conversational or pictorial cue.
HERB	30	12 gr.	Factory work	6 yrs.	Parietal gun shot wound	Slight expressive-receptive aphasia. Articulation and repetition are normal. Occasional slowness in word finding, and difficulty in formulating phrases. Does not grasp involved sentences.
HERR	42	16 gr. (Col)	Accountant	1 yr. 2 mos.	Ruptured aneurysm	Expressive aphasia. Has a fairly small vocabulary for one-word phrases and rare complete sentences. Articulation is slow and awkward, grammar defective. Writes much better than speaks.

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Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of aphasia
LEI	29	12 gr.	Bank teller	2 yrs.	Cerebral thrombosis	Expressive aphasia. Uses telegraphic sentence structure and a small vocabulary. Articulation tends to be labored.
MAT	52	8 gr.	Plumber	10 mos.	Subdural hematoma	Mild expressive aphasia. Speech slow and articulation labored. Sentence structure normal. Some slowness in word finding.
MEY	33	12 gr.	Auto mech.	1 yr. 6 mos.	embolus lt. mid. cer. art.	Moderate expressive receptive aphasia. Speaks many phrases and short sentences normally, but is completely anommic. Voluntary repetition is poor. Writes words he cannot say.
MOK	42	12 gr.	Salesman	5 yrs. 7 mos.	Frontal shrapnel wound	Very severe expressive aphasia, with good comprehension. Both articulation and word-finding are very poor.
MOR	39	14 gr.	Under-taker	1 yr.	excision lt. frontal otemporal tumor	Very severe expressive-receptive aphasia. Can say very few words in response to well practiced cues. Recites verses or word series but cannot repeat words otherwise.

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Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of Aphasia
MUR	46	12 gr.	Nurse	4 mos.	embolus, lt. mid. cer. art.	Very severe receptive-expressive aphasia. Uses stereotyped phrases and short sentences, sometimes inappropriately. Poor voluntary repetition; anomia.
ONE	55	9 gr.	Fireman	9 mos.	Thrombosis, lt. mid. cer. artery	Moderate expressive-receptive aphasia. Articulation near normal and grammatical usage good. Spontaneous speech much reduced. Severe anomia.
PHI	57	9 gr.	Carpenter	3 mos.	Cerebral hemorrhage	Mild expressive aphasia. Speech halting but sentences are complete grammatically. Articulation of individual words is good.
QUE	60	16 gr (Col)	Acc't	6 mos.	Cerebral hemorrhage	Slight expressive aphasia. Speech is normally spontaneous and sentences complete. Slightly halting in rhythm.
RED	36	10 gr	Labor	1 mo.	Depressed parietal fracture	Very slight expressive aphasia. Speech almost normal in rate; occasional slight hesitancy. Reading retarded.

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Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of Aphasia
ROH	57	8 gr.	Cook	6 yrs.	closed head inj.	Severe expressive-receptive aphasia. Can say very few words in response to picture or conversational cues. Must have words repeated. Cannot recognize any written words.
SAN	55	12 gr.	Factory foreman	1 yr.	Cerebral thrombosis	Slight expressive aphasia. Speech slowed somewhat; occasional word-hunting and labored articulation.
SHE	55	16 Law	Lawyer	3 yrs.	Vascular occlusion	Severe expressive aphasia; very slight receptive difficulty. Articulation very labored. Formulates words and sentences with difficulty. Reads few words and cannot write.
STE	44	8 gr.	Carpenter	1 yr. 3 mos.	Thrombosis, lt. mid.cer. artery	Moderate expressive-receptive aphasia. Articulation difficult and grammatical forms slightly defective. Word and phrase-hunting often totally unsuccessful.
TER	52	16	Salesman	1 yr. 8 mos.	Cerebral thrombosis	Moderate mixed receptive and expressive aphasia. Articulation is good; needs to have things repeated; some anomia.

(continued on next page)

Table I (continued)

Subject	Age	Educ.	Occup.	Onset	Cause	Description of Aphasia
TOB	30	16	Engineer	1 yr. 7 mos.	Cerebral thromb- osis	Slight, predominantly recep- tive aphasia. Requires much repetition, especially words out of context. Reads better than understands spoken words
TRA	40	12	Salesman	10 mos.	Aneurysm, lt. int. carotid; operated	Severe predominantly recep- tive aphasia. Copious spon- taneous speech with much jargon and confused rambling Very marked amnesic word- finding difficulty.
VEN	53	6	Mechanic	3 yrs.	embolus, lt. mid. cer.art.	Severe mixed expressive-re- ceptive aphasia, affecting articulation, grammar-forms, and word finding. Misunder- stands and requires repeti- tion of words; cannot read or write with meaning.
YOU	60	8	Mailman	3 yrs.	Cer.hem- orrhage	Very severe mixed aphasia. Articulation severely affected. Spoken vocabulary of few words in response to well-rehearsed cues.
ZAU	40	8	Farmer	2 yrs.	Closed head injury	Very severe predominantly ex- pressive aphasia, with faulty articulation. Has small vo- cabulary available for single word responses, but never speaks spontaneously. Reads and writes words better than can speak them.

The fact of the tremendous range in the severity of the speech handicaps of these subjects makes it impossible to use the scores of the entire group on any single speech subtest. It was anticipated that from twenty-five to thirty percent of the subjects would cluster at the maximum or minimum scores of most of the subtests; that is, some subjects would be unable to attempt the difficult tasks at all, while the less handicapped subjects might all perform perfectly on the easy tasks. For this reason, it is necessary to regard each array of scores in a pair of subtests as involving a new group of subjects, made up of a part of the total population. The reason for discarding many of the maximum and minimum scorers in subtest pairs will be further explained under 'Statistical Procedure'.

The fact that the total aphasic group of 41 can be treated as a pool from which suitable subjects are drawn for each of the test comparisons makes it possible to use the results obtained from subjects who were not available for the complete battery of performance and language tests. Subject LEI, for example, took only seven of the language subtests and only the Goldstein-Scheerer non-language test because he was discharged from the hospital before testing could be completed. On the other hand, subjects MEY, MOK, MOR, and MUR gave usable scores on only seven of the language subtests because they were too profoundly aphasic to attempt the remaining ones.

2. Non-Aphasics and Matching Procedure

The control group for this study consists of twenty non-aphasic brain-damaged hospital patients, selected from a total of twenty-nine such individuals tested. The initial criteria for selection of controls for testing were (1) that they have suffered cerebral damage, on the basis of medical diagnosis, without any manifestations of aphasia; (2) that they have no psychosis or silliness of response; (3) that they be physically capable of cooperating for a ninety minute testing session. They were selected by a search of the files at the Fort Thomas and Dayton hospitals and further screened before testing by examination of their clinical charts.

The reason for deciding on a brain damaged rather than a neurologically normal control group was that a normal group would presumably cluster very closely around the maximum performance in the non-verbal tests. In order for correlations to be directly comparable, they must come from groups having a similar range of dispersion. Selecting subjects from a group of brain damaged individuals would greatly increase the chances of matching the distribution of the aphasic group with respect to the impairment of abstraction. Another variable in the subjects soon became apparent, namely: - the difference in education and cultural background. These differences were kept within the range of 'average to above average', as far as the aphasic group was concerned by the circumstance that they were all selected as promising for language retraining.

However, the population of non-aphasics was discovered to include some illiterates, whose language usage was probably out of keeping with their non-verbal performance. It was therefore felt profitable to match the distribution of the years of schooling, and Goldstein-Scheerer Test scores of aphasic and non-aphasic groups. Although age was not considered an essential factor to be equated, it was included as a further precaution.

As we have seen, there is no fixed "aphasic group," but simply a pool from which subjects are drawn for tests in which their results are relevant. In order to provide a basis for matching, such a fixed group was necessary. This sub-group of "matched aphasics" was made up of twenty aphasics who had achieved usable scores on all of the eight subtests which were given to the controls. The fact that the two groups could be matched with respect to mean and average deviation in Goldstein Scheerer Cube test score, years of schooling, and age was believed to compensate for the small number of individuals

Table II
Comparison of Controls and Matched Aphasics with Respect
to Matching Criteria

	Scores on Goldstein-Scheerer			Years of Educ.			Age		
	Range	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.
Aphasics	+9 to -134	-33	39.5	6 to 16	10.7	3.0	24 to 57	42.7	10.8
Controls	+12 to -200	-35.7	55.3	6 to 14	10.1	2.6	25 to 56	40.4	12.1
*t ratio for significance of differen- ces)		.17	1.4		.67	.63		.62	.50

* A ratio of 2.09 would indicate a significant difference in each case.

in each group. The procedure for matching was to list the twenty aphasics to be matched on one chart, with the data on the three criteria for matching. On another chart were the twenty-nine non-aphasic candidates for the control group, with the relevant data for each of them. By inspection, those individuals of the two groups were first paired who were most nearly alike with respect to all three criteria. Next, those individuals were paired who were nearly alike in two of the three criteria.

As a result of this rough pairing of individuals, a non-aphasic control group was established which, as a group, does not differ significantly from the twenty matched aphasics with respect to the mean or standard deviation of the three criteria. A summary of the characteristics of the two groups with respect to the matching criteria is given in Table II. The data concerning ages, education, and diagnosis of the non-aphasic controls is given in Table III. The same table also shows how these individuals were paired with their aphasic counterparts.

D. Tests and Related Materials

1. General

The selection of sets of speech-eliciting stimuli for this study required the assembly of a number of original speech subtests. Only five of the fifteen used (i.e., Color Naming, Color Reading, Word Naming, Animal Naming, Easy Opposites) are essentially the same in form and content as tests already

Table III

Summary of Data on Non-Aphasic Subjects and Comparison with Matched Aphasics

Non-Aphasics				Matched Aphasics				
Subject	Age	Educ. (yrs.)	Goldstein- Scheerer	Diagnosis	Subject	Age	Educ. (yrs.)	Goldstein- Scheerer
AIR	50	12	-40	Post-encephalitic	VEN	53	6	-34
BEL	25	8	+12	Multiple sclerosis	CRA	28	10	+ 1
BRO	56	8	-24	Left hemiplegia*	GRA	42	13	- 7
BUR	40	12	-41	Left hemiplegia*	FEA	51	12	-67
DIG	30	12	-175	Cereb. atrophy	CAD	56	11	-117
DIS	56	11	-77	Left hemiplegia*	FER	49	16	-90
ELK	49	14	-19	Rt. hemiplegia*	TRA	40	12	-20
ELW	56	10	- 9	Left hemiplegia*	CRO	27	13	-25
FOW	27	6	-13	Rt. hemiplegia*	SHE	55	16	-14
GAR	48	8	-46	Left Hemiplegia*	RED	36	10	-42
HAM	29	10	-14	Post encephalitic	FRA	33	10	-22
HOD	51	8	-24	CNS Les	GAU	50	8	-16
JAR	26	7	- 3	Multiple Sclerosis	STE	44	8	0
KEN	57	16	-47	Left hemiplegia*	ONE	55	9	-60
MAC	42	6	- 1	Lt.hemipl.(injury)	GOF	32	6	- 3
PAT	29	12	+ 3	Lt.hemipl(war ")	HER	42	16	- 3
PIC	27	12	-+ 8	Closed head injury	MAT	52	8	+ 9
TEN	29	10	-10	Closed head injury	CLI	28	10	-16
TIM	54	8	-200	Left hemiplegia*	PHI	57	9	-134
VAN	27	12	+ 6	Skull fracture	FUL	24	11	- 1
Mean	40.4	10.1	-35.7		Mean	42.7	10.7	-33

* All cases of hemiplegia so marked are secondary to cerebral vascular accidents.

reported or currently in use. Of the remaining ten, some are familiar in form, but simply involve a new set of response words, suited to the purposes of this investigation. Still others are new both in form and content.

The ideals which were set up in the construction of the tests were (1) that the vocabulary difficulty of all stimulus and expected response words be kept within the range of the three thousand most common words in the Thorndike Lorge word list; (2) that the ability to supply a response word never be contingent on the solution of a problem in reasoning; (3) that each subtest contain a sampling of items which are fairly uniform with respect to one of the speech-stimulus-variables; (4) that each subtest be clearly contrasted with at least one other, with respect to one of the stimulus-variables. The notorious inconstancy in the efficiency of aphasics is well known, while individual experience helps to determine whether any particular word comes to mind easily. Both of these facts reduce the significance of any single response, and require that an adequate sampling of the performance of each individual under the various conditions be obtained. Fifteen items were found during preliminary trials to be the greatest practicable length for each subtest and only two of the subtests have as few as ten items.

2. Description of Individual Word-Association Subtests

An exposition of the rationale and details of construction and scoring of the subtests is presented here. The full content

of each will be found in the appendix.

Tests High in Stereotypy

CONTINUING SERIES (Con. S.): The automatic sequence of word after word in the recitation of a well learned verse or word series is an act which can take place without the designation of meaning or the transmission of information; it is a performance which can frequently take place in the absence of any capacity to use words as symbols. Some word sequences follow each other as readily as syllables of a single word, while others require a degree of conscious recall of the sound of the familiar sequence. The ability of patients who were allegedly deficient in abstract behavior to complete this sort of performance is cited by Goldstein.

The continuing series test consists of fifteen items in which a portion of a familiar word sequence is recited for the subject and he is asked to fill in the next word or two. Two items each are based on the days of the week, the months of the year, the alphabet, counting forward, and counting backwards. In addition there are some items consisting of filling in the last words to lines from the Star Spangled Banner, America, Yankee Doodle, and a familiar proverb. This subtest and the next one (Easy Opposites) give by far the most stereotyped cues of any in the test battery. They may be contrasted with each of the other subtests on the basis of this factor.

Scoring of this subtest is based on a maximum of zero

and a negative score of three for each item failed. A partial failure of one point is charged for hesitation of two to five seconds and a deduction of two points for a hesitation of six to thirty seconds. No credit is allowed if the subject persists in trying for the response for more than a half minute, even if he then succeeds.

EASY OPPOSITES (E. Op.): The stimulus words for this test consist of fifteen of the words of the kind given by Wells and Ruesch (50, p. 85) as easy stimuli for the giving of opposites. It includes such pairs as "hot-cold," "good-bad," "high-low" and "east-west." All of the pairs form familiar phrases together. In the administration of the test, the first item was always preceded by some examples of what was meant by opposites. This procedure was followed because it had been observed that many subjects would miss the first item (hot-cold) but succeed quite consistently later in the list, when they had become well established in the set to give opposites. When they were given another try at the first item, later in the series, they invariably succeeded without hesitation.

Scoring standards for this subtest are the same as for the preceding one: three points off for each failure, two points off for success in six to thirty seconds, and one point off for a hesitation of two to five seconds.

SENTENCE COMPLETION (S. C.): This test consists of a series of fifteen sentences to be spoken by the examiner. In each case, the last word is left out, to be filled in by the

subject. They vary in stereotypy from such sentences as "The American flag is red, white, and" to "To make the baby go to sleep you rock his" In responding to this test, the subject cannot rely entirely on automatic associations, because most of the phrases which lead up to the last word can be concluded in several different ways when removed from the context of the sentences. However, given the mental set provided by the beginning of each sentence, there is little possible variation in the response given. For example, the words "a pair of" can be completed in several different ways, when they stand alone. However, in the sentence "The tailor cuts cloth with a pair of", there is only one possible conclusion.

Although superficially similar to the Ebbinghaus type sentence-completion intelligence test, this subtest was designed to avoid measuring differences in intelligence by having all the response words within easy reach of a child's vocabulary, and making the intended word extremely obvious. The device of providing a familiar sentence setting to help recall a word is a familiar one to teachers of aphasics. However, this device has never been embodied in a test for eliciting speech under different conditions. The scoring of the Sentence Completion test is the same as for the two preceding tests.

Highly Restrictive Tests

COLOR READING (C. R.): This test consisted in having

the subject read off serially, as rapidly as he could, a series of thirty written color-names composed of five different colors in random sequence. It was scored in terms of seconds needed to complete the series. Subjects who read with great difficulty were not required to complete the series but were timed for half of the series and the time score doubled. While the inaccuracy of pro-rating in this manner is recognized, there were only four cases involved and this technique permitted them to be placed in their proper ranks at the end of the distribution, and to be distinguished from those who could not read at all.

Aside from the subtests involving stereotypy, which are necessarily highly limiting, the use of a familiar written word as a stimulus allows a minimum of latitude in the choice of response. Color Reading can be contrasted with any but the preceding three tests as representing a more restricting speech-stimulus. Its use is suggested by Wells and Ruesch, without reference to norms, as a means of tracing improvement of an individual after head injury.

WORD READING (Wr.): This test consists of a series of fifteen familiar written words, and includes two number words and two color names. The words are exposed one at a time through a slit in a card and the subject reads each as it is exposed. The score is based on a maximum of zero and a loss of three points for each word failed. Partial failures are scored in the same way as for the first three tests mentioned.

This test is essentially the same in form as the word

reading tests included in examinations for aphasia. The list of words is longer, but each word is tried only once, during a single administration. In this way it differs from the procedure of Head and of Chesher. This test is believed to provide a stimulus of essentially the same kind as the Color Reading test, but it is on an easier level because it does not require the continuous effort and flexibility that the preceding test does. As a result, this one is more suitable for the more handicapped of the aphasic group, while the other is suitable not only for the less aphasic but for normals as well.

Non-Restrictive Tests

SYNONYMS (Sy.): This is an orally presented list of fifteen stimulus words for synonyms or approximate synonyms. The words are very commonplace ones including "hit," "liquor," "talk," "hurt," and most of them have at least two or three commonplace substitutes. However, the responses are by no means stereotyped associations and are rarely given as promptly as are responses in the subtests listed above. This test was designed to offer several possible reactions for each word, as contrasted with an Opposites subtest, where it would be hard to think of more than a single word in reply to each stimulus. In practice it has proved to be somewhat more restrictive than anticipated, as five of the fifteen words (shut, infant, large, start, glad) tend to elicit a single popular association.

Scoring of this test recognizes several degrees of

similarity as well as speediness of response. Full credit is given for a response within five seconds, one credit is deducted for a hesitation of between five and twelve seconds, and two credits are deducted for a hesitation of between twelve and thirty seconds. Standards for judging the correctness of a similarity were very liberal and credit was not deducted for any response which might, in some circumstance be used as a substitute for the stimulus word. Thus, "gigantic" was accepted as a synonym for "large," but one point was deducted for "breezy" given as a synonym for "chilly." One point was deducted for a response which added a new connotation to the meaning of the stimulus, as "argue" for "talk." Point deductions for slowness and accuracy were added, up to a total of three points off per item, which was the equivalent of failure.

The literature on vocabulary and association tests fails to reveal any previous use of synonyms as a type of controlled association test for oral administration, nor is there any published list of stimulus words for this purpose. In spite of the apparent simplicity of the task, it was one of those which had to be omitted in the testing of the most severely aphasic subjects. This is also one of the subtests difficult enough for use with the non-aphasic control group.

PART-WHOLE ASSOCIATIONS (P. W.): This is a ten/^{item}subtest in which the subject is instructed that each stimulus word is a part of something else and that he can respond with any word

that tells what the stimulus may be a part of. As an example, he is given the word "drawer" and asked for his association. A number of alternative responses are then mentioned and it is stressed that any one of those words fits the requirements of the task. The ten words on this list were selected after all the subjects had been tested with a seventeen-word preliminary list. All the response words for each item on the preliminary list were tallied, so that those words which tended to elicit only one or two popular responses could be eliminated. Of the ten words finally chosen, all had at least four different responses given by more than one person; none had as many as two thirds of the total responses concentrated among the two most popular ones. The frequency of the responses are listed, along with the ten stimulus words on page 171 of the Appendix.

The Part-Whole association test was scored in two ways. The reaction time for each word was measured with a stop-watch and recorded, so that the mean reaction time for each subject was available. The speed and correctness score was computed on the basis of a maximum of zero and three points off for each failure with no partial correctness credit permitted. Deductions for slowness were the same as in the Synonyms test, immediately above. This subtest was used with both aphasics and controls.

Subtests without Specific Stimuli

WORD NAMING (W. N.) and ANIMAL NAMING (A. N.): These two subtests are the only ones in the battery in which the subject is required to give a sequence of independent responses after receiving only initial instructions from the examiner. Both are found originally in the Stanford Binet scale at the ten year level, where the norm for word-naming is 28 words in one minute and the norm for animal naming is 12 animals in one minute. The word-naming task is one of virtually uncontrolled association, where the instructions are to name as many words at random as come to mind for a minute. In the Animal Naming test, the subjects are asked to mention all the animals that come to mind for a minute -- a task which is much more controlled than the other, yet which resembles it in that the subject is constantly called on to hunt anew for a word, without receiving an external cue. In this way, both of these subtests require more in the way of spontaneity and initiative than any of the others in the battery. The relation of spontaneity in speech to abstract behavior has already been discussed. (p. 33)

Animal Naming may be contrasted with Word Naming as being more restrictive than the latter. According to theory, we should find a relative drop in Word-Naming ability among the subjects who are deficient in abstraction, because in that situation they are given no preliminary mental set whatsoever, to guide their choice of words. In the early trial use of these two subtests, the investigator observed that

those aphasics who had the most difficulty in initiating speech without a conversational cue from outside also seemed to be the ones who were at a loss in the Word Naming task, but relatively competent in the more highly structured Animal Naming task. Terman and Merrill (41) call attention to the fact that limiting the scope of associations cuts down the number of words given from 28 to 12 -- a ratio of better than two to one. In contrast, the aphasics in question tended to name nearly as many animals as words at random and, in a few cases, even more animals. However, the relation of this characteristic to abstract behavior, as measured by non-verbal tests, was not observed.

These two subtests are particularly suited to both aphasics and non-aphasics because there is no maximum score and they differentiate degrees of word fluency at the highest levels. In the recording of performance, no effort was made to write each word, but each was recorded by a tally mark on a sixty point scale, to show the time distribution of the responses. A stop watch was used to guide the examiner in this procedure. The score in Word-Naming was the total number named, while that in animal naming was the greatest number named in any continuous thirty-second period.

Other Subtests

INITIATING SERIES (In. S.): This set of ten items was chosen to be contrasted particularly with the subtest Continuing Series. Here, instead of giving the subject a start, we tell

him to recite from the beginning such things as the days of the week, the months of the year, the alphabet, the Star-Spangled Banner, and other equally familiar word sequences. In asking for the first line of each of the songs used, the examiner first whistled the beginning and asked the subject if he knew what the song was, then asked for the first few words. Success in this test was scored on the basis of the ability to supply the first three words of the required word-sequence, and a partial deduction of one point was made in the case of minor distortions in any but the first word. Scoring was on the basis of zero for a perfect performance, one point off for any hesitation of from six to twelve seconds, and two points off for a hesitation of thirteen to thirty seconds. More than thirty seconds delay in supplying the beginning of the series was counted as a failure.

This test is suitable for contrast with any of the three tests which are high in stereotypy, since there is no stereotypy at all in this stimulus situation. It may also be contrasted with the subtests which are least restrictive, since in this subtest no more than a single response is possible for any item.

OPPOSITES (Op): This subtest consists of fifteen stimulus words for opposites chosen from the list supplied by Wells and Ruesch. They are contrasted with the Easy Opposites because they do not constitute familiar phrases with their opposites, and hence are very low in stereotypy of linkage between stimulus and response. It was also intended as a more

restrictive subtest than synonyms, on the basis that only a single response word was commonly available for each stimulus word. This supposition was not completely borne out, as the words "narrow," "stand," and "work," have each elicited two or more adequate opposites. Still it is suitable for contrast with both Synonyms and Part Whole associations, as representing a more restrictive stimulus situation. Scoring for this subtest is exactly the same as for the "synonyms" test, except that no part credit for inaccurate meaning is allowed.

DEFINITIONS(Def.): These are fifteen questions, each of which defines or gives the outstanding characteristic of a familiar word and asks what the word is. For example, it includes items like "What do cows give us to drink?" and "What do we call a ten cent piece?" This subtest was constructed originally to be contrasted with the Sentence Completion subtest, and thirteen of the expected response words are the same as in the latter test. For example, the two items cited correspond, in the Sentence Completion test, to the sentences: "Some people like coffee for breakfast, but others prefer a glass of" and "Two nickels make a" The contrast lies in the absence of the stereotypy variable from the stimulus situation represented by the Definitions subtest. It is therefore suitable for contrast with the Continuing Series and Easy Opposites subtests as well. Although most of the questions tend to elicit the same word each time, there is enough variability in possible responses to prevent us from

considering this as a restrictive stimulus situation.

The scoring of Definitions is similar to that of Sentence Completion and the other relatively easy subtests -- i.e. the penalty for hesitation starts with any delay of more than two seconds. This is one of the subtests which does not differentiate adequately among the more mildly affected aphasics and is therefore unsuitable for use with non-aphasics.

COLOR NAMING (C.N.): Serial color naming, like serial color reading, is known as a clinical test for indicating brain damage. A Color Naming chart is included, for this purpose, in the Wells-Ruesch handbook. The reasons for the longer mean reaction time in naming colors, as against reading their names, were discussed earlier (p42) and related to the problem of abstract behavior. The present color naming chart consists of thirty squares of the five colors: red, blue, green, yellow, and black, mounted in a random sequence on a five by eight inch white card. The subject is asked to name the colors in sequence as quickly as possible and time for the naming is kept in seconds. The same pro-rating procedure was followed in this case as for the Color Reading subtest, for those aphasic subjects who could not be asked to persevere through all thirty colors.

In order to check for color blindness, the subjects were asked to find all the squares of each color named by the examiner before performing the test proper, in addition to being asked directly whether their color vision was good.

Only one color blind subject was detected in this way, and he had identified himself as color blind on being asked.

The Color Naming subtest is contrasted with the Color Reading and Word Reading subtests for the variable of restrictiveness. It is not clearly suitable for contrast with any of the other oral subtests with respect to the variable of restrictiveness, but it is suitable for contrast with subtests high in stereotypy. It is used with both aphasic and control groups.

PICTURES (Pic.): This is the usual object naming test which is a basic part of any examination for aphasia. It parallels the Word Reading test in that the response words are exactly the same. The stimulus cards for this subtest have line drawings of the various objects (watch, star, heel, etc.) to be named. The words "writing" and "sleeping" are represented by a drawing of a person in each of those activities and in pointing to them, the examiner asks, "What is he doing?" The two numbers --five and three-- are represented by dice with the appropriate face turned up, and in pointing to them, the examiner asks, "How much?" Two colors are also represented.

The accuracy scoring in this test allows no part credit, as the only word which can be named correctly in more than one way is "stove" for which the words "oven" or "range" are acceptable. However, the responses "write" and "sleep" instead of "writing" and "sleeping" were accepted. This was done in order not to penalize those aphasics who used a type of agrammatic speech which is termed "telegraphic" and is

characterized by the omission of articles and prepositions and the inability to use any but the infinitive form of verbs. The penalty for hesitation is the same as in the other easy subtests, beginning with two seconds delay. This test, of course, discriminates only among the moderately to severely aphasic, and is not suitable for use with the non-aphasic controls.

With regard to the speech stimulus variables under study, the Pictures subtest is believed to contrast with either Color Reading or Word Reading, in being less restrictive than those written-word stimuli. On the other hand, it is decidedly more restrictive than either the Synonyms or the Part-Whole Associations and may be contrasted with them in the reverse way. It is also devoid of stereotypy, in the sense of a much-practised word-sequence, and may be contrasted with the two most highly stereotyped subtests.

3. Non-language Tests of Abstract Behavior

1. General

The adequate evaluation of performance of nearly all the tests of abstract behavior discussed earlier requires some verbalization on the part of the subject. A verbal explanation sometimes serves to show that a successful performance was actually arrived at accidentally in a purely concrete way; on the other hand, it may reveal a process of abstract reasoning which is hidden by an accidental failure in performance. This investigation required the use of tests which could be solved only by the adoption of an abstracting approach, and

which could be evaluated in quantitative fashion by the observation of behavior. In addition, considering the physical and language limitations of the subjects, the tests had to be easy to explain and easy to carry out with one hand. Because of the variable degrees of paralysis and manual incoordination in the subjects, the speed factor was almost entirely omitted from the scoring criteria, being given only a minimal role in the Goldstein-Scheerer cube test performance.

b. Description of Tests

GOLDSTEIN SCHEERER CUBE TEST

This test, which has been briefly described above (p.18) consists of a series of twelve colored designs in the form of squares, all of which can be reproduced by the proper manipulation of four one inch wooden cubes having their sides colored all red, all white, all blue, all yellow, half-red-half-white, and half-yellow-half-blue. The designs themselves were selected from the Kohs Block Design test, well known to psychometricians. In the standard administration, which was closely followed by the investigator, the subject is first presented with a half-scale reproduction of the test design, in which no lines are drawn to indicate boundaries between blocks, except where these happen to coincide with the lines of the design. If the subject cannot reproduce this one, he is given a card on which the design is drawn full-size. If he fails to do this after three minutes, he is shown the design in half-scale again, but with lines drawn in to show how the four blocks are placed. If he cannot work from this drawing,

he is shown a reproduction in full size, with the boundaries of the four blocks indicated. Failure at this level is followed by having him try to reproduce the design from a model built by the examiner. If this cannot be done, he is asked to select the correct reproduction out of three set up by the examiner. If the subject succeeds at any of the simplified levels, he is again given the first version of the design to see if he has actually acquired insight.

Recording and scoring: in order to permit the ranking of subjects in terms of abstract behavior, as manifested in the handling of the blocks, a numerical scoring system was devised, for use in connection with a move by move record of activity in the solution of the design. This approach to scoring permits taking into account the actual quality of the moves, rather than merely success or failure with each design. It is more cumbersome than the scoring procedure suggested by Nadel or Goldstein and Scheerer, and it requires defining a number of types of activity, and assigning to each an arbitrary plus or minus value towards the rating in abstract behavior. In the recording each block in the design was assigned a number from one to four. Each move by the subject was identified by the number of the block which he was placing, followed by a check or a cross to indicate whether the move was correct or incorrect. The use of the wrong block face was indicated by the initial of the color turned up (e.g. "y" for yellow or "r/w" for red-white). When the numbering of blocks did not cover the situation (as in case of random turning of blocks),

the activity was described verbally or the resulting design sketched onto the record.

The various types of moves which were given plus or minus credit in the scoring of the performance are listed and defined below:

A. Activity reflecting on general abstractness of approach.

1. Conceptual approach* - The subject examines the design only once and proceeds without having to look back at the design to compare details. Adds two points to score.
2. Copying* - The subject looks back at the design to recall the appearance of it and check on his reproduction. Adds one point to score for design.
3. Matching* - The subject compares each block with the corresponding portion of the design to make sure it is oriented in the same way as the drawing before he places it. No credit.
4. Trial and Error* - The subject places the block and checks its resemblance to the design by the resulting appearance. Usually involves several trial placements of a block, in rapid succession, until the desired result is obtained, or until the block is discarded, or left in place incorrectly oriented. Subtract one from total score.

*Items marked in this way were suggested by Dr. Frederick Wyatt and were used by him as part of a standard scoring procedure for this test. Dr. Wyatt is not responsible for the arbitrary point values assigned here.

B. Activity reflecting on the ability to differentiate the various aspects of each problem.

1. Incorrect placement - any placement of a block which is permitted to stand, in spite of its incompatibility with the design. Subtract one for each such move.
2. Inability to manipulate* - The subject discards a block which he has been trying to place and picks up another one, ignoring the fact that all the blocks are identical. Subtract two from score for each occurrence.
3. Failure to orient - The subject cannot orient his reproduction with respect to the horizontal to correspond with the test design. He may attempt to rotate the test booklet to make a diagonally placed design appear horizontal. Subtract two points.
4. Misinterpretation - The subject builds as though he perceives the design as slightly different from its actual appearance. For example, he may attempt to reproduce an all-red square by placing four half-red-half-white faces with their red corners together, so that a red square is formed in the center, embedded diagonally in a square white background. Subtract two points.
5. Irrelevant pattern - The subject is diverted from the actual design by an apparent need to

*See footnote p. 81

- complete a pattern which is suggested by an accidental configuration of the blocks he is handling. He acts as though he is still attempting to solve the original design. Subtract two points.
6. Failure at any level - Each presentation of the design -- both the original version and the simplified versions -- which the subject fails results in the subtraction of two points.
 7. Failure of re-try - Failure to reproduce the design from the original form after succeeding with one of the simplified presentations. Three points.
 8. Broken square* - Any placement of a block which is incompatible with the completion of a square design. Subtract three points.
 9. Overtime: Any design which takes more than ninety seconds to complete, without going beyond the first level of difficulty is penalized two points.

Color and Form Sorting

The Color and Form Sorting test was devised to introduce a performance situation in which the number of response possibilities is systematically varied. This is done with respect to a task which requires the subject to maintain an abstract criterion in mind while carrying it out. The material

* See footnote p. 81.

for the test consists of sixty small ($3/4$ inch in diameter) cutouts of colored cardboard. They are of four different colors plus black, white and grey, and of twelve different shapes. The shapes are grouped as follows: three pointed figures, consisting of three-pointed stars, triangles, and convex-sided triangles; four-pointed figures, consisting of four-pointed stars, squares, and rhombuses; five-pointed figures, consisting of five-pointed stars, pentagons, and concave-sided pentagons; rounded figures, consisting of circles, ovals, and ellipses.

In order to perform the first part of the experiment, the subject must grasp the distinction between "colored" and "uncolored" cutouts, and be able to identify those which are red, blue, green, or yellow as "colored," while considering the three achromatic shades as "uncolored." He is then given the task of selecting the "colored" piece or pieces under increasingly complicated conditions. The simplest problem is selecting one colored piece from among three of the same shape, where only one is colored. The most complicated one is selecting all the colored pieces from a large assortment of pieces of various shapes, both colored and achromatic.

In the second portion of the experiment, the subject must disregard color and deal with the categories of shapes. He is first shown sample cards to illustrate the categories "stars," "three-pointed," "four-pointed," "five-pointed," and "rounded" figures. For the simple levels of form selection, a card was used on which were mounted one of each of the twelve shapes, all of the same color. These were exposed three at a

time, so that the subject could demonstrate his ability to select a piece belonging to a category named by the examiner. The next level of difficulty required the subject to find all three members of a given category, by inspecting the entire test card. The most complex task in this half of the experiment was to select all the pieces of a given category (e.g. "stars") from a large assortment of pieces of all shapes and colors. Thus, in selecting all the "stars," the subject had to disregard both the color and the number of points.

At each level of difficulty, if the subject failed to perform the selection on being told the name of the category, he was permitted a glance at the sample card for that category to remind him of what its members looked like. When that failed, he was permitted to compare the sample card directly with the pieces to be sorted and solve the problem by matching. If he failed to sort according to the abstract criteria in either half of the experiment, he was given a series sorting task in which the criterion was a specific color (e.g. "Pick out the red ones") or a specific form (e.g. "Pick out the squares"). The exact sequence of the tasks and samples of the test pieces are shown on pp. 176-8 in the appendix. This was the only non-verbal test which was given to the aphasic, but not to the control group.

Color Matrices

This test consists of a series of twelve cards

presenting multiple choice problems of selecting either one of three or one of six colored squares which will best fit into the empty space in a color pattern, or matrix. The first of the problem matrices consists of only two rows of three squares each. The lower row contains three light blue squares; the upper row, two purple squares and one left blank. The subject must point to one of three colored squares mounted above the pattern to show which

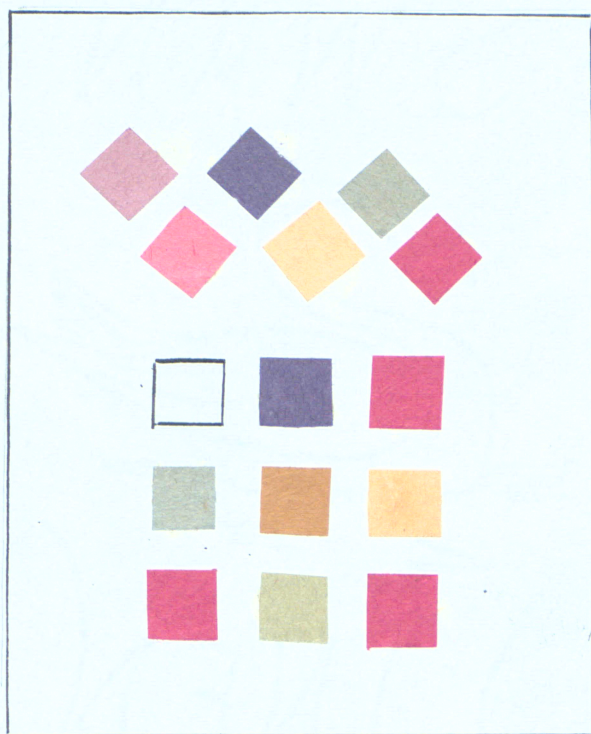


Figure II - Card II of the Color Matrices Test (reduced by one half)
 one would complete it. Most of the remaining problem matrices are composed of nine colored squares, of which one is blank. The most difficult of the problems is illustrated in Figure II. The redness of the corner squares is the only characteristic of the design which can be differentiated and then applied to the solution of the empty space.

Two of the twelve problems were deliberately made ambiguous, and had several solutions. While these two problems had a "most correct" solution, they did not contribute to the score, but acted as buffers. The score consisted of one point for each problem correctly solved in the second of two successive administrations. Where the first run indicated possible misunderstanding of the requirements of the problem, it was re-explained without any comment on the correctness or incorrectness of the original choices.

The pattern-completion test is applied to the measurement of abstract intelligence by Raven (39), who used the term "progressive matrices" and Cattell (4) who incorporates a section of "matrices" in his Culture-Free Test. Much of the difficulty of Cattell's items appears to lie in the necessity for dealing simultaneously with many abstract characteristics of the designs which make up his matrices. The use of colors instead of abstract designs has not been suggested previously. The resulting items do not give us a power test of abstract reasoning, yet they can hardly be solved by a mere "feel" for the symmetry of the pattern.

4. Concepts Test

This test, used with both aphasic and control groups, consists of twenty-five items cut out of the SEA Non Verbal test (33) and mounted on five by eight inch cards, five to a card. This is a "cross out" type of test, in which the subject must point out which of the five pictures or designs in each

Table IV. Description of Items of Concepts Test

Item Number	Original Number on SRA Non-Verbal Form	Description	Leading Question Cue
1.	Sample 9	Four pennies and a nickel.	Are they all pennies?
2.	Sample 4	Four crossed pairs of rectangles; four show all lines crossing.	Do they all show the lines crossing?
3.	9	Four pairs of squares, corner to corner; one pair side by side.	Are they all corner to corner?
4.	Sample 7	Four squares in different positions; one triangle.	Are they all squares?
5.	Sample 5	A bus, a man, a train, an auto, and a bicycle.	Are they all vehicles?
6.	31	Four people eating or drinking; one woman using a skillet.	Are they all taking in food?
7.	37	A sink, a kitchen stool, an armchair, an ice-box, a stove.	Do they all belong in the kitchen?
8.	10	A newspaper, three books, a radio, a magazine, one book.	Are they all to read?
9.	22	A racket, a broom, a golf stick, a baseball bat, a hockey stick.	Are they all for sport?
10.	14	Can of applesauce, banana, pear, grapes, half grapefruit	Are they all fresh fruit?
11.	33	Four closed geometric shapes, each with a small gap; one S-shaped figure	Are they all closed?

Table IV: (continued)

Item Number	Original Number on SRA Non-Verbal Form	Description	Leading Question Cue
12.	42	Perspective drawings of sets of three cylinders and prisms. All but one set are parallel.	Are they all side by side?
13.	Sample 10	Four circles with crossed chords in various positions; one with uncrossed chords.	Do they all have crossed lines?
14.	36	Four circles, each with two dots just inside the circumference and a third just outside, but adjacent. One circle has outer dot on far side.	Do they all have the dots together?
15.	60	Square, trapezoid, kite-shape, rectangle, triangle.	Are they all four-sided?
16.	13	Hand, glasses, face, ear, leg.	Are they all part of a person?
17.	16	Light bulb, lantern, candle, sunset, flashlight.	Are they all manufactured?
18.	50	Stool, window with curtains, fence, chair, ladder.	Are they all wooden?
19.	25	Watch, calendar, clock, sundial, hourglass.	Do they all tell time?
20.	46	Jack-O-lantern, Valentine, Christmas tree, birthday cake, bursting firecracker.	Do they all stand for a public holiday?
21.	55	Icecream cone, shoe, fan, ice-cream soda, bathing suit.	Are they all for keeping cool?
22.	44	Bathtub, comb, vacuum cleaner, washing machine, toothbrush.	Are they all for washing and cleaning?

Table IV (continued)

Item Number	Original Number on SRA Non-Verbal Form	Description	Leading Question Cue
23.	51	Two drawings of a large square with a small circle inside and a small square just outside; two large circles with small square inside and circles outside. One square with square inside and circle outside.	Is the outside shape always the same as the big design?
24.	32	Pencil, hammer, pen, paintbrush, art brush.	Are they all for making markings?
25.	40	Auto, sailboat, kite, windmill, glider plane.	Do they all use windpower?

item does not belong with the other four. It is almost impossible to solve these items without abstracting the characteristic which is common to four of the five. When an item was not correctly identified without help, the essential characteristic was supplied by asking "Are they all ... (e.g. things to read) ...?" If the subject could utilize this lead to identify the odd picture, he was allowed a credit of one point, instead of the three points given for each fully correct solution.

In Table IV, the twenty-five items are described verbally and identified by their item numbers in the original test. The leading question used with each follows the description.

E. Order of Procedure in Gathering Data

1. Aphasic subjects

Control of test conditions at all the installations where testing was carried out, a fairly quiet room was obtained in which testing could proceed in privacy. Scheduling of patients for examination was often complicated by their varied rehabilitative programs in the hospital, but when several sessions were required with a single patient, he was always seen at the same hour of the day. In this way, the patient's systematic variations in efficiency according to the time of day were controlled. The much more elusive factor of fatigue could be minimized only by constant readiness on the part of the examiner to terminate the session when fatigue appeared. The patient was asked fairly frequently whether he was tiring

and at the first admission of fatigue, a new appointment was made for another day. Both the factors of the patient's programs and their different degrees of tolerance of testing made it impossible to follow the same schedule of testing for all, insofar as the number of subtests covered in one session was concerned.

A uniform approach to enlist the patients' cooperation proved successful with almost all who were asked to serve as subjects. Only one aphasic refused to have anything to do with the project. The examiner explained in simple terms the purpose of the study, putting it on the basis that no one quite understood why they could find words to say under some conditions but not under others; that this study was intended to clarify just what those conditions were, and that a great many aphasics were cooperating in it. The response of the patients varied from passive acceptance of the testing as an obligation which they owed the hospital to a high degree of enthusiasm, to the point where they asked for more tests.

The maintenance of morale in the face of inevitable failures during testing was anticipated as the most severe problem affecting the reliability of results. The speech function becomes highly charged with emotion to most aphasics. While a great many learn to accept their failures with equanimity, even the most passive and depressed seem to be compelled to make a real effort to reply to each test item. Thresholds for the recall of words vary spontaneously in

the aphasics to a much greater extent than in normals, but they vary even more under emotional stress. Therefore, without sacrificing uniformity of standards for recording and scoring responses as they occurred, the examiner gave the subject every possible opportunity to experience success during the examination. This was done by frequently assisting the subject to say what he failed to say under the test conditions, by giving him the cue he needed as soon as it became evident that he could not produce the response otherwise. The examination was thus, in part, a learning experience. This was done at the risk that teaching the patients the answers to the test items might spoil the possibility of securing reliability measurements by re-test later on. Such a risk was considered minimal because there is little carry over in aphasics from one day to the next, as a result of only one practice trial. Re-tests in this study were planned after a two week interval. Slight illness and emotional upsets outside of the testing situation itself were also considered sufficient reason for postponing or entirely cancelling a testing session. In general, the effects of fatigue and emotional conditions upon thresholds for the observed performances are admittedly imperfectly controlled. To the extent that they were detected, they were avoided by the postponement of the tests.

b. Order of testing

The language tests were administered first and in a fixed sequence in all cases. The sequence was:

- | | |
|------------------------|----------------------------|
| 1. Pictures | 8. Definitions |
| 2. Written words | 9. Synonyms |
| 3. Word Naming | 10. Easy Opposites |
| 4. Animal Naming | 11. Opposites |
| 5. Color Naming | 12. Initiating Series |
| 6. Color Reading | 13. Continuing Series |
| 7. Sentence Completion | 14. Part Whole Association |

No subtests were omitted from the examination of a subject on the grounds that they might be too easy, but a number of subtests were customarily omitted in the testing of the severely aphasic. Those occasionally omitted were, in order of frequency, numbers 9, 14, 11, 5, 6, and 4. The non-verbal tests began with the Goldstein-Scheerer Cube test. Concepts, Color and Form Sorting, and Color Matrices followed in that order.

In the great majority of cases, all but one or two subtests of the language battery were covered in the first testing session. The second session was scheduled no more than one or two days after the first, and usually saw the completion of the remainder of the examination. Subjects YOU, CAD, and FEA all required three sessions of forty minutes each for the completion of the speech battery alone -- the first two because of program difficulties and the third because of easy fatiguing. Subjects MEY, PHI, RED, ROH, SAN, HEA, and TER managed to complete all their testing in a single session of less than two and a half hours. Subjects BON and HERB, who were seen in the out-patient clinic of Massachusetts General Hospital were each available for only two brief sessions during which the speech battery was completed with them and no tests of

abstraction done.

A second administration of the entire speech battery was originally planned for all the subjects. However, this plan could not be put into effect for any of the patients seen either at Massachusetts General Hospital or the Dayton V. A. center. Nearly all of the subjects tested at Cushing and Fort Thomas Hospitals were given a second testing between two and three weeks after the first. Again, it proved administrative-ly impossible to give the tests exactly two weeks later to each patient, as planned. However, the time of day of the second testing and the break-up of the battery, when two sessions were required, precisely paralleled the first administration.

2. Non-Aphasic Subjects

The cooperation of the non-aphasic control group was obtained by a frank explanation of the purpose of the study, quite similar to the one given the aphasics. They were told that their cooperation was purely voluntary and that this investigation was directed at understanding more about their fellow patients who had suffered loss of speech as a result of head injury or stroke. Only one subject (BUR) asked some skeptical questions before agreeing to participate. The assurance by the investigator that this testing had no bearing on their own treatment in no way lessened their interest and probably removed much of the feeling that they might be threatened in some way by the procedure.

In order to condense the entire battery into a single session of an hour and a half, the Color and Form Test was

omitted from the Non-verbal portion. The order of administration of the tests was followed uniformly with all subjects in this way: Word Naming, Animal Naming, Color Naming, Color Reading, Synonyms, Easy Opposites, Opposites, Part-Whole Associations, Goldstein-Scheerer Test, Concepts, and Color Matrices.

3. Basis of Scoring

All subtests were recorded on mimeographed record sheets having enough room for verbatim responses. A stop watch was left running constantly and the examiner marked off seconds by short vertical lines until the response was given. The response was written out only when it was incorrect or when a number of possible responses could be considered correct. It was indicated with a check when it conformed to the usual correct word.

The scoring of each of the subtests was regarded principally as a means of ranking the subjects with respect to their proficiency under the conditions of each subject. In order that these scores might reflect what was relevant about the performance, it was necessary to decide what characteristics of the response should contribute to the numerical rating. The problem concerns the ability of people to bring to mind and express in speech the words they want, under different stimulus conditions. Thus, if the word the subject wanted and used was fairly appropriate to the meaning of the stimulus, it was accepted, even though it was not quite what the examiner had in mind. On the other hand, when the response showed that the patient was only approximating what he wanted to say,

(e.g. the word "letter " given instead of "writing") it was scored so as to indicate a deficiency in performance. As a general rule, we may assume that the amount of time needed to bring a word to mind and speak it aloud is also a measure of deficiency in this function. One is justified in combining into a single score for each subtest a measure of the promptness of the responses, a measure of the appropriateness of the meanings, and a measure of the absolute failures.

Articulation, throughout this battery, is treated on an all-or-none basis; poor articulation was never penalized, provided that the subject acted as though he had said what he intended and the examiner could tell what word was meant. When the subject acted as though he did not consider that his attempt at speech constituted a response, it was scored as a failure, even though the examiner recognized an attempt at the correct word.

F. Procedure in Treating Data

1. Operations Performed on the Raw Subtest Scores to Derive Scores Related to the Three Speech-Stimulus-Factors

The array of scores on any single subtest by itself cannot legitimately be used to demonstrate the existence of a relationship between a factor embodied in that speech subtest and the abstraction scores of the subjects involved. Although Word Naming, for example, may be shown to correlate very significantly with the Goldstein Scheerer Cube test, a part of this correlation is due to the fact that both performances

are inevitably affected by the individual's overall deterioration, or the severity of his brain lesion. In order to draw conclusions concerning a single factor of the speech stimulus, it is necessary to contrast scores on two speech tests which differ only with respect to the factor concerned. The difference in scores must then represent the effect of the factor which has been varied. If the test populations were the same in each case, it would be sufficient to find the difference between the correlations of the two subtests with the criterion of abstract behavior.

The fact that each pair of contrasting subtests represents a partly different population from that of either subtest alone, makes it preferable to examine the differences in performance of each individual under the two conditions. The difference in performance is best measured by the difference in the individual's ranks in the two arrays of scores. Thus, if a subject is adversely affected by the removal of a stereotyped cue in the stimulus, his rank in a subtest like Initiating Series should be lower than it would be in Continuing Series. Those who suffer least by the removal of the stereotyped lead will have a higher standing in the first-named subtest. The rank difference for each subject can therefore represent the effect of stereotypy on his performance, and may itself be treated as a score. If we rank these rank-differences, the resulting array will give the standing of the subjects with respect to the effect of stereotypy on their performance. The procedure of ranking the rank-differences was used with

each contrasted pair of subtests to isolate the effect of the speech-stimulus-factors. The abbreviation Rrd, followed by the names of the two subtests involved, refers to each array resulting from this procedure. In the case of the subtests cited as examples, this array of scores is headed Rrd (Con. S. - In.S.). The Rrd's of the paired subtests represent the dependent variables in both major problems of this investigation. (Cf. p. 46, second paragraph)

In addition to being cumbersome, the Rrd method has another disadvantage which results in the loss of several subjects from the population common to each pair of subtests. Any individuals whose performances head the distribution in both subtests automatically have a rank difference of zero and a spurious Rrd score as a result, regardless of the actual difference in difficulty which they may have experienced under the two conditions. This applies not only to those at the head or at the end of both distributions, but to those tied or almost tied for first or last place. The solution to this problem has been simply to discard those cases, an operation which does not prejudice the resulting correlation in one direction more than the other, except by chance.

Some specific combinations of subtests which could be contrasted for the isolation of each factor were suggested in the course of the description of the subtests. The following four tables present the actual combinations of subtests for which the Rrd's were obtained. In the actual computation of

rank differences the rank in the less structured test was always subtracted from the rank in the more highly structured one. This assured that the highest positive rank difference would go to the subject who performed well under the condition requiring independence of the stimulus-structuring.

The partial overlapping of the three factors is recognized in the construction of the tables. The concept of the restrictive stimulus includes the stereotyped stimulus as well -- since under conditions of stereotypy only one reaction is possible. The category of non-restrictive stimuli, on the other hand, includes the two subtests having no specific stimuli. Therefore, in Table V, restrictiveness is kept fairly constant by contrasting subtests high in stereotypy with others which are restrictive but not stereotyped in their stimulus-structure. Analogously, neither the highly restrictive nor the stereotyped-stimulus subtests are included in Table VI, where isolation of the specific stimulus factor is sought. Those subtest pairs which appear to differ with respect to two or all three of the factors are listed in Table VIII.

2. Treatment of Data Bearing on First Major Problem

Each of the Rrd arrays obtained through the procedure just described is compared by means of a rank order correlation, with each of the criteria of abstract behavior.

a. Data from Aphasic Group

Each of the fifteen Rrd arrays in Table V is one measure of the dependent variable "effect on performance of a stereotyped stimulus-response link." Each array of scores

Table V

Subtests Contrasted for the Isolation of the Effect of the Stereotypy Factor on Performance, Giving Number of Subjects in Each Subtest Pair

Subtests High in Stereotypy	Contin. Ser.	Easy Opp.	Sent. Compl.
Subtests Low in Stereotypy			
Init. Ser.	28	35	37
Pictures	32	34	31
Definitions	27	30	30
Opposites	30	31	30
Col. Nam.	24	28	26

Table VI

Subtests Contrasted for the Isolation of the Effect of a Specific Stimulus for Each Response, Giving Number of Subjects in Each Subtest Pair

Subtests Which Do Not Provide Specific Stimuli	Word Naming	Animal Naming
Subtests Providing Specific Stimuli		
Synonyms	27	28
Opposites	30	30
Part Whole	27	29
Col. Nam.	23	23
Pictures	26	29

Table VII

Subtests Contrasted for the Isolation of the Effect of
Restrictiveness of Stimulus upon Performance,
Showing Number of Subjects in Each Pair

More Restrictive Stimulus Structure	Col.R.	Wr.Wds.	Opp.	Pict.	In.Ser.	An.N.
Less Restrictive Stimulus Structure						
Color Naming	22	20	--	--	--	--
Pictures	23	24	--	--	--	--
Synonyms	26	26	26	27	29	--
Part Whole	26	24	30	24	24	--
Opposites	29	22	--	--	--	--
Word Naming	--	--	--	--	--	26

Table VIII

Subtests Contrasted for the Isolation of the Combined
Effect of Two or Three of the Stimulus-Factors,
Giving Number of S's in Each Subtest Pair

More Highly Structured Stimulus	Def.	Wr. Wds.	Col. R.	Con. S.	E.Op.	S.Com.	In. Ser.
Less Structured Stimulus							
Word Naming	(a)38	(a)35	(a)27	(b)32	(b)29	(b)32	(a)31
Animal Naming	(a)31	(a)26	(a)29	(b)31	(b)33	(b)34	(a)29
Synonyms	--	--	--	(c)28	(c)28	(c)30	--
Part Whole	--	--	--	(c)26	(c)32	(c)28	--

(a) designates contrast in restrictiveness and in presence of specific stimulus for each response.

(b) designates contrast in restrictiveness, stereotypy, and presence of specific stimulus for each response.

(c) designates contrast in restrictiveness and stereotypy.

on the four non-language tests of abstract behavior is a separate measure of the independent variable. The computation of the rank order correlations between each of the Rrd's and the non-verbal scores provides sixty separate measures in the determination of the relationship hypothesized in the first subproblem. These measures are not wholly independent, because each speech subtest contributes in part to either twelve or twenty of the sixty measures.

The low number of subjects concerned in each of the computations results in the requirement that individual correlations be as high as .39 to be considered statistically significant. This study requires only that we demonstrate the presence or absence of significant relationships between the variables. In the face of a large number of coefficients of correlation which are positive but too small in magnitude to be considered significant, taken individually, a supplementary technique is used to check on the significance of the relationships. The existence of a systematic relationship can be established if the distribution of coefficients of correlation about the zero point differs significantly from chance. The Chi Square test for this purpose is easily applied when it is known that all the measures are independent. In this case, the Chi Square method is used, but its results must be taken with reservations, because of the partial interdependence of some of the measures.

The operations described for examining the relationship between the first of the speech-stimulus-factors and the measures of abstraction are repeated for the next two speech factors by

using the sets of Rrd's listed in Tables VI and VII. The Chi Square technique is repeated both times, although more of the individual correlation coefficients are of significant magnitude in these two cases. The computation of the correlations derived from Table VIII shows whether the combination of two or three factors has a cumulative effect.

b. Data from Matched Groups

The Rrd's of the twenty-two test combinations which are underlined in the four preceding tables were obtained both for the twenty matched aphasics and for the non-aphasic control group. Two of the twenty-two are considered purely indicative of the effect of stereotypy, while two more are treated as representing the combined effects of stereotypy and restrictiveness in the stimulus structure. Six of the twenty-two are considered to isolate the effect of restrictiveness in the stimulus structure, while eight represent the effect of providing individual stimuli for each response. Four combine the effects of stereotypy and the presence of specific stimuli.

Each of the Rrd's so obtained is compared to the distribution of the same twenty subjects on each of the three non-language subtests, using the Spearman rank-order coefficient of correlation. Here again, the purpose of the computation is to show the presence or absence of similar relationships in the two groups -- aphasics and controls. The finding of positive relationships in the data from the control group is necessary before we can generalize that any of the three factors really helps define abstract behavior.

3. Treatment of Second Major Problem

The independent variable for the second problem is the general level of word-saying ability of the subjects. This takes the form of a single array in which the subjects are all ranked in the order determined by the mean of their ranks on all the subtests which they have taken. This array, which is the result of ranking the means of the ranks, is referred to as the Rmr. In order to determine the relationship of each of the speech-stimulus-variables to the Rmr, the coefficients of correlation are obtained between the Rmr and the Rrd's which correspond to each of the speech variables. Again, the classification followed in Tables V to VII tells which subtest pairs are considered to give a measure of which speech-stimulus-factors. As in the treatment of the first problem, the existence of significant relationships depends both on the magnitude of the correlations found and their distribution around the zero point. The Chi Square technique is again applied to the determination of the possible chance occurrence of the distribution of the correlations in each group. The same reservations concerning the interpretation of Chi Square must be kept in mind, since the same partly interdependent measures are involved.

4. Reliability of Subtests

An indication of the reliability of the speech performances used is obtained by tabulating the original and re-test scores of the twenty-four subjects who had two administrations. Since the twenty-four subjects are spread over a great range of

speech disability, the coefficients of reliability may be expected to be deceptively high. While these results may give an exaggerated idea of the reliability of the subtests for repeated individual measurements, they will accurately reflect the reliability of the subtests, as applied in this investigation. That is because all the computations here are based on the stability of the ranks obtained by the individuals in this same wide distribution of speech impairments.

The possibility of improvement through practice is investigated by finding the significance of differences between the means of scores obtained on first and second testings. The question arises of whether the occurrence of improvement on the second testing is due to practice or to overall improvement in the patients' condition. This is handled by tabulating the duration of the condition against the occurrence of improvement. Only those whose illness is of less than a year's duration would still be making spontaneous gains that could be noticed from week to week.

Chapter IV

Results

A. Analysis of Results on Individual Tests

1. Speech Subtests

The original scores and ranks of aphasic and non-aphasic subjects in the subtests of the word-association battery are given in Tables XXXIII through XXXVI of the Appendix. In this section, the distributions of scores are treated in terms of comparisons between tests and comparisons between aphasic and non-aphasic groups.

In referring to the subtests of the word association battery, it is necessary to abbreviate their titles because of space limitations in the tables. The following abbreviations are used throughout this chapter when it is awkward to write out the entire expression:

E. Op.:	Easy Opposites	A. N.	: Animal Naming
Op.	: Opposites	Def.	: Definitions
Sy.	: Synonyms	Sen. C.:	Sentence Completion
P. W.	: Part-Whole	Wr.	: Written Word Reading
In.S.	: Initiating Series	Col. N.:	Color Naming
Con.S.:	Continuing Series	Col. R.:	Color Reading
W. N.	: Word Naming	Pic.	: Pictures

The following abbreviations are used consistently for statistical operations peculiar to this study:

Rrd: Ranked rank differences -- a ranking of subjects in an order which shows how their standings in the group differ

from one subtest to another.

Rrd (E.Op.-W.N.): Ranked rank differences for Easy Opposites minus Word Naming. This indicates that each individual's rank in Word Naming has been subtracted from his rank in Easy Opposites and that the resulting rank differences have been ranked from the highest positive difference to the lowest negative difference. In each case, the subtest which is more highly structured with respect to one of the speech stimulus factors is the first-named of the pair. The way in which the Rrd procedure isolates the effect of the speech stimulus factors was discussed on page 98.

Rmr: Ranked mean ranks. This refers to the standing of all the aphasic subjects in the order determined by the mean of each person's ranks on all the subtests of the word-association battery.

a. Distributions of Scores of Aphasic Subjects

The data on the performance of aphasics on the fourteen word-association subtests are summarized in histogram form on Plates I and II, diagrams a through n, on the next two pages. Since these distributions are almost all decidedly skewed, both the mean and the median scores are listed on the diagram for each subtest, along with the range of the raw scores. In a skewed distribution, the mean tends to be influenced by the extreme cases, while the median is drawn in the direction of the scores having the greatest frequency of cases.

Three types of distributions may be distinguished among the fourteen diagrams. The first is that of the "easy"

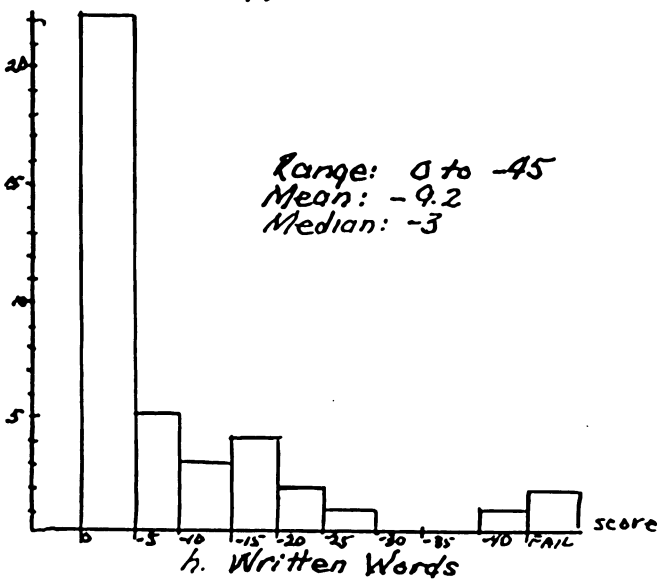
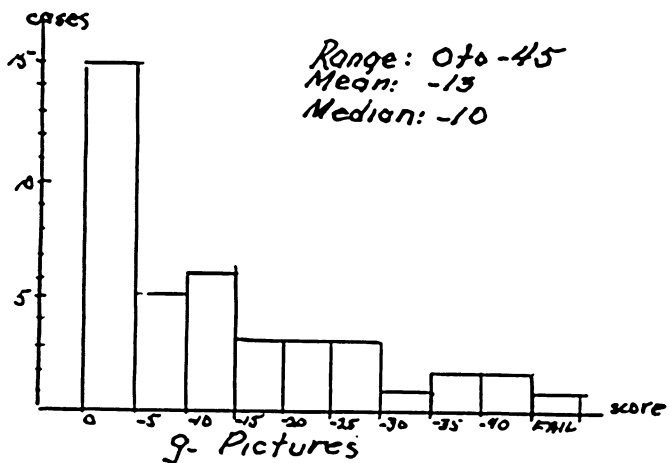
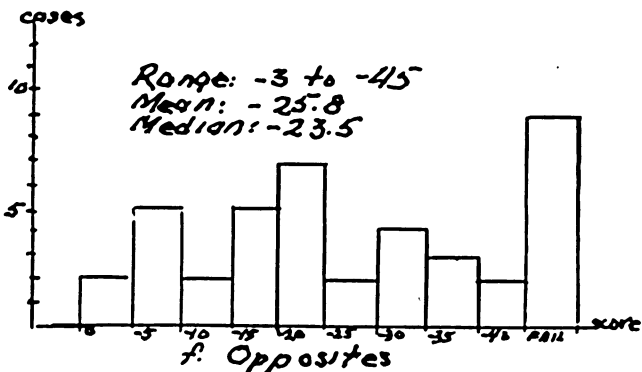
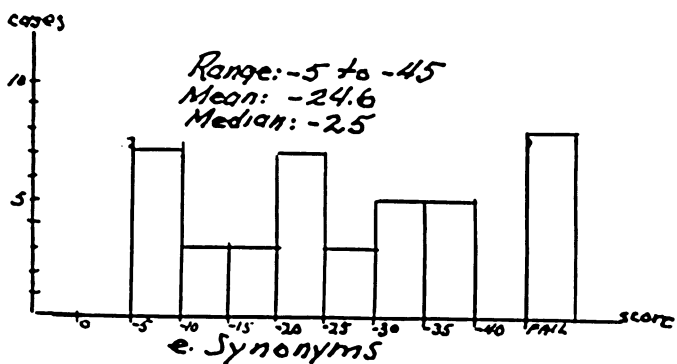
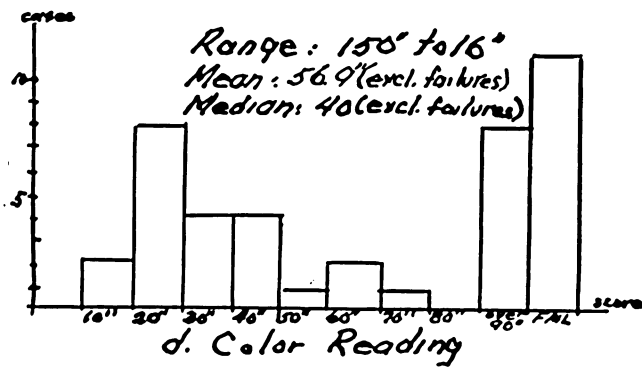
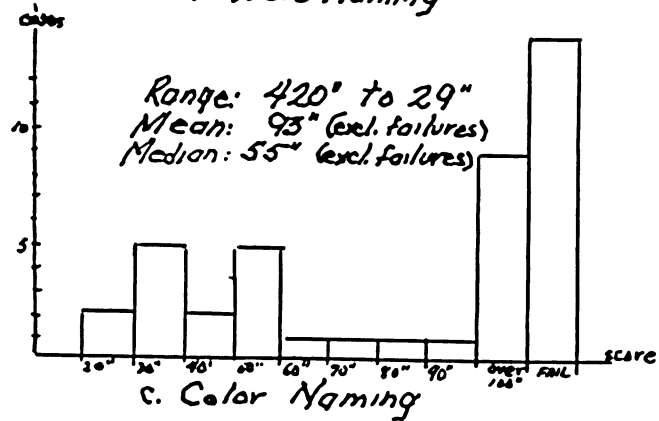
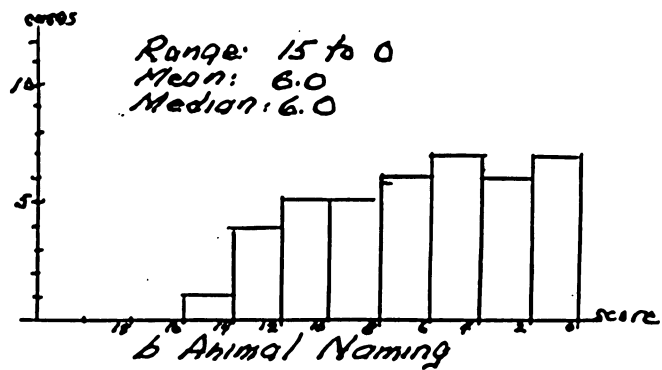
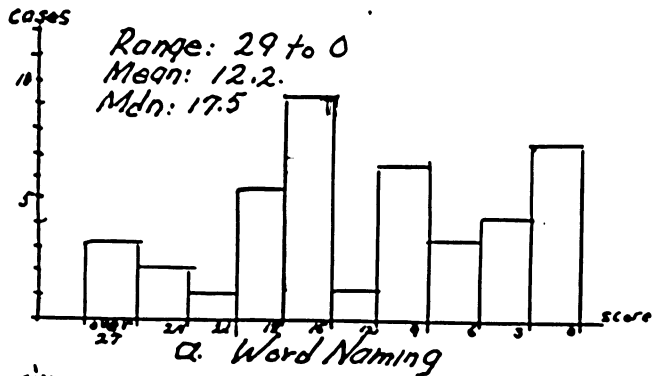


Plate I. Distribution of Scores of Aphasics on Speech Subtests

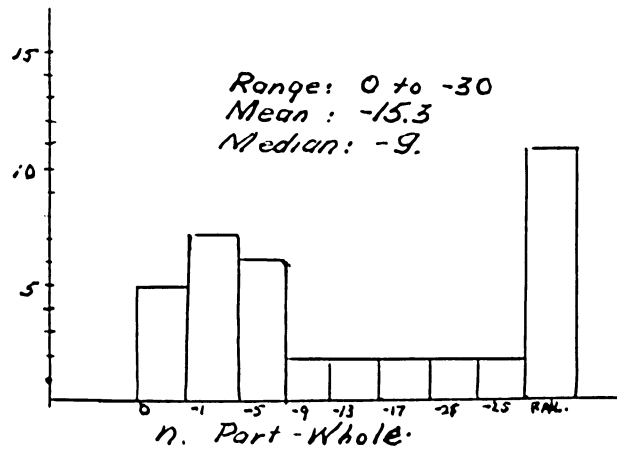
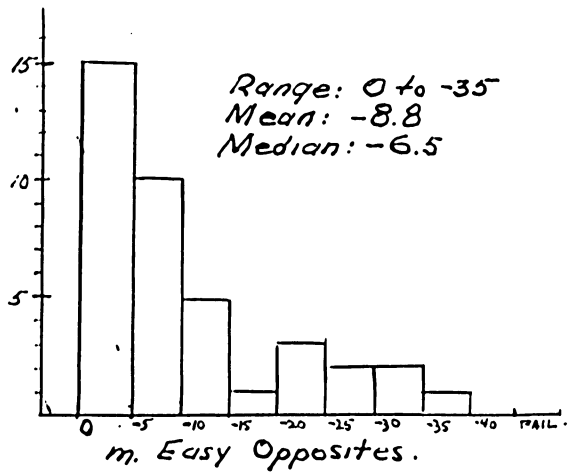
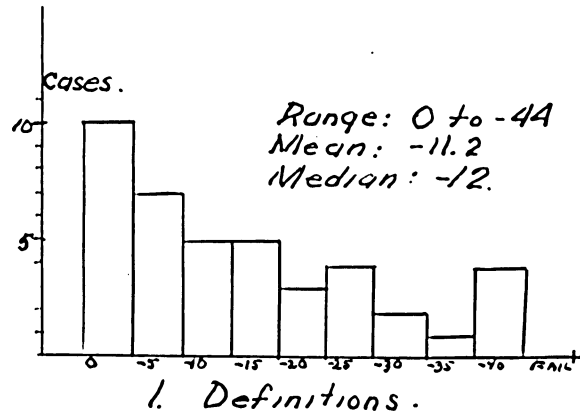
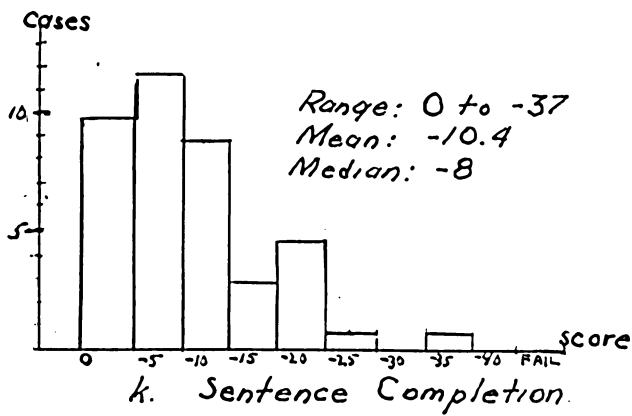
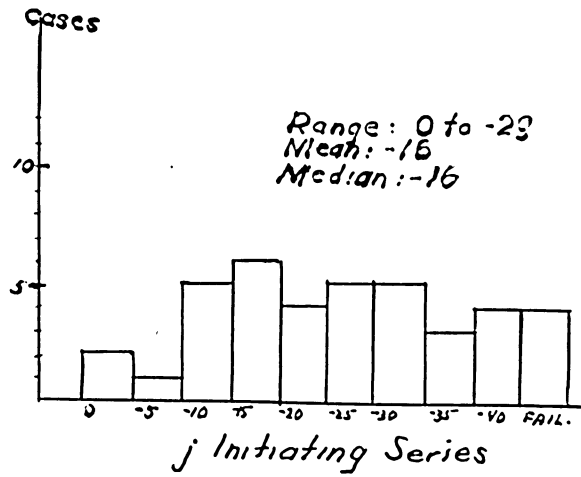
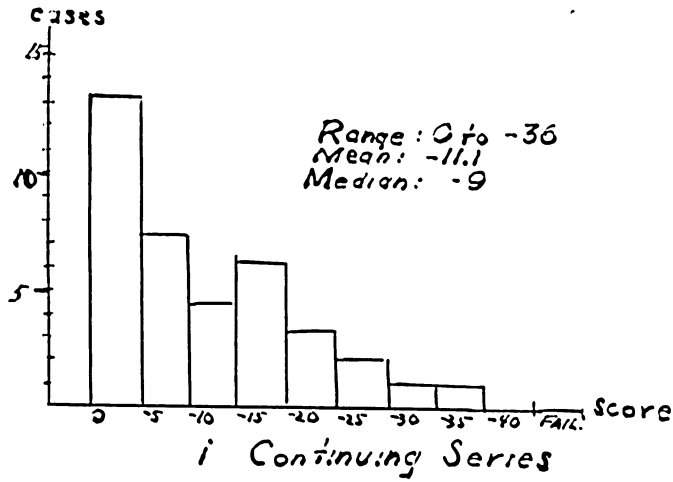


Plate II Distribution of Scores of Aphasics on Speech Subtests.

tests, in which there is a heavy concentration at the left hand side of the scale, among the perfect and near perfect performances. Here we find the three subtests in which the stereotypy of the stimulus-response link is a factor (diagrams i, k, and m). These are the only tasks in which no patients come within six points of total failures. Three more subtests: Written Words, Pictures, and Definitions (diagrams g, h, and i) have distributions of this shape, although each of the latter three includes some total failures, or nearly complete failures.

The second type of distribution is that which approaches uniformity in the scatter of cases from near-normal performance to total failure. In this group can be placed Initiating Series, Word Naming, Animal Naming, Synonyms, and Opposites (diagrams a, b, e, f, and j). These are the subtests which succeed in discriminating among the greatest range of levels of ability of partially aphasic individuals.

The third type of distribution is distinctly bi-modal, in that it shows a clustering of cases at or near total failure, and another relative concentration of cases near the range of normal performance. In this category are the subtests Color Reading, Color Naming, and Part-Whole Associations (diagrams c, d, and n). These are the tasks which discriminate only among subjects above a moderate level of expressive impairment. It will be noted that the four subtests: Color Naming and Reading and Animal and Word Naming are scored in

terms of production versus time, and therefore have no fixed maximum score. This fact, however, does not determine their distribution patterns, since the first named pair has a different pattern from the second pair.

b. Results of the Re-Testing for Reliability Study

The changes in raw score on re-testing twenty-four of the aphasic subjects are given in Table VIXI. The mean differences in score were computed for all subtests except Color Reading and Color Naming, where the small number of cases and the great variability of the differences in score made such a procedure valueless. A consistent but very small improvement appears in all of the mean re-test scores, these improvements ranging from one tenth of a point to three and one tenth points (raw score). When the mean score differences for the seven cases of less than one year's duration are compared with the mean score differences in the seven cases of over three years' duration, it is seen that in exactly six of the twelve subtests, the old cases showed more improvement than the recent ones. From this we may conclude that the consistent improvement on re-testing is due more to the effects of practice than to the spontaneous improvement of the recent cases. Nevertheless, there is great variability in the direction of the changes on re-testing, and most of the subtests have nearly as many cases with lower scores as with higher scores on the second administration. This fact is reflected in the values listed in the row \overline{Md} in Table VIXI,

TABLE IX
Changes in Performance on Re-testing Twenty-four Aphasics
Difference in Raw Score on Re-testing

Subj.	Pic.	Wr.	W.M.	A.N.	Col.N.	Col.R.	Sen.C.	Def.	Syn.	E.Op.	Op.	In.S.	Con.S.	P.W.
AHE (o)	0	-0	-3	-2	f10	f11	0	f2	-4	-2	f1	f4	0	0
BYR (o)	0	0	f5	-1	f4	-1	f1	f2	-8	f2	f1	0	0	f3
CAM	0	0	f1	0	---	---	0	0	f6	0	f4	f1	0	f7
CLI	-4	-1	0	-1	-4	f4	f2	f3	f7	0	-2	0	0	f2
CRO (o)	-1	f3	-5	-3	-6	-5.5	-1	f3	-6	0	-3	f1	f3	-2
CRO (o)	f11	-5	-2	-3	---	---	0	0	f3	f2	f1	f5	f5	f7
FEA (r)	f5	f2	f3	f2	---	f20	f3	f5	f5	-1	f6	f7	-1	f9
FRA (r)	f8	f15	f5	f3	f6.5	f5	f5	f8	f2	-5	f5	f2	-1	-2
FUL (o)	-2	-3	f1	-1	-21	f18	f8	f7	-5	f3	f5	f3	f3	f5
GOF (o)	f1	f3	-4	f2	f1	-6	f2	-1	f5	f2	-4	f1	f2	f2
GRA	-1	0	f6	-3	f9	f19	-1	f2	f6	f2	f4	---	---	f4
HAL	f5	f6	f1	f1	---	---	f2	f5	f6	-4	-2	-1	f1	f2
HER	f8	0	f6	f2	f8	f1	f3	f3	f5	-3	f7	f3	f9	f8
MAT (r)	-3	-3	f6	f1	-6	f21	f5	f4	f4	f5	-2	-5	-8	-3
MOK (o)	f2	-2	0	0	---	---	-3	0	f2	-3	0	-3	f6	0
MOR (r)	-3	0	0	0	---	---	f3	f7	0	-1	0	f4	-3	0
QUE (r)	f1	-1	f1	-2	---	---	-1	-3	f3	0	-2	-2	-3	0
SAN (r)	-2	0	f2	f3	-4	-2	0	f1	-1	f2	f4	f3	f4	0
SHE	f2	-1	-2	f1	---	-43	-2	-1	-5	-5	-1	-2	-3	f3
STE	f2	f1	f5	f3	f150	f61	f2	f6	-5	f2	f5	f2	f4	f6
TRA (r)	-3	f2	f5	0	---	f2	f5	f1	-4	0	f4	-1	f3	f2
VEN	0	0	-6	-1	---	-18	0	f8	-3	0	0	f2	f3	f5
YOU	-1	f2	-1	0	---	---	f7	-1	0	f2	0	f1	-4	0
ZAU	-3	f6	f3	f1	-39	-52	-4	f2	f4	f8	0	f5	f6	f3
Mean(test)	-14.1	-10.6	-12.6	6.4	---	-11.3	-11.3	-19	-30.4	-11.4	-27.1	-18	-11.8	-17
Mean(retest)	-13.0	-9.4	-13.7	6.5	---	-9.5	-9.5	-15.9	-29.6	-11.1	-25.8	-16.5	-10.5	-13.9
Mean Diff.	f1.1	f1.2	f1.1	f.1	---	f1.8	f3.1	f3.1	f.8	f.3	f1.3	f1.5	f1.3	f3.1
Md	3.4	2.8	3.7	1.5	---	3.0	3.0	3.5	4.5	2.7	3.2	2.9	3.6	3.4
Md (o)	f1.0	-0.6	-1.1	-1.1	---	f1.0	f1.0	f1.6	f1.9	f.6	f.1	f1.4	f2.7	f2.1
Md (r)	f.4	f2.1	f1.1	f1.0	---	---	f2.8	f3.3	f1.3	0	f2.1	f1.1	-1.3	f.9
o(test-retest)	.88	.78	.93	.89	.95	.92	.94	.94	.94	.89	.96	.94	.92	.91

(o) - old case; onset more than three years previous (r) - recent case; onset less than one year previous
 Md (o)-Mean difference in score of seven old cases Md (r) - Mean difference in score of seven recent cases
 Md - Mean of absolute differences in scores, disregarding plus and minus values.

which represents the mean difference in scores on re-testing, disregarding the sign. In eight of the twelve subtests involved, \overline{Md} is more than twice as great as the difference between means. Improvement on re-testing can be predicted with the most certainty in the cases of the subtests Sentence Completion, Definitions, Initiating Series, and Part-Whole associations, each of which has over twice as many individuals showing improvement as showing a loss on the second testing.

The rank order correlations between first and second test administrations are given in the last row of Table IX. Only four of the fourteen coefficients of correlation are less than .90, and only one of these is smaller than .88, that being the correlation between the two administrations of the Written Words subtest, which was .78. Although these coefficients of reliability fall in a range ordinarily considered satisfactory for the testing of individuals, they are spuriously high because of the great spread of abilities in the test population. Because of this spread, a change in raw score causes little or no change in an individual's rank among the members of the population just above and below him.

c. Comparison of Matched Aphasics with Non-Aphasic Controls

Histograms illustrating the distribution of scores on the eight subtests which were given to the two matched groups are presented in Plates III and IV, diagrams a through h. On each diagram, the data for the range of scores, the mean, and

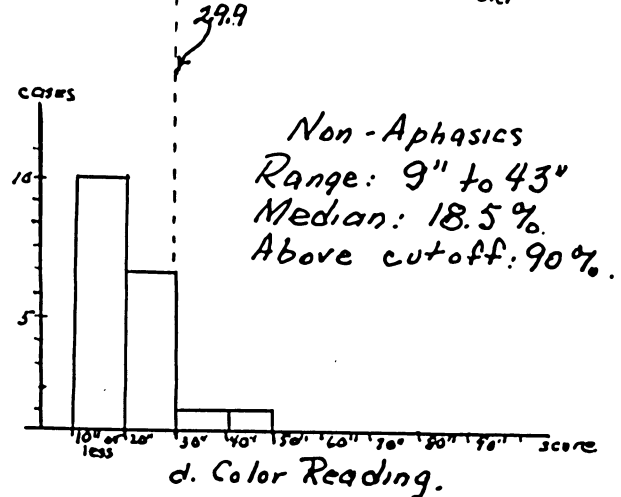
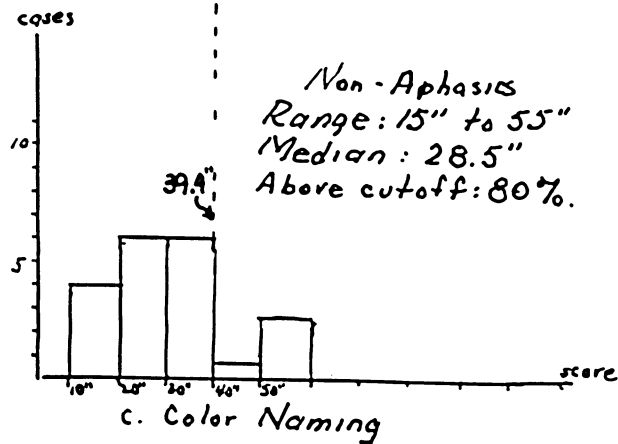
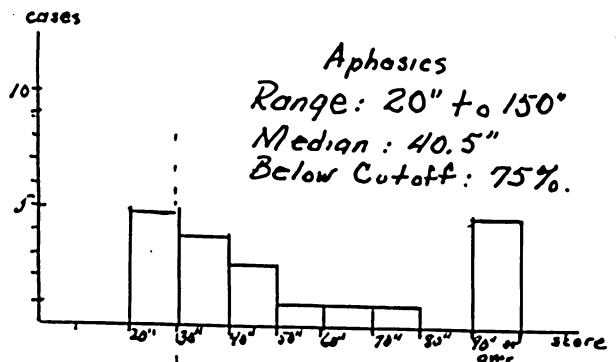
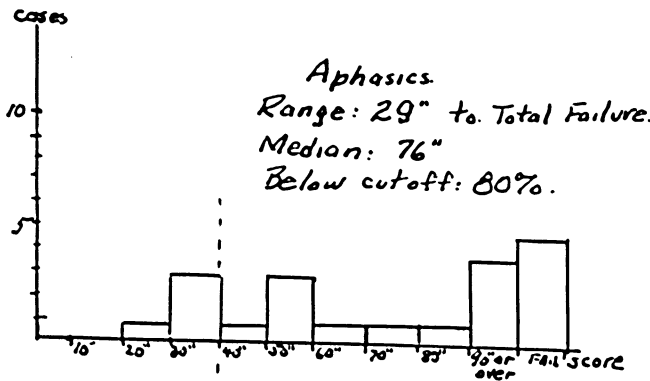
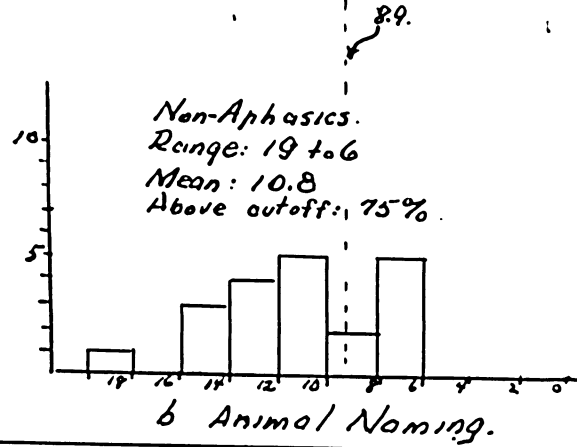
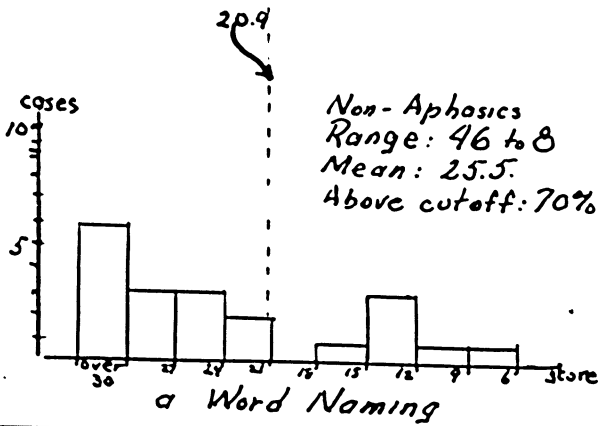
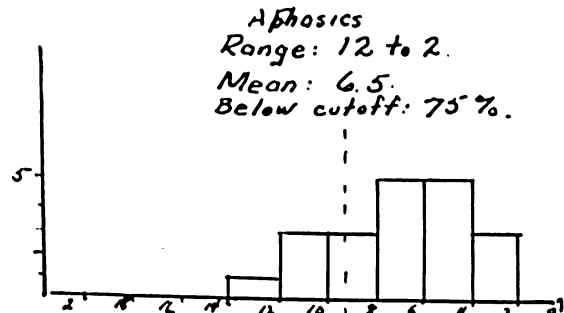
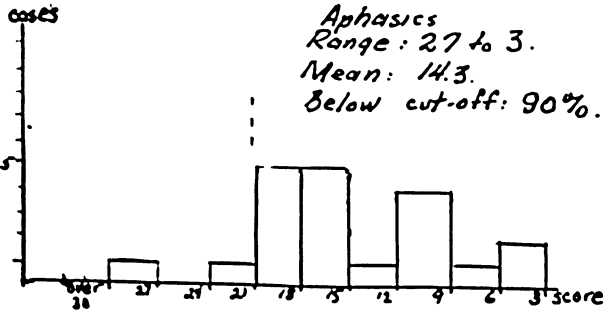
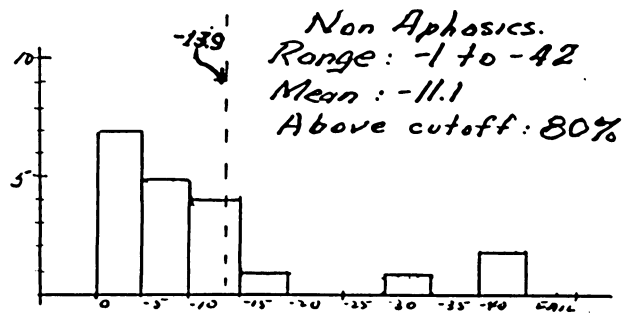
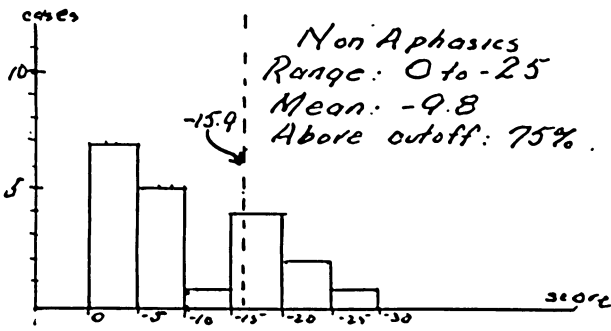
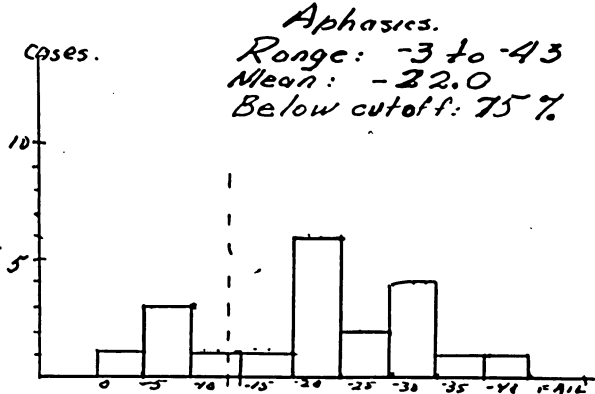
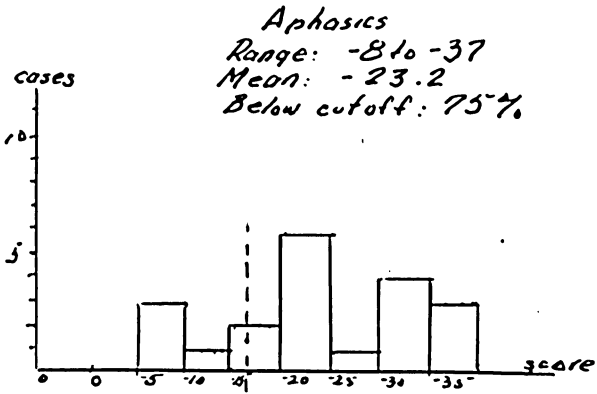
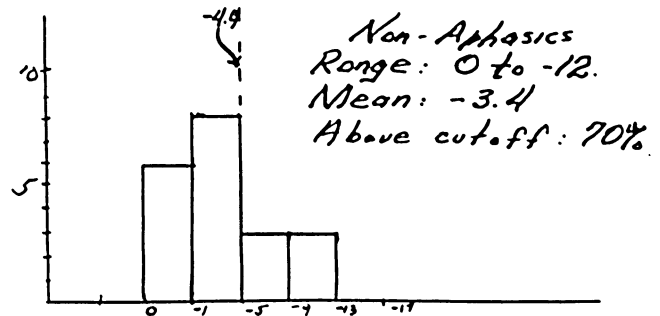
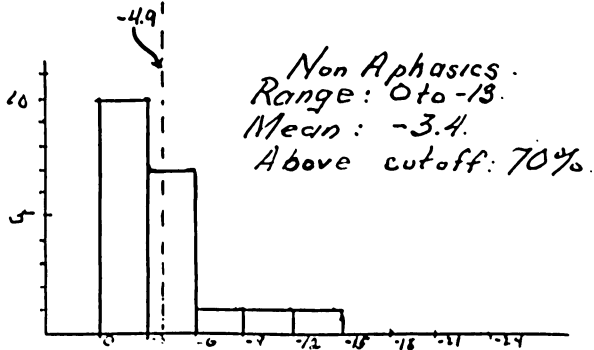
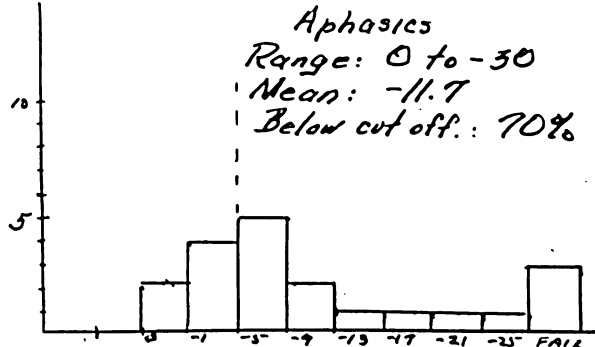
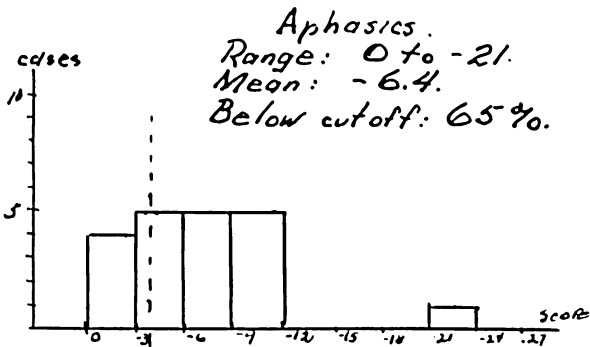


Plate III Distributions of Speech Subtest Scores of the Matched Groups



e. Synonyms

f. Opposites



g. Easy Opposites

h. Part Whole.

Plate IV. Distribution of Scores in the Speech Subtests for Matched Groups.

the optimal cut-off point for discriminating between the two groups are stated in number form. The optimal cut-off points were determined by an actual count of cases above and below the critical scores, so that the greatest number of individuals were correctly classified.

Comparison of the two groups with respect to the spread of scores on the eight subtests reveals that in Word-Naming, Animal Naming, Synonyms, and Opposites, aphasics and non-aphasics covered comparably extensive ranges. In the other four subtests, the scores of the non-aphasics are concentrated within a smaller range near the high end of the scale. In all cases, the distributions of non-aphasic scores are essentially unimodal, while these of the matched aphasics closely parallel the distributions for the parent aphasic population, as seen in Plates I and II.

The three subtests which appear to discriminate best between the two matched groups are Color Reading, Color Naming, and Word Naming. Only two of the twenty non-aphasic subjects took more than thirty seconds to read off the thirty written color names, while fifteen of the aphasics fell below that standard. Four of the aphasics could name the thirty colors on the chart in less than forty seconds, but only four of the non-aphasics failed to better that mark. Twenty-one words at random named in one minute was the criterion which only two of the aphasic group could surpass, while fourteen of the control subjects beat that mark, nine of them exceeding the top aphasic

performance of twenty-seven words named.

The two subtests which are least discriminating are Easy Opposites and Part-Whole associations. These are the only subtests whose optimal cut-off scores fail to classify correctly at least three fourths of the population of the combined groups.

2. Performance Tests

The original scores and ranks of both aphasic and non-aphasic subjects on the non-verbal tests of abstract behavior are to be found in the appendix. The distribution of the scores on the four tests is illustrated by means of frequency polygons in the four diagrams on Plate V. The parent population of aphasics is shown in blue, the matched aphasics in green, and the non-aphasics in red. It will be seen that the peaks of all four distributions are near the upper end of the range of scores. The maximum concentration of cases for the non-aphasic group tends to be even closer to the highest scores than in the matched aphasic group. Nevertheless, the mean scores of the two matched groups are close together on the three performance tests which they had in common, the greatest deviation being in the Goldstein Cubes, where the mean non-aphasic score was -39.2 as against -33 for the matched aphasics. A single extreme score (subject TIM, -250) accounted for this difference.

Table XX gives the intercorrelations of the performance tests for the two matched groups. The strength of the correlations lies in the same range in both groups. The outstandingly low correlation of .23 between Color Matrices and

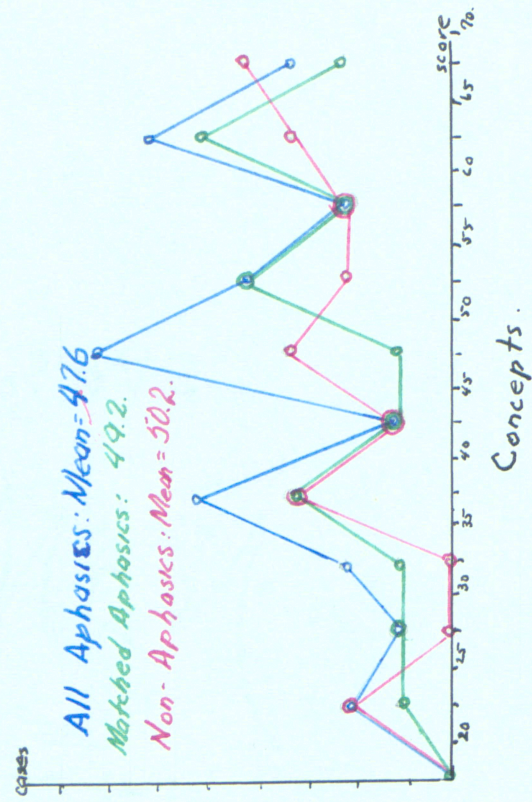
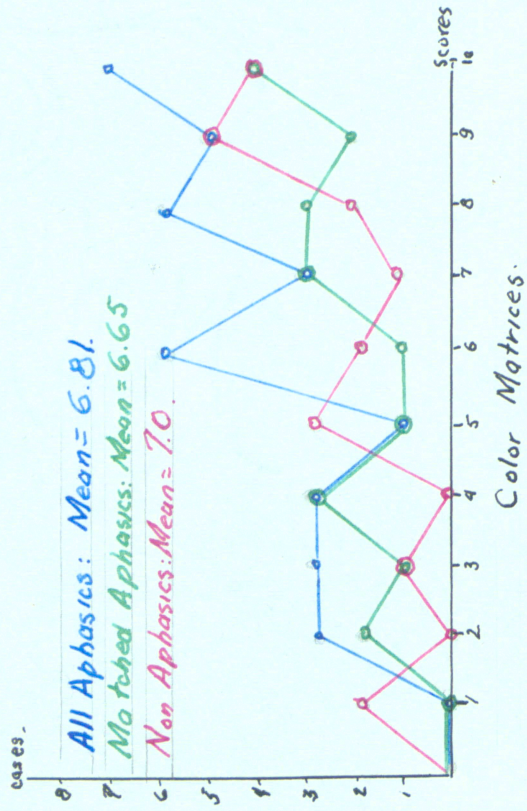
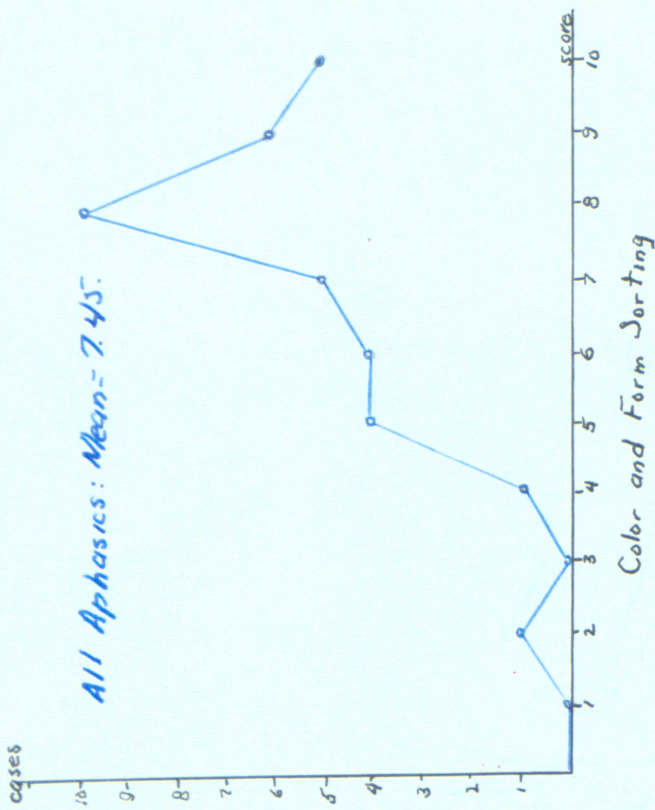
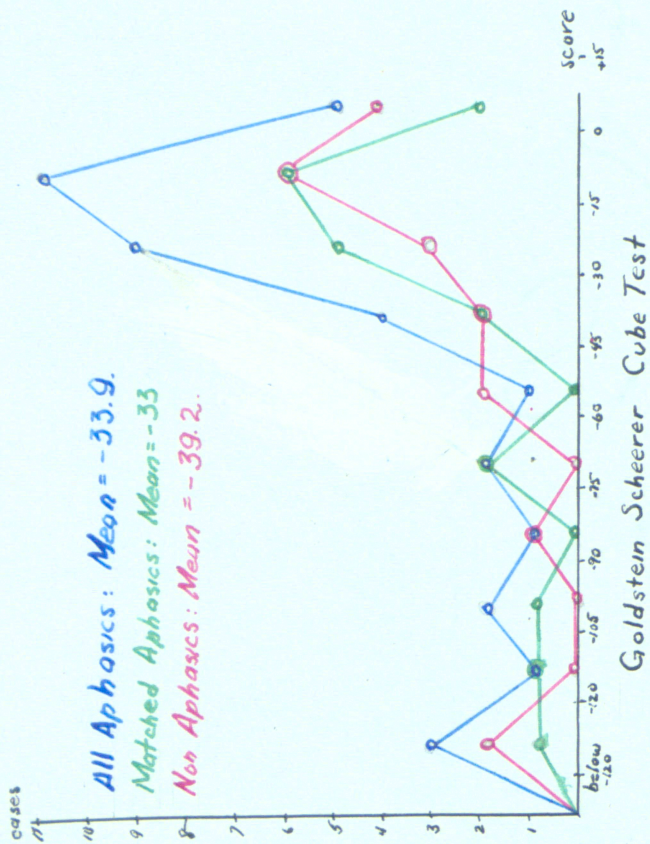


Plate V Distributions of Scores in Tests of Abstract Performance

Color and Form Sorting is due to the great variability in the performance of certain patients. Aphasic subject VEN, for example, whose performance on all the other tests of abstraction was very poor, solved all of the Color Matrices problems. Since there is insufficient data for concluding that any of these tests is more or less valid than the others as a measure of abstract behavior, they are all given equal weight as samples of the subjects' abstract performance.

TABLE X

Intercorrelations among Performance Tests
for Matched Aphasics and Non-Aphasics

	Matched Aphasics			Non-Aphasics	
	Goldstein- Scheerer	Concepts	Color Matrices	Goldstein- Scheerer	Color Matrices
Concepts	.64	--	--	.56	.50
Color Matrices	.61	.41	--	.52	--
Color and Form	.73	.52	.23	--	--

B. Treatment of the Effects of the Three Speech Stimulus Factors

Because of their bulk, no attempt has been made to include here the actual derivation of the sixty-two arrays of ranked rank differences (Rrd's) between aphasic subjects' standings in paired combinations of subjects. All the data from which these Rrd's are derived are to be found in Tables XXXIV and XXXVI of the Appendix. The same applies to the forty-six smaller arrays of Rrd's for the two matched groups. In this section, the Rrd's for the effect of each speech stimulus variable are treated separately, most of the tables below being devoted to an examination of correlations between the Rrd's and the non-verbal tests of abstraction.

1. Stereotypy Factor

Five of the arrays of ranked rank differences for the isolation of the effect of the stereotypy factor are based on the comparison between subjects' standings on the Continuing Series subtest and each of the five subtests having stimuli which are considered to be restrictive, but not stereotyped. In Table XI above will be seen the coefficients of correlation, rho, between each of these Rrd's and each of the four performance tests. In this and the subsequent tables, the number

TABLE XI

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Stereotypy on their Word Association Scores: I. Rrd's between Continuing Series and Five Subtests Having Non-Stereotyped Stimulus Structure

Ranked Rank Differences:	Non-Verbal Tests of Abstract Performance											
	Goldstein-Scheerer			Concepts			Color Match			Color & Form		
	rho	N	P	rho	N	P	rho	N	P	rho	N	P
Con.S.-In.S.	+.28	28	.15	+.03	24		+.30	28	.10	+.23	27	.20
Con.S.-Pic.	+.30	32	.10	+.04	27		+.36	31	.05	+.19	29	.35
Con.S.-Def.	+.17	27		+.10	23		-.05	23		+.38	24	.10
Con.S.-Op.	+.22	30	.25	+.24	26	.30	+.36	30	.10	+.23	28	.25
Con.S.-Col.N.	+.05	24		-.06	21		+.22	24	.30	+.19	22	.40

of subjects available for each correlation is given in the column N. In the column headed P may be read the level of significance of the given rho to the next higher multiple of .05. The probability level is given only when it is .40 or less. In the evaluation of the significance of these values it should be remembered that they represent the percent probability that a rho of either sign having the given magnitude could occur by chance in a population of size N, where no correlation really exists. In considering the probability of simultaneous

occurrence of a number of rho's having the same sign, the P value for each rho must be considered as one half of the one given in the table.

Of the twenty correlations in Table XI, all but two are positive, three of them having P values of better than .10 and one having better than .05. The two negative correlations are both insignificantly small, and the existence of a positive relationship of small magnitude must be acknowledged between the capacity represented by these five Rrd's and the non-verbal performances.

TABLE XII

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Stereotypy on their Word Association Scores: II. Rrd's between Easy Opposites and Five Subtests Having a Non-Stereotyped Stimulus Structure

Ranked Rank Differences:	Non-Verbal Tests of Abstract Performance											
	Goldstein-Scheerer Cubes			Concepts			Color Mat.			Color & Form		
	rho	N	P	rho	N	P	rho	N	P	rho	N	P
E.Op.-In.S.	+.13	35		+.09	29		-.14	34		+.34	32	.10
E.Op.-Pic.	+.15	33		+.11	27		-.09	32		+.21	30	.30
E.Op.-Def.	+.07	29		-.01	25		-.46	27	.05	+.29		.15
E.Op.-Op.	+.07	29		+.23	26	.25	-.08			+.21	27	.30
E.Op.-Col.N.	+.04	26		+.18	24		+.001	24		+.22	24	.30

The ranked rank differences (Rrd's) based on the comparison of standings of subjects in the Easy Opposites subtests with their ranks in five non-stereotyped subtests give somewhat ambiguous results when correlated with the non-verbal tests. Only fifteen of the twenty correlation coefficients (in Table XII) are positive, and only one of these is at the .10 level of probability, while one of the negative rho's exceeds the .05 probability level. However, it is important to note that four of the five negative correlations occur with only one of the

performance tests -- the Color Matrices.

In Table XIII, the effect of stereotypy in the speech stimulus situation is represented by Rrd's derived from the Sentence Completion subtest and the same five non-stereotyped subtests which were employed in the preceding tables. Here again, a very tenuous relationship between the Rrd's and the tests of abstraction emerges from the twenty coefficients of correlation. Six of these rho's have negative values, although of extremely low significance. However, four of the six negative rho's are accounted for by the differences in subjects' standings in the Definitions subtest as compared to Sentence Completion. Most of the positive rho's are also of negligible statistical significance when taken one at a time, only one of them attaining the .05 level.

TABLE XIII

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Stereotypy on their Word Association Scores: III. Rrd's between Sentence Completion and Five Subtests Having a Non-stereotyped Stimulus

Ranked Rank Differences	Non-Verbal Tests of Abstract Performance											
	Goldstein-Scheerer			Concepts			Color Mat.			Color & Form		
	rho	N	P	rho	N	P	rho	N	P	rho	N	P
Sen.C.-In.S.	+.16	37	.35	-.01	30		+.25	36		+.14	34	
Sen.C.-Pic.	+.21	30	.25	+.04	25		+.37	29	.05	+.08	28	
Sen.C.-Def.	-.08	29		-.05	25		-.09	27		-.05	24	
Sen.C.-Op.	+.08	29		+.11	27		+.25	29	.20	-.14	26	
Sen.C.-Col.N.	+.20	24	.35	+.10	22		+.30	23	.20	+.11	22	

Another way of dealing with the large number of rho's of very low significance is to examine their distribution around the zero point and test the hypothesis that the observed distribution could occur by chance in the absence of a true

relationship. The Chi Square test for this purpose is applied in Table XIV. In this table the frequency with which each of the subtests contributed to a correlation in the predicted (positive) direction is contrasted with the number of negative rho's which it helped determine. In addition, the right hand column gives the data for the Chi Square of all the rho's, taken as a group.

The existence of a true relationship between the effect of stereotypy in a speech stimulus on non-verbal tests

TABLE XIV

Chi Square Test for Significance of Relationships between Abstract Performance and Subjects' Response to Stereotypy of Speech Stimuli, Giving Frequency with which Each Speech Subtest Contributes to Positive and to Negative Correlations

	Subtests high in Stereotypy			Subtests low in Stereotypy					Total
	Con.S.	E.Op.	Sen.C.	In.S.	Pic.	Def.	Op.	Col.N.	
Number of rho's	20	20	20	12	12	12	12	12	60
Positive rho's	18	15	14	10	11	5	10	10	46
Negative rho's	2	5	6	2	1	7	2	2	14
χ^2	11.25	4.05	2.5	4.08	6.75	.08	4.08	4.08	16.02
P	.01	.05	.15	.05	.01	.80	.05	.05	.01

of abstraction is indicated beyond a reasonable doubt by the χ^2 value of 16.02 for the distribution of all the rho's around zero. The Sentence Completion subtest appears to be of dubious significance for the purpose of isolating the effect of stereotypy. Among the subtests which were assumed to be low in the factor of stereotypy, Definitions alone give results which could be explained as occurring by chance.

The mean ranks of all the aphasic subjects in all of the speech subtests will be found in Table XXXIV of the appendix and the Rank of the mean ranks (Rmr) is indicated in the extreme left hand column of the same table. The Rmr is

used as a measure of the over-all proficiency of the subjects in the command of individual spoken words. The fifteen Rrd's representing the effect of stereotypy in the speech stimulus were correlated with the ranked mean ranks (Rmr) and the resulting rho's are presented in the following table(XV).

TABLE XV

Correlations between the Level of Subjects' Word-Saying Ability and the Effect of Stereotypy on their Word-Association Scores: Rho's Obtained between the Rmr and the Fifteen Rrd's for Stereotypy Subtests

Subtests high in Ster.	Speech Subtests Assumed to Be Low in Stereotypy														
	In.S.			Pic.			Def.			Op.			Col.N.		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Con.S.	+.52	28	.01	+.34	32	.110	+.23	27	.25	+.39	30	.05	+.23	24	.30
E.Op.	+.19	35	.30	+.17	34	.35	+.15	30		+.26	31	.20	+.11	28	
Sen.C.	+.03	37		+.08	31		+.09	30		+.16	30	.40	-.06	26	

TABLE XVI

Correlations between Abstract Performance and the Rrd's for Stereotypy Obtained from Matched Aphasic and Non-aphasic Control Groups

Ranked Rank Diff. between:	Matched Aphasics						Non-Aphasics					
	G - S		Concepts		Color Mat		G - S		Concepts		Color Mat.	
	Rho	P	Rho	P	Rho	P	Rho	P	Rho	P	Rho	P
E.Op.-Op.	+.01		+.23	.35	-.05		-.13		-.04		-.30	.20
E.Op.-Col.N.	+.10		+.26	.30	-.09		-.01		+.18		-.35	.15

Inspection of the table indicates that there is a more definite relationship here than with the performance tests. The subtest Continuing Series again stands out as the best indicator of the effect of stereotypy on speech performance, contributing to coefficients of correlation ranging from .23 to .52. The Sentence Completion subtest, here too, is the weakest indicator of the predicted relationship, with one negative rho and all four of negligible significance.

b. Comparison of Matched Aphasics and Controls.

A comparison of the two matched groups with respect to the effect of stereotypy in the speech stimulus is made in Table XVI. The results for the twenty matched aphasics are fairly similar to

those of the parent population, reflecting the slight relationship between the effect of stereotypy and ability on tests of abstraction. A contrary trend is indicated in the correlations of the control group, although in neither case are the results decisive enough to support definite conclusions.

2. Effect of the Restrictiveness Factor

The two subtests involving written stimuli - Color Reading and Written Words - have each been contrasted with five subtests involving less restrictive stimuli, both visual and oral, as indicated in Table VI. The Rrd's thus derived represent the effect of restrictiveness of the stimulus on word-saying ability. Tables XVII and XVIII, on the next page, list the coefficients of correlation between these ranked rank differences (Rrd's) and the four non-verbal tests of abstraction. All of the rho's involving the Color Reading subtest are positive and they range from .01 to .50. Four of the twenty are significant at the five percent level and the strongest correlations are those arising from contrast between Color Reading performance and performances on the two visual-stimulus subtests in the non-restrictive group - Color Naming and Pictures. The coefficients of correlation derived from the Written Words subtest (Table XVIII) show a much weaker relationship, the most significant rho being one of .36, significant at the ten percent level. The great majority of the positive correlations in this table are smaller than .20, but eighteen of the twenty are in the predicted direction.

TABLE XVII

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Restrictiveness on their Word Association Scores: I. Rrd's between Color Reading and Five Subtests Having a Less Restrictive Stimulus Structure

Ranked Rank Difference:	Non-verbal Tests of Abstract Performance											
	Goldstein-Scheerer			Concepts			Col. Mat.			Col. & Form		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Col.R.-Col.N.	+.47	22	.05	+.38	21	.10	+.33	20	.15	+.27	21	.25
Col.R.-Pic.	+.50	21	.05	+.43	21	.5	+.27	21	.25	+.47	20	.05
Col.R.-Sy.	+.30	25	.15	+.28	24	.20	+.01	26		+.25	23	.25
Col.R.-P.W.	+.35	25	.10	+.19	23		+.13	24		+.22	24	.30
Col.R.-Op.	+.15	27		+.21	25	.35	+.10	25		+.20	25	.35

TABLE XVIII

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Restrictiveness on their Word Association Scores: II. Rrd's between Written Word Reading and Five Subtests Having A Less Restrictive Stimulus Structure

Ranked Rank Difference:	Non-verbal Tests of Abstract Performance											
	Goldstein-Scheerer			Concepts			Col. Mat.			Col. & Form		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Col.Wr.-Col.N.	+.01	20		+.04	20		-.08	20		+.22	19	.40
Wr.-Pic.	+.14	23		+.19	20		-.06	22		+.11	20	
Wr.-Sy.	+.16	25		+.32	23	.15	+.24	24	.25	+.18	23	
Wr.-P.W.	+.10	23		+.23	22	.30	+.36	23	.10	+.14	24	
Wr.-Op.	+.11	22		+.08	21		+.20	22	.40	+.18	21	

In addition to the ten Rrd's treated in the two preceding Tables, seven more are listed in Table VI as suitable for the isolation of the effect of restrictiveness. The correlations between these seven and the tests of abstraction are listed in Table XIX. Although none of the positive correlations here is

TABLE XIX

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Restrictiveness on their Word Association Scores: III. Rrd's between Seven Other Pairs of Subtests Assumed to Differ with Respect to the Restrictiveness of their Stimulus Structure

Ranked Rank Differences:	Non-verbal Tests of Abstract Performance											
	Goldstein-Scheerer			Concepts			Col. Mat.			Col. & Form		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Op.-Sy.	+.05	25		+.24	23	.30	+.03	25		+.17	23	
Op.-P.W.	+.24	28	.20	+.25	26	.20	+.16	28		+.19	27	.35
Pic.-Sy.	-.10	26		+.13	23		+.01			-.06		
Pic.-P.W.	+.24	23	.30	+.05	20		+.21	23	.35	+.23	23	.30
In.S.-Sy.	+.06	24		+.26	26	.20	-.03	27		+.11	27	
In.S.-P.W.	+.24	24	.25	+.27	22	.25	+.22	24	.30	+.26	24	.25
A.N.-W.N.	-.31	26	.15	-.25	24	.25	-.32	24	.15	-.01	26	

statistically significant by itself and none as high as .30, the

vast majority of these rho's are in the positive direction. A notable exception to this trend is the marked negative correlation between Rrd (Animal Naming-Word Naming) and the tests of abstraction. In terms of actual cases, we find that many of the individuals (FUL, AHE, CSO, MAT, TOB, HERR, HAL) who perform relatively well on tests of abstraction are the ones whose standing in the group improves under the more restrictive stimulus conditions represented by Animal Naming, as compared to Word Naming.

Table XX lists the data for the computation of Chi Square for testing the hypothesis of chance occurrence of the

TABLE XX

Chi Square Test for Significance of Relationship between Subjects' Abstract Performance and their Response to a Change in Restrictiveness of Word Association Stimuli, Giving the Frequency with Which Each Subtest Contributes to Positive and Negative Correlations

	Less Restrictive Subtests						More Restrictive Subtests						Total
	Col. N.	Pic.	Sy.	P. W.	Op.	W. N.	Col. R.	Wr.	Op.	Pic. S.	In. N.	A. N.	
Number of Rho's	8	8	20	20	8	4	20	20	8	8	8	4	68
Positive Rho's	7	7	17	20	8	0	20	18	8	6	7	0	59
Negative Rho's	1	1	3	0	0	4	0	2	0	2	1	4	9
χ^2	3.12	3.12	8.45	0	0	0	0	14.45	0	1.12	1.12	0	35.3
P	.10	.10	.01	0	0	0	0	.01	0	.30	.10	0	.01

predominantly positive correlation coefficients in the three preceding tables, in the absence of a true relationship. The frequency with which each of the subtests contributes to rho's in the predicted direction and in the negative direction is listed. This permits us to judge the value of each subtest as a representative of a restricting or non-restricting stimulus, as the case may be. The Chi Square test confirms the existence

of a significant relationship between the ability to abstract and the Rrd's representing the effect of a restricting stimulus. Color Reading appears most effective as a representative of a restricting stimulus, while Synonyms and Part-Whole associations are the most consistent examples of a non-restrictive stimulus, judging by the frequency with which they contribute to correlations in the predicted direction.

TABLE XXI

Correlations between Level of Subjects' Word Saying Ability and the Effect of a Change in Restrictiveness on their Word Association Scores: Rho's Obtained between the Rmr and the Seventeen Rrd's for Restrictiveness

Subtests Assumed Less Res.	Subtests Assumed to be More Restrictive																	
	Col.R			Wr.			Op.			Pic.			In.S.			A.N.		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Col.N.	+.17	22		+.44	20	.05	--	-	-	--	-	-	--	-	-	--	-	-
Pic.	+.12	23		+.21	24	.35	--	-	-	--	-	-	--	-	-	--	-	-
Syn.	-.08	26		+.16	26		-.04	26		-.08	27		-.08	29	-	--	-	-
P.W.	*.07	26		+.04	24		-.05	30		-.22	24		-.04	24		--	-	-
Op.	+.22	29	.25	-.05	22		--	--	-	--	--	-	--	--	-	--	-	-
W.N.	--	--	--	--	--	--	--	--	-	--	--	-	--	--	-	-.01	26	

When the ranked rank differences for the effect of restrictiveness are correlated with the subjects' over-all word-saying ability (Rmr) fully half of the resulting rho's are negative. However, the possibility of a slight relationship is suggested by the fact that the positive rho's are considerably greater than the negative, one of them attaining statistical significance at the .05 level. These results are listed in Table XXI above.

The following table permits us to compare the two matched groups with respect to the effect of a restricting speech stimulus and its relation to abstract performance. The rho's for the

matched aphasics reflect the existence of such relationship just as strongly as do the corresponding correlations from the parent population. The unexpected negative relationship derived from Animal Naming - Word Naming appears just as strongly in this limited group, too. In the non-aphasic group, however, there is an even split between positive and negative rho's involving all subtests except the pair Animal Naming-Word Naming. The control group gives the expected positive

TABLE XXII
Correlations between Abstract Performance and the Ranked Rank Differences for "Restrictiveness" Obtained from Matched Aphasic and Non-aphasic Groups

Ranked Rank Difference:	Matched Aphasics						Non-Aphasics					
	G.-S.		Concepts		Col.Mat		G.-S.		Concepts		Col.Mat.	
	rho	P	rho	P	rho	P	rho	P	rho	P	rho	P
Col.R.-Col.N.	+.45	.05	+.24	.30	+.15		-.08		-.10		+.06	
Col.R.-Sy	+.39	.10	+.38	.10	+.18		-.06		+.08		+.46	.05
Col.R.-P.W.	+.39	.10	+.20		+.20		-.04		-.12		-.03	
Col.R.-Op.	+.31	.20	+.36	.15	+.21		+.03		+.07		+.30	.20
Op.-Sy.	+.15		+.16		-.11		-.08		-.01		+.25	.30
Op.-P.W.	+.49	.05	+.23	.30	+.24	.30	-.12		+.26	.30	-.22	.35
A.N.-W.N.	-.31	.20	-.45	.05	-.13		+.43	.05	+.40	.10	+.41	.10

relationship between abstract performance and ability to name words at random. This relationship is statistically significant and even more marked than the reverse relationship found in the aphasic group.

3. Effect of a Specific Stimulus for Each Response

The two subtests, Word Naming and Animal Naming, require serial, disconnected responses without the benefit of a new specific stimulus for each response word. The ranked rank differences indicated in Table VII were obtained as indicators of the change in the subjects' standings in the group when their performances in Word or Animal Naming are compared to

their performances on the subtests where they have the benefit of specific stimuli. The correlations of these Rrd's with the four performance tests are given in Tables XXIII and XXIV. Inspection of Table XXIII reveals that the Rrd's derived from the Word Naming subtest show a very small and wavering relationship with the tests of abstraction. Six of the twenty rho's are negative, although all of the negative rho's are .10 or below, and only four of the positive coefficients are of such low magnitude. The rho's derived from the Animal Naming subtest (Table XXIV) give a picture of a much stronger and consistent relationship with abstract performance. All of them are in the positive direction, while one is significant at the one percent level, two more at the five percent level and three fall just short of that degree of significance.

Table XXV gives the data for applying the Chi Square test of statistical significance to the distribution of positive and negative rho's in the two preceding tables. The row labeled P gives the percent probability of obtaining the observed proportion of positive and negative correlations for each of the subtests, if there were no real relationship with abstract performance. The subtests which contribute most consistently to the very significant Chi Square value of the entire distribution are Pictures (as a representative of the 'specific stimulus' condition) and Animal Naming (as a representative of the other condition). The Opposites subtest is the least reliable one for demonstrating the effect of a specific stimulus on word finding ability, judging by the weakness of the correlations to which it contributes.

TABLE XXIII

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Specific Stimuli on their Word Association Scores: I - Rrd's between Word Naming and Five Subtests Providing Specific Stimuli

Ranked rank differences:	Tests of Abstract Performance											
	G - S			Concepts			Color Mat.			Color and Form		
	rho	N	P	rho	N	P	rho	N	P	rho	N	P
Sy.-W.N.	+.21	26	.30	-.05	23		+.23	25		+.12	23	
Op.-W.N.	+.10	28		-.10	24		-.10	27		-.01	25	
P.W.-W.N.	+.16	25		-.02	23		+.12	25		+.08	24	
Col.N.-W.N.	+.32	21	.15	+.03	19		-.02	21		+.23	19	
Pic.-W.N.	+.21	25	.30	+.06	22		+.08	24		+.16	22	

TABLE XXIV

Rank Order Correlations between Aphasics' Abstract Performance and the Effect of Specific Stimuli on their Word Association Scores: II - Rrd's between Animal Naming and Five Subtests Providing Specific Stimuli

Ranked rank differences:	Tests of Abstract Performance											
	G - S			Concepts			Color Mat.			Color and Form		
	rho	N	P	rho	N	P	rho	N	P	rho	N	P
Sy.-A.N.	+.49	27	.01	+.18	24	.40	+.35	26	.10	+.16	24	
Op.-A.N.	+.21	29	.30	+.17	27	.40	+.40	30	.05	+.18	27	.40
P.W.-A.N.	+.36	27	.10	+.23	25	.30	+.08	22		+.24	27	.25
Col.N.-A.N.	+.44	22	.05	+.21	20	.40	+.07	27		+.34	20	
Pic.-A.N.	+.36	28	.10	+.20	35	.35	+.13	27		+.15	25	

TABLE XXV

Chi Square Test for Significance of Relationship between Abstract Performance and the Effect of Specific Stimuli on Subjects' Word Association Scores, Giving Frequency with which Each Subtest Contributes to Positive and Negative Results

	Subtests lacking specific stimulus		Subtests providing specific stimulus					Total
	W.N.	A.N.	Syn.	Op.	PW	Col.N.	Pic	
Number of Rho's	20	20	8	8	8	8	8	40
Positive Rho's	14	20	7	5	7	7	8	34
Negative Rho's	6	0	1	3	1	1	0	6
χ^2	2.45	0	3.12	.13	3.12	3.12	0	18.2
P	.15	0	.10	.75	.10	.10	0	.01

When the ranked rank differences for the effect of a specific stimulus on word-saying are correlated with the subjects' overall proficiency in word-saying, the resulting coefficients are predominantly negative. The negative relationship is a weak one and none of the rho's, standing by itself, attains a probability level of more than .25. However, the

trend appears equally in the correlations derived from Animal Naming and from Word Naming. This data is presented in Table XXVI below.

TABLE XXVI
Correlations between Level of Subjects' Word-Saying Ability (Ranked Mean Ranks) and the Effect of a Specific Stimulus on their Word Association Scores

Subtests lacking specific stimulus	Subtests Providing a Specific Stimulus														
	Syn.			Op.			P.W.			Col.N.			Pic.		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
W. N.	-.21	27	.30	+.01	30		-.18	27		-.08	23		-.25	26	.25
A. N.	-.21	28	.30	-.24	30		-.12	29		-.02	23		-.23	29	.25

TABLE XXVII
Correlations between Abstract Performance and Rrd's for the "Effect of a Specific Stimulus" Obtained from Matched Aphasic and Non-aphasic Control Groups

Ranked Rank Differences:	Matched Aphasics						Non-aphasics					
	G. - S.		Concepts		Col.M.		G. - S.		Concepts		Color Mat.	
	rho	P	rho	P	rho	P	rho	P	rho	P	rho	P
Sy.-W.N.	+.28	.25	-.07		+.23	.35	-.04		+.16		-.03	
Op.-W.N.	+.32	.20	-.03		+.12		+.08		+.24	.35	+.14	
P.W.-W.N.	+.18		-.07		+.08		+.25	.30	+.43	.05	+.39	.10
Col.N.-W.N.	+.20		-.13		+.14		-.03		+.41	.10	+.34	.15
Sy.-A.N.	+.47	.05	+.20		+.34	.15	-.17		-.18		-.16	
Op.-A.N.	+.55	.01	+.15		+.18		-.24	.35	-.18		-.11	
P.W.-A.N.	+.18		+.04		+.02		-.33	.15	-.16		-.02	
Col.N.-A.N.	+.39	.10	+.09		+.20		-.28	.25	-.16		-.09	

The data summarized in Table XXVII permits us to compare the matched aphasic and non-aphasic groups with respect to the effect of the specific stimulus factor, and its relation to abstract performance. The coefficients for the matched aphasic sub-group are similar to those for the parent group, but the rho's for the non-aphasics show a much stronger relationship between Word-Naming and abstraction, while the Animal-Naming subtest gives consistently negative coefficients of correlation.

4. Effect of Combined Factors

All of the preceding tables have dealt with Rrd's which represented the effect of one of the speech stimulus

factors at a time. In Table VII twenty additional combinations of subtests are listed; Rrd's derived from these are considered to measure the effect of two or three of the factors acting together. Tables XXVIII, XXIX, and XXX on the next page summarize the relationships observed between the effects of combined speech factors and abstract performance. Table XXVIII concerns Rrd's derived from test pairs of which one member provides a stereotyped stimulus-response link and the other member requires repeated responses without the benefit of specific stimuli. Since all of the stereotyped stimuli are necessarily restrictive, as well, these six Rrd's are assumed to show the combined effect of all three speech factors on the subjects' standings in the group. The correlations with abstract performance in this table are slightly more consistent and stronger than those in Tables XXIII and XXIV, where only the effect of specific stimuli was supposed to influence the results. There is only one insignificantly small negative rho among the twelve derived from the Word-Naming subtest and the subtests having stereotyped stimulus structure.

Table XXIX deals with Rrd's which show the effects of combining the 'specific stimulus' and 'restrictiveness' factors. Here, too, the correlations with abstract performance are more consistent and somewhat stronger than in Table XXIII, where only the specific stimulus factor is believed to determine the relationship. Table XXX gives the correlations between abstract performance and the combined effect of stereotypy and restrictiveness in the speech stimulus. Twenty of the twenty-four

TABLE XXVIII
Correlations between Subjects' Abstract Performance and Rrd's
Representing the Combined Effect of Stereotypy, Restrictiveness,
and Specific Stimuli on their Word Association Scores

Rrd's	Tests of Abstract Performance											
	G - S			Conc.			Col. N.			Col. & Form		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Rrd (Con.S.-W.N.)	+.22	32	.25	+.05	27		+.07	26		+.28	29	.15
Rrd (E.Op.-W.N.)	+.23	29	.25	+.19	23		+.32	31	.10	+.33	26	.10
Rrd (Sen.C.-W.N.)	+.20	32	.25	+.02	27		-.01	28		+.08	28	
Rrd (Con.S.-A.N.)	+.35	31	.10	+.24	26	.25	+.35	29	.10	+.34	28	.10
Rrd (E.Op.-A.N.)	+.40	31	.05	+.33	26	.10	+.12	30		+.38	29	.05
Rrd (Sen.C.-A.N.)	+.37	33	.05	+.14	28	.40	+.38	31	.05	+.17	29	.35

TABLE XXIX
Correlations between Subjects' Abstract Performance and Rrd's
Representing the Combined Effect of "Restrictiveness" and
"Specific Stimuli" on their Word Association Scores

Rrd's	Tests of Abstract Performance											
	G - S			Conc.			Col. N.			Col. & Form		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Def. - W.N.	-.02	28		-.03	23		+.36	25	.10	+.12	24	
Wr. - W.N.	+.21	25	.30	+.41	21	.10	+.20	23		+.20	21	
Col.R.-W.N.	+.37	27	.10	+.09	25		+.07	26		+.27	24	.20
In.S.-W.N.	+.12	31		-.00	28		+.12	31		+.02	29	
Def.-A.N.	+.45	29	.05	+.21	27	.30	+.52	27	.01	+.06	25	
Wr.-A.N.	+.47	26	.05	+.45	23	.05	+.28	24	.25	+.39	23	.10
Col.R.-A.N.	+.45	27	.05	+.19	25	.35	+.15	27		+.38	25	.10
In.S.-A.N.	+.45	29	.05	+.30	25	.15	+.38	28	.05	+.22	27	.30

TABLE XXX
Correlations between Subjects' Abstract Performance and Rrd's
Representing the Combined Effect of "Restrictiveness" and
"Stereotypy" on their Word Association Scores

	Tests of Abstract Performance											
	G - S			Conc.			Col. Mat.			Col. & Form		
	Rho	N	P	Rho	N	P	Rho	N	P	Rho	N	P
Con.S.-Sy	+.15	28		+.22	24	.30	+.28	28	.15	+.29	26	.15
E.Op.-Sy	+.19	29	.35-	+.37	24	.20	-.08	28		+.32	26	.15-
Sen.C.-Sy	+.21	29	.30-	-.07	24	.25	-.09	27		+.15	26	
Con.S.-P.W.	+.14	28		+.24	24	.25	+.40	28	.05	+.09	26	
E.Op.-P.W.	+.21	30	.30-	+.32	25	.15	+.03	29		+.35	29	.10
Sen.C.-P.W.	+.21	29	.30-	+.07			+.31	27	.15-	-.01	26	

correlations are positive and most of them are greater than .30. These results, however, are no stronger or more consistent than those in Tables XI or XVII where the separate effects of stereotypy and restrictiveness are assumed to determine the relationships observed.

Table XXXI summarizes the relationships between the effects of factors in combination and the overall word-saying ability of the subjects, the Rmr. It is evident that only the group of rho's in the lower right-hand quadrant of the table show a consistent relationship and these are derived from the Rrd's representing the combined effects of 'stereotypy' and 'restrictiveness' in the speech-stimulus structure.

TABLE XXXI
Correlations between Level of Subjects' Word-Saying Ability (Ranked Mean Ranks) and Rrd's for the Effects of Two or Three Factors Combined

More highly structured stimuli	Subtests low in all 3 factors						Subtests low in restrictiveness and stereotypy					
	W. N.			A. N.			Synonyms			Part-Whole		
	rho	N	P	rho	N	P	rho	N	P	rho	N	P
a. restrictive stim. structure												
Definitions	-.18	28		-.08	31		--	-	-	--	-	-
Written Wds.	-.06	25		-.04	26		--	-	-	--	-	-
Col. Reading	.00	27		+.07	29		--	-	-	--	-	-
Init. Series	+.21	31		-.19	20		--	-	-	--	-	-
b. stereotyped stim. structure												
Contin. Ser.	+.11	32		+.11	31		+.17	28	.40	+.09	26	
Easy Opposites	+.16	29		+.11	33		+.47	28	.05	+.10	32	
Sent. Compl.	-.05	32		-.11	34		+.24	30	.20	-.01	28	

Inspection of the correlations for the matched aphasic group reveals that abstract performance is related to the Rrd's for the effect of the 'specific stimulus' factor in combination with both 'restrictiveness' (Col.R.-W.N.; Col.R.-A.N.) and with stereotypy (E.Op.-W.N.; E.Op.-A.N.). However, these correlations show no more strength or consistency than those dealing with the 'specific stimulus' factor alone, as seen in Table XXIV. The correlations between abstract performance and Rrd's for the effects of 'restrictiveness' together

with 'stereotypy' (E.Op.-Sy.; E.Op.-P.W.) are too low and inconsistent to support any conclusions. The results for the non-aphasic control group reveal positive rho's for five of the six correlations involving the Word-Naming subtest and negative rho's for eleven of the remaining twelve correlations.

TABLE XXXII

Correlations between Abstract Performance and Rrd's for Combined Factors, Obtained from Matched Aphasic and Non-Aphasic Control Groups

Ranked rank dif- ferences:	Matched Aphasics						Non-Aphasics					
	G.-S.		Conc.		Col.Mat.		G.-S.		Conc.		Col.M.	
	rho	P	rho	P	rho	P	rho	P	rho	P	rho	P
a) Col.R.-W.N.	+.41	.10	+.12		+.05		+.01		+.39	.10	+.34	.15
a) Col.R.-A.N.	+.61	.01	+.28	.20	+.15		-.31	.20	-.17		-.01	
b) E.Op.-W.N.	+.12		-.15		+.22	.40	+.13		+.19		-.06	
b) E.Op.-A.N.	+.33	.15	+.08		+.29	.20	-.14		-.14		-.25	.30
c) E.Op.-Syn.	+.05		-.02		+.22	.40	-.08		-.06		-.15	
c) E.Op.-P.W.	+.08		-.11		+.26	.30	+.08		-.08		-.30	.20

Chapter V
Summary and Conclusions

A. Interpretative Summary of Findings

In order to examine the principal hypothesis that there are correlates of abstract behavior in aphasic speech characteristics, it was first necessary to set up a criterion for abstract behavior. Four separate tests were chosen, each of which was scored on the basis of non-language performances by the aphasic subjects and the controls. The correlations among these tests ranged from .23 to .73, indicating a substantial inter-relationship. The common factors which account for this relationship represent "abstract behavior" for the purposes of this study. The ultimate validity of the assumption that this operational definition of "abstract behavior" coincides with the theoretical definition given on page 9 depends on the analysis of the tasks imposed by the four performance tests. While the common factors between these tests induce a substantial relationship between their scores, the greater portion of the variance of each is accounted for by other, accidental factors. When the correlation between two tests is .60, only 36 percent of the variance of each is accounted for by the common factors. Since there is no objective criterion by which to judge the relative validity of the performance tests as measures of abstract behavior, we are justified in treating each as a separate sampling of this ability. Repeated positive

correlations of an outside measure with each of the performance tests then has to be attributed to the factor which the four tests have in common, i.e., the requirement for abstract behavior.

Correlates of abstract behavior were sought in the differences in subjects' ability to deal with speech stimuli having certain differences in structure, as predicted by prior clinical, experimental, and theoretical observations. Three factors in the structure of speech stimuli were defined; any one of these, when present, could be expected to serve as a crutch for the subject who was deficient in abstract behavior. Such a subject's performances in the subtests embodying these crutches would then be expected to exceed his performances in subtests in which the given factor was minimized.

1. The Relation between Abstract Performance and the Three Speech Factors

The first of the speech stimulus factors whose effect was isolated was that of stereotypy of the bond between stimulus word and response. The three subtests which, more than any others, were deemed to embody the stereotypy factor were Continuing Series, Easy Opposites, and Sentence Completion. The differences between subjects' standings in these subtests and their standings in subtests lacking the stereotypy factor proved to follow this rule: those aphasics lowest in abstract performance profited the most from a stereotyped word-association stimulus. The coefficients of correlation on which this observation is based are low and the great majority of them are statistically unreliable, standing alone. It is also pointed out that they are not wholly independent measures because a single array

of ranked scores (e.g., Continuing Series) partly determine each of twenty correlation computations. The fact that eighteen of these twenty are positive cannot then be given the same weight as if the twenty rho's were wholly independent samples.

Another way of expressing these findings is that when we provide four separate performance tests of abstraction, we are able to show that the Continuing Series subtest has a lower coefficient of correlation with each one of them than any of the non-stereotyped speech subtests.* This finding is repeated much more weakly with the subtests Easy Opposites and Sentence Completion. In twenty-nine out of the forty correlations involving these two subtests, they proved to be less closely correlated with abstract performance than the subtests with non-stereotyped stimuli. Not only is this predominance of correlations in the predicted direction far more than could be accounted for by chance, but the negative correlations are insignificantly small, with only one exception.

No indication of a similar relationship between abstract performance and speech behavior can be shown for non-aphasics. Indeed five of the six correlations computed for the control group were in the reverse direction. However, only

*

Each of the correlation coefficients between an Rrd array and a performance test is actually determined by the difference between the separate correlations of the two paired speech subtests with the performance test. Thus, the rho of +.28 between Goldstein Scheerer Cubes and Rrd (Con.S.-In.S.) means that the scores on Initiating Series are more closely correlated with the Goldstein Scheerer than are the scores on Continuing Series, and the difference between those rho's is approximately .28. Since all of the speech subtests are inevitably positively correlated with the performance tests, the maximum values of the differences between these correlations can rarely be expected to exceed the minimum for statistical significance in a population of twenty to thirty-five subjects.

one subtest representing the condition of stereotypy was given to the non-aphasics, namely, Easy Opposites. The concentration of their scores at or near the maximum was so marked that little significance can be attached to the differences between the subjects' ranks in this test or to computations based on them. It is probably true that any other speech subtest embodying a stereotyped stimulus structure would give a similar concentration of scores in a non-aphasic group.

Restrictiveness of the stimulus was the second factor whose presence in word association subtests could be expected to produce a relative improvement in the standings of subjects deficient in abstraction. The written word stimulus was believed to embody this factor to the greatest possible degree and the two subtests using written words as stimuli (Written Word Reading and Color Reading) gave the most consistent results in the predicted direction. The relationships involving these two subtests are much more definite than those observed in connection with the stereotypy factor. However, the variability in the correlations (from +.50 to -.08) and the small numbers of subjects used (from 19 to 27) make it impractical to attempt to find the difference in the strength of the relationship between each of these two factors and abstract performance.

The predicted relationship continued to appear, although less strongly between other pairs of subtests requiring one word responses either to pictures or spoken stimuli. In twenty-one out of twenty-four cases (Table XIX), the subtests in which

several response words were available correlated more highly with abstract performance than did the subtests in which a single popular response word was expected. In a number of cases, it was possible to predict for a given subtest a position between two others. For example, the Opposites subtest correlated more closely with abstract performance than either of the written stimulus tests and less closely than the subtests Synonyms and Part-Whole. Initiating Series and Pictures also occupied predicted positions between other subtests, with respect to the strength of their correlation with abstract performance.

These findings tend to justify the writer's suggestion that experimental observations cited on pages 41 to 43 can be reconciled under one heading. The relative decrease in reaction time for written stimuli, observed by Lund (31) and Wells and Card (52) can be regarded in the same light as the briefer reaction times for restrictive word-association stimuli, reported by Woodworth and Wells (56) and J. M. Cattell.* In each case, a more restricting stimulus structure makes the response more nearly automatic, less subject to the necessity for deliberate choice, and therefore less 'abstract', in Goldstein's sense. This differs from Lund's interpretation of his findings. He held that the greater facility in color reading over color naming was due entirely to greater exercise of the bond between the written and the spoken word.

The results obtained from the control group again throw little light on the problem and can barely be interpreted

*As cited by Woodworth (55)

as supporting the foregoing hypothesis. Two of the three tests of abstract performances (Goldstein-Scheerer and Concepts) show absolutely no more relation with the non-restrictive subtests than with the restrictive ones. The third performance test (Color Matrices) does show a wavering relationship in the predicted direction. Here again, the greatly compressed range of the non-aphasics' scores in the restrictive Color Reading subtest may be responsible for the indecisiveness of the findings. The most important conclusion from these results is that without damage to the language function the relationship between abstract performance and speech stimulus structure is either absent or too small to emerge in such a small scale study. It may also be held that when the language areas of the brain are intact, all of the speech reactions tested by our subtests are so near their normal automaticity that they are nearly immune to the general loss in abstract behavior which the individual may have undergone. With the aphasics, on the other hand, the automaticity of meaningful word associations is undermined and requires a more deliberate effort in the choice of reactions -- i.e., the capacity for abstract behavior. This could explain why the capacity for abstraction seems to affect the aphasics' word-associations so much more clearly than the non-aphasics'.

Random Word-Naming appears to give an especial advantage to the patients whose aphasia has not affected their word-fluency,

regardless of their capacity to abstract. It places those with a more severe loss of word formulation ability at a relative disadvantage which is exaggerated by the greater potential spread of scores inherent in this test, as against the Animal-Naming subtest. This may explain why Word-Naming, among aphasics, correlated much more poorly with abstract performance than did Animal-Naming. It may also explain why the expected higher correlation between Word-Naming and abstraction did appear in the non-aphasic control group, where differences in the type of aphasia could not counteract the effect of a great difference in the degree of structuring of the speech task. The strength and consistency of this finding in the non-aphasic control group (correlations of .43, .41, and .40 with the three performance tests) supports the belief that withdrawal of restrictiveness in the speech stimulus always places a greater demand on the capacity for abstraction.

In spite of the reversal of the expected relationship between Word-Naming and Animal-Naming in the aphasic group, both subtests show a consistently closer relationship to abstract performance than do any of the subtests in which repeated specific stimuli are provided for each response word. To be sure, the correlations derived from Word Naming show a very slight trend in the expected direction; fourteen out of twenty comparisons with non-restrictive subtests give positive rho's which range from .03 to .32, while the six negative correlations are all smaller than .11. Much more decided

differences appear in the relationship between the unstructured Word-Naming test and the subtests which provide a restricting or a stereotyped stimulus. Of twenty-eight rho's which were computed, twenty-three indicate that Word-Naming is more closely related to abstract performance. The positive correlations range up to .41, while all of the negative rho's are insignificantly small. The Animal-Naming subtest, without an exception in forty-eight trials, proved to be more closely related to all of the abstract performance tests than any other speech subtest, as far as the aphasics went.

Inspection of the results of the control group makes it seem doubtful that the absence of a specific stimulus in word-association tests makes them any harder for those non-aphasics who have lost their capacity for abstraction. On one hand, their Word-Naming scores are more closely correlated with their abstract performance than most other speech subtests; on the other hand, the Animal-Naming subtest is the least correlated with the non-aphasics' abstract performance. Only when the absence of specific external cues is combined with the removal of restrictiveness, as in Word-Naming, does a relationship appear between the non-aphasics' word-saying and their abstracting ability. The most important conclusion from this data is that the person with damage to cortical language areas suffers a considerable loss in his ability to initiate separate speech responses without external cues -- that the preservation of abstract behavior seems to go with the ability to focus the

limited speech apparatus for the production of such spontaneous expressions.

Each of the three factors of stereotypy, restrictiveness, and specific stimulation in word-association tests, has been found to facilitate most the performance of aphasics who are deficient in the ability to behave abstractly. Each of these factors is, in effect, a way of increasing the structuring of the stimulus situation. In general, then, the less structured that a speech stimulus is, the more difficult it will be for those aphasics who cannot perform abstractly.

2. The Relation of Stimulus-Structure to Over-all Word-saying Ability

The one factor 'stereotypy' appears to exert a different degree of influence on the speech performance of aphasics, depending on how impaired their speech is. The more severe a patient's word-saying loss is, the more marked is the relative preservation of his ability to complete a familiar spoken word sequence. This relationship emerges more definitely from our data than does the relationship between abstract performance and stereotypy. From this we can conclude that the type of psychological bond most resistant to the effects of organic damage is that which leads to the completion of a practiced sequence, once it is under way.

3. Utility of the Individual Speech Subtests for Clinical Purposes

Of fourteen word association subtests used in this study, five have proved capable of discriminating levels of

aphasic impairment over a range extending from normal speech to very severe speech loss. The proficiency in word-saying measured by these subtests is not to be identified with general proficiency in communication, although it is usually very similar to it. Moderate recovery of fluency in conversation is compatible with very poor performance in saying individual words -- the task demanded throughout this experiment. Such a configuration occurs in many cases of aphasia in which there is a sensory component (Subjects CUS, TER, TRA, ONE, and ROH).

The five subtests having the widest range of discrimination are Word-Naming, Animal-Naming, Synonyms, Opposites, and Initiating Series. The first four named, when administered to matched aphasic and non-aphasic groups, classified correctly between thirty and thirty-two (seventy-five to eighty percent) of the forty subjects with regard to the presence of aphasia. The norms for these subtests are available on Plates I through IV. Since the selection of the test populations is largely an accidental one, with a tendency to exclude cases of severe sensory aphasia, these norms must be regarded as tentative.

Six subtests of the battery proved to discriminate only among the more severely aphasic portion of the experimental group. These were Easy Opposites, Continuing Series, Sentence Completion, Definitions, Written Word Reading, and Pictures. Only the first of these was given to the non-aphasic group and it correctly classified twenty-seven of the combined

population of forty in the two matched groups.

Two subtests of the battery discriminate only among the upper half of the aphasic population. These are Color Naming and Color Reading. The excessive difficulty of these two subtests was due to the requirement for at least fifteen responses, one after another, before any score could be given. A better distribution of scores, including nearly the entire population, would probably be obtained by basing the score on the number of correct responses which the subject can give, at his own pace, within a fixed time limit. The subtests, as given, correctly classified thirty-two to thirty-three of the forty subjects in the matched aphasic and non-aphasic groups.

The least effective of the subtests, as a single instrument for classifying aphasics, was the Part-Whole Association test. Not only did one quarter of the aphasics fail completely, but another eighth (five subjects) also achieved perfect scores, so that this subtest discriminates only in the middle range of aphasic disability. It classified correctly only twenty-eight of the forty subjects in the two matched groups.

When considered for their effectiveness in discriminating aphasics from non-aphasics, no one of the subtests correctly classified more than ninety percent of either aphasic or non-aphasic group. Over half of the subjects in both groups scored on the "wrong side" of the critical score on one or more subtests. When all eight subtests are taken together, there are still ten out of forty subjects who are incorrectly classified by four or more subtests. However, when the two subtests Color

Reading and Word Naming are taken together, only two subjects out of forty are incorrectly classified by both subtests. The combination of these two subtests, then, gives promise of being an effective screening device in detecting aphasia. It will have to be subjected to more use before it can be known that the results obtained here are not an accident of sampling.

With regard to the reliability of the subtests, they are all within the range which justifies their use for group studies, such as the present one. Used to trace the improvement of individuals, changes in score would have to be interpreted with great caution, unless they clearly exceed the mean differences between test and re-test, given in Table IX.

B. Conclusions

The following conclusions provide specific answers to the questions raised in the statement of the problem.

1. There are demonstrable correlates of abstract behavior in the speech reactions of aphasic patients, as manifested in word association tests.
2. Among aphasics, loss of capacity for abstract performance is correlated with increased dependence on stereotypy, on restrictiveness of stimuli, and on specific external cues for each response in word association tests. In general, the less structured the stimulus situation in word association tests, the greater the disadvantage of the aphasic who is most deficient in abstracting ability.
3. The speech performance of non-aphasics are affected to a much smaller degree, if at all, by their capacity for abstract behavior than is the case with aphasics.

4. There is weak evidence that non-aphasics who are lowest in abstract performance are, like aphasics, at a relative disadvantage in responding to non-restrictive word association stimuli.

5. The more severely affected an aphasic's word-saying ability, the more outstanding the relative preservation of his ability to complete familiar spoken word sequences.

Further hypotheses which arise from these conclusions are:

1. Only when the cortical language areas are damaged does the production of meaningful word associations become less automatic and require more deliberate effort for the choice of responses. Hence the ability to mobilize focused attention, inherent in abstract behavior, affects primarily the speech performance of aphasics.

2. The type of psychologic bond most resistant to the effects of organic damage is that which leads to the completion of a practiced sequence, once it is under way.

Chapter VI

Discussion

A. Abstract Behavior and Language

Our findings in the aphasic population lend support to Goldstein's observations that certain of their language performances reflect a loss of abstract behavior. However, we cannot conclude, like Goldstein, that we have distinguished abstract and concrete uses of language. For such a conclusion, parallel findings in a non-aphasic group would have been necessary. What, then, do the abstract performance tasks have in common -- to aphasics -- with the less structured speech stimuli? The answer suggested here is that both require the ability to focus attention selectively -- the ability to impose structure on one's perceptual field.

A digression to develop briefly the important concept of structuring is in order here. Structuring means the degree to which a set of circumstances (configuration of stimuli, neurological bonds) makes a single outcome (or response, or subjective interpretation) inevitable. When we speak of the structuring of a stimulus or of a perceptual field, we mean the features in the stimulus, plus certain assumed conditions in the perceiver, which tend to determine a single response and no other. When learning takes place, a change of structuring takes place within the perceiver - presumably in the cerebral cortex. All language behavior is learned and most of the structuring on which speech reactions depend consists of

modifications in the so-called language areas of the cortex. As we have seen, part of the structuring resides in the stimuli themselves to the extent that they have come to determine one and only one reaction. Only when the cortical language areas are damaged (as in aphasia) is there any marked change in the effective structuring of speech stimuli. For the aphasic, then, there is a great apparent increase in the range of differences in structuring of speech stimuli. Where, for example, a reaction is normally determined seventy percent by internal conditions and thirty by external conditions, after cortical injury the thirty percent becomes all important. The aphasic is therefore called on to deal successfully with a less structured -- i.e. a less pre-determined, less automatic situation.

When an individual is faced with a situation which is not already highly structured for him, he may force some features of it to stand out together, first in one way, then in another. In so doing, he directs his attention selectively or imposes structure on a mass of stimuli, both internal and external. To some extent, we do this whenever we make a deliberate choice, make a comparison, or attempt to solve a problem rationally. The four non-verbal tests used as criteria for abstract behavior all require some exercise of this capacity. Thus, where the degree of structuring in the stimulus is insufficient to evoke an habitual response, the individual may use his ability to impose structure on it to complete a reaction.

The aphasic, faced with an unstructured speech stimulus, must force himself to get a clearer idea of the words from which he is to select his reply and perhaps of the mouth movements he is to make. If he is unable to direct his attention to these, he may fail to come up with a response at all. The results of this study give us grounds for believing that the capacity for directing attention selectively is a general factor which emerges in such disparate activities as word-finding and design-building. This capacity is fundamental to all acts of abstracting common properties and to much behavior which is not ordinarily considered as "abstract." The broadness of this basic capacity makes it very much like speaking of a "level of active awareness" or a component of general intelligence. To all indications, it is the capacity for selective attention, rather than the ability to make abstractions, which is really the common factor in all of what Goldstein terms "abstract behavior."

B. Differences among Aphasics

Up to this point in the discussion, "aphasia" has been referred to as though it were a general disruption of structure in the cortical language area. However, such an implication is not intended nor is it suggested by the results of this study. Among our subjects, the disruption of speech has in some cases affected the act of choosing words out-of-context, while leaving contextual conversation nearly intact. In other cases,

the disruption has affected equally the finding and articulation of all sorts of words and slowed down conversation as a result, without disturbing sentence structure. The specific nature of an individual's aphasic speech disorder sometimes caused certain of his test performances to clash with the general trend of results. This was pointed out in regard to the Word-Naming ability of one type of aphasic. However, every subject conformed to the expected trends in some of his performances. It is not possible to generalize that the aphasic whose telegraphic-style sentences consist mainly of nouns and verbs is a better abstracter than the aphasic who cannot supply nouns or verbs out-of-context. In this respect, Goldstein's and Head's analyses of the abstractness of the naming process did not conform to experimental observations. Our findings are more in accordance with those of Meyers (34) who found that the absence of verbal cues was no deterrent in the solution of a problem requiring abstract reasoning.

From an examination of word-saying performance alone, we must allow for the existence of several diagnostic sub-categories of aphasia, which are probably accounted for by differences in the site of cortical destruction. This study indicates a dimension of aphasic speech impairment which is, in principle, independent both of the diagnostic sub-category and of the severity of the speech defect. It consists of changes in speech performance which depend on the intactness of the aphasic's ability to direct his attention selectively and thus mobilize his damaged language apparatus.

C. Significance of the Findings in Clinical Practice

Some immediate use of the subtests of this study can be made in clinical work with aphasics. However, interpretations of scores should be tentative until more extensive data modifies or verifies the preliminary norms obtained from the test groups. The use of a pair of the subtests as a means of screening aphasics from other brain injuries has already been suggested. Another important fact which has immediate applicability is that, in the exploratory examination of the channels of communication, the factor of stimulus-structuring should be kept relatively constant, so that results are not contaminated by the subject's capacity for selective attention (or abstract behavior). The most highly structured subtests for eliciting speech through visual and auditory channels respectively are serial Color Reading and Continuing Series.

A hierarchy in degrees of structuring of speech stimuli has been roughly indicated and refinement of our knowledge of this sequence should now be possible. In the clinical examination of aphasics, the finding of a relative deficiency in answering highly structured stimuli must be interpreted as a specific disability which reflects the diagnostic subcategory of the patient. On the other hand, a relative deficiency in answering an unstructured stimulus may denote only a lowering of the capacity for selective attention. For instance, a patient's superiority in picture-naming over oral word-reading definitely indicates a specific deficiency in word recognition;

superiority in word-reading over picture-naming may be quite marked and reflect only a decrease in the patient's selective attention.

D. Suggestions for Further Research

The inclusion in this study of many diagnostic categories of aphasics has served its major purpose, yet introduced factors which obscure the significance of the results. It has been possible to show clearly only the presence or absence of relationships. Differences in degree of relationship are indicated too weakly for statistical significance. More clear-cut findings may emerge, if the essential parts of the study are repeated on more homogeneous aphasic groups. The basis for selecting subjects would be the similarity in the clinical picture of the speech defect and in the cause of aphasia. It would be best to exclude the nearly normal in speech and the profoundly aphasic, but the range of severity of defects should not be limited too much. The subtests which have been most successful in the present study should be tested again.

Modifications in the form of some of the speech subtests would make them applicable to the entire range of the aphasic population. For example, Written Word Reading might become a timed test of serial word reading. Color-Reading and Color-Naming should be scored on the basis of colors spoken in a fixed time unit, rather than on the basis of time taken for a fixed number of colors. The use of a battery of subtests

applicable to the entire population will enormously simplify the methodology. The relatively small number of direct correlation computations between each speech subtest and the non-verbal criteria will give all the information that, in the present study, required several hundred correlations involving ranked rank differences between subtests. Of course, a considerable length of time may be required for the accumulation of a sufficient number of cases of the same type.

Other areas of symbolic behavior are affected in aphasics and can also be studied in relation to a general loss of capacity, as measured by performance tests. The use of arithmetic, the ability to understand spoken or written stimuli, may be attacked in this way. The existence of a possible relationship between re-learning ability and the capacity for selective attention should be explored. Such a study may lead to the discovery of an effective criterion for predicting success in the re-training of aphasics.

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APPENDIX I

Tables of Scores and Ranks of Subjects on All Tests

TABLE XXXIII
Scores of Aphasic Subjects on the Fourteen Speech Subtests

Subj.	Pic.	Wr.	W.N.	A.N.	Col.N.	Col.R.	Sen.C.	Def.	Syn.	E.Op.	Op.	In.S.	Con.S.	P.W.
AHE	0	0	24	13	50	46	0	-2	-6	0	-19	-6	0	0
BON	0	0	28	12	55	29	0	0	-6	-1	-5	-	-	-1
BYR	0	0	29	5	43	25	-1	-2	-5	-3	-4	-6	0	-3
CAD	0	0	15	6	39	26	0	0	-15	-10	-3	-8	-3	-1
CAM	0	0	0	0	-	-	0	-2	-26	0	-16	-7	-3	-21
CLI	0	0	27	7	55	41	-5	-4	-23	-3	-22	-12	-12	-5
CRA	0	0	20	10	40	34	-5	-6	-8	0	-5	-12	0	-3
CRO	0	-3	15	8	66	22	0	-8	-8	0	-8	-11	-3	-3
CSO	-26	-14	6	5	-	-	-18	-22	-35	-21	-40	-28	-29	-20
CUS	-28	-17	3	3	187	133	-11	-31	-39	-5	-36	-18	-6	-
FEA	-19	-3	3	3	-	69	-10	-17	-22	-11	-34	-17	-3	-19
FER	-23	-7	19	5	180	52	-19	-18	-31	-4	-30	-17	-21	-30
FRA	-8	-15	9	4	37	34	-7	-12	-21	-1	-20	-13	-5	0
FUL	-1	-1	16	9	81	125	-13	-9	-23	-8	-27	-15	-3	-5
GAU	-10	-10	18	7	90	40	-7	-3	-32	-4	-24	-15	-9	-7
GOF	-2	-3	21	10	35	20	-3	-5	-17	-4	-6	-11	-17	-3
GRA	-2	0	17	12	70	70	-7	-11	-36	-6	-30	-	-	-8
HAL	-17	-18	11	7	-	-	-12	-26	-33	-27	-39	-18	-8	-28
HEA	-35	-23	0	0	-	-	-21	-42	-45	-24	-46	-29	-17	-30
HERB	-8	-2	5	12	32	28	-7	-12	-12	-2	-6	-	-	-2
HERR	-11	-1	13	7	55	28	-3	-3	-11	-2	-23	-14	-12	-9
LEI	-10	-14	16	8	-	-	-10	-15	-23	-	-	-	-	-
MAT	-6	-4	18	10	54	49	-5	-6	-20	-6	-15	-2	-3	0
MEY	-35	-19	0	0	-	-	-26	-28	-45	-35	-45	-20	-36	-30
MOK	-42	-40	0	0	-	-	-37	-44	-45	-33	-45	-24	-33	-30
MOR	-40	-45	0	0	-	-	-9	-44	-45	-8	-45	-28	-2	-30
MUR	-45	-45	0	0	-	-	-22	-42	-45	-10	-45	-28	-9	-30
ONE	-10	-1	9	3	-	35	-12	-12	-29	-10	-29	-20	-8	-20
PHI	-7	-5	5	2	134	108	-8	-8	-35	-7	-21	-12	0	-9
QUE	-1	0	26	10	-	-	-5	-7	-8	0	-21	-4	-4	0
RED	-2	0	15	8	29	20	0	-2	-9	-9	-10	-9	0	-7
ROH	-30	-	8	3	-	-	-22	-27	-45	-14	-45	-25	-28	-30
SAN	-	-	17	8	32	18	0	-1	-11	-2	-15	-9	-6	0
SHE	-22	-5	10	5	-	117	-6	-23	-31	-5	-33	-22	-11	-30
STE	-7	-2	6	4	420	150	-12	-12	-32	-21	-37	-21	-10	-16
TER	-10	-5	9	4	101	63	-18	-17	-18	-15	-19	-16	-17	-15
TOB	0	0	16	10	29	16	-8	-17	-28	-3	-14	-10	-16	-
TRA	-22	-9	9	4	-	32	-22	-22	-24	-0	-20	-18	-15	-24
VEN	-11	0	11	6	-	95	-13	-29	-37	-7	-43	-22	-18	-25
YOU	-17	-29	1	0	-	-	-23	-39	-45	-32	-45	-26	-22	-30
ZAU	-27	-20	4	3	321	114	-10	-30	-45	-28	-45	-25	-20	-30

TABLE XXXIV
Ranks of Aphasic Subjects on the Speech Subtests

Subj.	Pic.	Wr.	W.N.	A.N.	CoI. N.	CoI. R.	Sen. C.	Def.	Syn.	E.Op.	Op.	S. n.	Gen.	P.W.	Mean	Rmr
AHE	5.5	77	5	2	10	17	4	5.5	2.5	3	13.5	4.5	3	3	6.1	3
BON	5.5	7	2	4	13	10	4	1.5	2.5	6.5	3.5	-	-	6.5	5.5	1
BYR	5.5	7	1	1	9	6	8	5.5	1	12	2	4.5	3	13	5.6	2
CAD	5.5	7	17.5	20.5	7	7	4	1.5	11	28	1	7	9.5	6.5	9.5	7
CAM	5.5	7	37	38	34.5	34.5	4	5.5	21	3	12	6	9.5	24	17.2	14
CLI	5.5	7	3	17.5	13	16	12.5	10	18	12	19	13.5	23.5	13	13.1	13
CRA	5.5	7	7	8	8	12.5	12.5	12.5	5	3	3.5	1.5	3	10	7.1	4
CRO	5.5	19	17.5	13.5	15	5	4	15.5	5	3	7	11.5	9.5	10	10.1	9
CSO	33	28.5	28.5	23	33.5	34.5	32.5	28.5	29.5	33.5	31	35	35	23	30.3	33
CUS	35	31	32.5	31	22	28	26	36	33	17.5	28	23	15.5	-	27.6	31.5
FEA	29	19	32.5	31	33.5	21	24	25	16	30	27	20.5	9.5	22	24.4	26
FER	32	25	8.5	23	21	19	34	27	24.5	15	24.5	20.5	32	33	24.2	25
FRA	19.5	30	8.5	26.5	6	12.5	17.5	20.5	15	6.5	15.5	15	14	3	15	15
FUL	11.5	13	14	11	17	27	30.5	17	18	23.5	22	17.5	9.5	13	17.4	19
GAU	22.5	27	10.5	17.5	18	15	17.5	8.5	26.5	15	21	17.5	19.5	15.5	17.9	20
GOF	14	19	6	8	5	3.5	9.5	11	12	15	5.5	11.5	28	10	11.3	10
GRA	14	7	12	4	16	22	17.5	18	31	19.5	24.5	-	-	17	17.3	18
HAL	27.5	32	21.5	17.5	33.5	34.5	28	31	28	36	30	23	17.5	27	27.6	31.5
HEA	37.5	35	37	38	38.5	34.5	35.5	38.5	36.5	35	36	37	28	33	35.3	39.9
HERB	19.5	16.5	17.5	4	3.5	8.5	17.5	20.5	10	9	5.5	-	-	8	11.7	11
HERR	25.5	14.5	20	17.5	13	8.5	9.5	8.5	8.5	9	20	16	23.5	18.5	15.2	16
LEI	22.5	28.5	14	13.5	33.5	-	24	23	18	-	-	-	-	-	22.1	22
MAT	16	21	10.5	8	11	18	12.5	12.5	14	19.5	10.5	1.5	9.5	3	13.6	14
MEY	37.5	33	37	38	33.5	34.5	40	33	36.5	40	36	25.5	37	33.5	35.3	30.5
MOK	40	37	37	38	33.5	34.5	41	39.5	36.5	39	36	30	36	33	36.4	39
MOR	39	38.5	37	38	33.5	34.5	22	39.5	36.5	23.5	36	35	6	33	32.3	35
MUR	41	38.5	37	38	33.5	34.5	37	38.5	36.5	28	36	35	19.5	33	34.7	38
ONE	22.5	14.5	25	38	26.5	14	28	20.5	23	28	23	25.5	17.5	33.5	23.5	24
PHI	17.5	23	30	34	20	24	20.5	15.5	29.5	21.5	17.5	13.5	3	19	20.6	21
QUE	11.5	7	4	8	-	-	12.5	14	5	3	17.5	3	13	3	8.5	6
RED	14	7	17.5	13.5	1.5	3.5	4	5.5	7	25.5	8	8.5	3	15.5	9.6	8
ROH	36	-	27	31	33.5	34.5	37	32	36.5	31	36	31.5	34	33.5	33.1	36
SAN	5.5	7	12	13.5	3.5	2	4	3	8.5	9	10.5	8.5	15.5	3	7.5	5
SHE	30.5	23	23	23	26.5	26	15	30	24.5	17.5	26.5	28.5	22	33	25	28.5
STE	17.5	16.5	28.5	26.5	24	29	28	20.5	26	33.5	29	27	21	21	24.9	28.5
TER	22.5	23	25	26.5	19	20	32.5	25	13	32	13.5	19	28	20	22.8	23
TOB	5.5	7	14	8	1.5	1	20.5	25	22	12	9	10	26	-	12.4	12
TRA	30.5	26	25	26.5	11	37	37	28.5	20	25.5	15.5	23	25	25	24.6	27
VEN	25.5	7	21.5	20.5	26.5	23	30.5	34	32	21.5	32	28.5	30	26	25.6	30
YOU	27.5	36	34	38	33.5	34.5	39	37	36.5	38	36	33	33	33	32.4	37
ZAU	34	34	31	31	23	25	24	35	36.5	37	36	31.5	31	33	32	34

TABLE III Scores and Ranks of Aphasic Subjects on Tests of Abstraction
 TABLE XXXV
 Goldstein-Scheerer

Subject	Goldstein-Scheerer		Concepts		Color Matrices		Color and Form	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
AHE	+ 1	4	60	7.5	9	10	8	16
BYR	+ 2	2	-	-	9	10	10	3
CAD	-117	36	37	25	4	30	7	23
CAM	- 19	19	24	31.5	6	24.5	5	31.5
CLI	- 16	17.5	61	5.5	8	15.5	9	8.5
CRA	+ 1	4	51	12	10	4	9	8.5
CRO	- 25	24.5	61	5.5	7	20	8	16
COS	- 7	12.5	49	16	8	15.5	7	23
CUS	- 25	24.5	48	18	8	15.5	-	-
FEA	- 67	32	35	27	3	33	8	16
FER	- 90	34	33	28	4	30	6	27.5
FRA	- 22	22.5	47	19.5	8	15.5	8	16
FUL	- 1	7	68	1	7	20	8	16
GAU	- 16	17.5	29	30	2	36	9	8.5
GOF	- 3	9.5	62	3.5	9	10	10	3
GRA	- 7	12.5	59	9.5	7	20	10	3
HAL	- 2	8	-	-	9	10	18	16
HEA	-130	38	-	-	3	33	6	27.5
HERR	- 3	9.5	60	7.5	9	10	9	8.5
LEI	- 8	14	-	-	-	-	-	-
MAT	+ 9	1	65	2	10	4	9	8.5
MEY	- 13	15	49	16	3	33	-	-
MOK	- 34	27.5	46	21	6	24.5	2	35
MOR	- 51	30	47	19.5	6	24.5	5	31.5
MUR	- 32	26	-	-	8	15.5	6	27.5
ONE	- 60	31	39	23	4	30	7	23
PHI	-134	39	42	22	5	28	7	23
QUE	-100	35	-30	29	6	24.5	7	23
RED	- 42	29	59	9.5	2	36	8	16
ROH	- 76	33	-	-	-	-	-	-
SAN	+ 1	4	62	3.5	10	4	9	8.5
SHE	- 14	16	51	12	6	24.5	8	16
STE	0	6	50	14	8	15.5	10	3
TER	- 22	22.5	49	16	6	24.5	8	16
TOB	- 4	11	-	-	10	4	-	-
TRA	- 20	20	51	12	10	4	5	31.5
VEN	- 34	27.5	24	31.5	10	4	5	31.5
YOU	- 21	21	36	26	10	4	4	34
ZAU	-120	37	38	24	2	36	6	27.5

TABLE XXXVI

Scores and Ranks of Non-Aphasic Subjects on Speech Subtests

Subject	Col.N.		Col.R.		W.N.		A.N.		Syn.		E.Op.		Op.		P-W.	
	sc.	rank	sc.	rank	sc.	rank	sc.	rank	sc.	rank	sc.	rank	sc.	rank	sc.	rank
AIR	51"	19	43"	20	26	11	12	7	-2	4.5	0	3	-13	16	-1	7.5
BEL	45"	17	29"	18	12	17.5	6	20	-15	14.5	0	3	-6	10.5	-12	20
BRO	37"	14	33"	19	28	9	14	3.5	-15	14.5	-1	13	-10	14	-3	11.5
BUR	19.5"	4	20"	12.5	26	11	11	10	-7	9.5	-2	9.5	-2	2.5	-3	11.5
DIG	38"	15.5	24"	16	8	20	11	10	-18	16.5	-13	20	-31	14	-10	19
DIS	55"	20	25"	17	15	15	12	7	-10	13	-7	18	-10	18	-4	13.5
ELK	50"	18	23"	14	10	19	7	17.5	-18	16.5	-5	16	-6	10.5	-9	18.
ELW	34"	12	14"	5	29	7.5	10	12.5	0	1	-3	11	-6	10.5	-2	9.5
FOW	20"	5	14"	5	30	6	7	17.5	-7	9.5	-1	7	-6	10.5	-5	15.5
GAR	15"	1	10"	2	39	3	7	17.5	-2	4.5	0	3	-3	4	-1	7.5
HAM	19"	3	17"	9	40	2	14	3.5	-8	11.5	-1	7	-10	14	0	3.5
HOD	38"	15.5	15"	7.5	29	7.5	12	7	-22	18	-5	16	-16	17	0	3.5
JAR	24"	8	20"	12.5	14	16	11	10	-23	19	-9	19	-42	20	0	3.5
KEN	27"	10	14"	5	26	11	13	5	-1	2	0	3	-2	2.5	-2	9.5
MAC	26"	9	19"	11	21	14	10	12.5	-2	4.5	-4	13	-4	6	-5	15.5
PAT	23"	7	12"	3	34	4.5	9	14.5	-6	8	0	3	-4	6	-4	13.5
PIC	17"	2	9"	1	46	1	19	1	-8	11.5	-2	9.5	-1	1	0	3.5
TEN	22"	6	18"	10	34"	4.5	15"	2	-4	7	-5	16	-4	6	-0	3.5
TIM	35"	13	24"	15	12	17.5	7	17.5	-25	20	-4	13	-41	19	-6	17
VAN	30"	11	15"	7.5	22	13	9	14.5	-2	4.5	-1	7	-5	8	0	3.5

TABLE XXXVII
 Scores and Ranks of Non-aphasic Subjects on Performance Tests of Abstraction

Subject	Goldstein-Scheerer		Concepts		Color Matrices	
	Score	Rank	Score	Rank	Score	Rank
AIR	- 40	14	64	5	9	7
BEL	+ 12	1	48	13	10	2.5
BRO	- 24	12.5	65	4	10	2.5
BUR	- 41	15	49	12	6	13.5
DIG	-175	19	18	20	3	18
DIS	- 77	18	45	14	5	16
ELK	- 19	11	24	19	5	16
ELW	- 9	7	56	8	8	10.5
FOW	- 13	9	66	2.5	10	2.5
GAR	-46	16	51	10	5	16
HAM	-14	10	35	18	9	7
HOD	-24	12.5	50	11	8	10.5
JAR	- 3	6	43	15	1	19.5
KEN	- 47	17	37	16	7	12
MAC	- 1	5	55	9	10	2.5
PAT	+ 3	4	70	1	9	7
PIC	+ 8	2	66	2.5	6	13.5
TEN	- 10	8	63	6.5	9	7
TIM	-250	20	36	17	1	19.5
VAN	+ 6	3	63	6.5	9	7

APPENDIX II

Content of the Fourteen Word-Association Subtests

I. Pictures

- | | |
|--|---|
| 1. a watch | 9. three dots, as on the face of a die. |
| 2. a man writing | 10. a camera |
| 3. a man sleeping | 11. a stove |
| 4. a star | 12. a radio |
| 5. a heel | 13. an iron |
| 6. a red rectangle | 14. a crescent moon |
| 7. a blue rectangle | 15. the outline of a square |
| 8. five dots, as on the face of a die. | |

II. Written Words

- | | |
|-------------|------------|
| 1. watch | 9. three |
| 2. writing | 10. camera |
| 3. sleeping | 11. stove |
| 4. star | 12. radio |
| 5. heel | 13. iron |
| 6. red | 14. moon |
| 7. blue | 15. square |
| 8. five | |

III. Word Naming

Subject is instructed to name words at random for a minute, as rapidly as they come to mind, while examiner counts them.

IV. Animal Naming

Subject is asked to name all the different animals he can think of for a minute.

V. Color Naming

A five by eight card on which are arranged, in five rows of six squares each, thirty small squares of five different colors, in the same sequence as the corresponding color words, below.

VI. Color Reading

green	black	yellow	green	blue	black
red	yellow	blue	red	green	blue
black	green	black	yellow	red	yellow
blue	red	blue	green	black	blue
yellow	blue	red	black	yellow	red

VII. Sentence Completion (Expected response word is given in parentheses.)

1. Before I go to sleep I set the time and I wind my (watch).
2. You cut the meat on your plate with a knife and (fork).
3. Two nickels make a (dime).
4. The tailor cuts cloth with a pair of (scissors).
5. The American flag is red, white, and (blue).
6. To make the baby sleep you rock the (cradle).
7. He keeps his hair neat with a brush and (comb).
8. To cut a roast, you need a good, sharp (knife).
9. He knows his business from A to (Z).
10. Some people drink coffee for breakfast but others prefer a glass of (milk).

11. My shoes have leather soles and rubber (heels) .
12. The stars are shining up in the (sky) .
13. It got so cold that the rain turned to (snow) .
14. Four and one make (five) .
15. The baker put the dough into a big, hot (oven) .

VIII. Definitions

1. What do I wear on my wrist to tell time with?
2. What do we call our ten cent coin?
3. Give me the name of a two-wheeled vehicle.
4. What is the color of the clear sky?
5. What shines in the sky at night?
6. What do you cut cloth with?
7. What do you call the little bed that baby sleeps in?
8. What do we use to straighten our hair when it's messed up?
9. What is the last letter in the alphabet?
10. What do cows give us to drink?
11. At the table, what do you cut your meat with?
12. What part of a shoe is made of rubber?
13. What do we call the frozen white flakes that fall in winter?
14. What is the number of toes on one foot?
15. What do we cook on?

IX. Synonyms

- | | |
|-----------|------------|
| 1. glad | 9. infant |
| 2. hit | 10. large |
| 3. shower | 11. chilly |
| 4. talk | 12. damp |
| 5. want | 13. hurt |
| 6. liquor | 14. finish |
| 7. toilet | 15. begin |
| 8. shut | |

X. Easy Opposites

- | | |
|----------|-------------|
| 1. hot | 9. north |
| 2. in | 10. mother |
| 3. black | 11. good |
| 4. high | 12. brother |
| 5. big | 13. east |
| 6. up | 14. summer |
| 7. rich | 15. fat |
| 8. boy | |

XI. Opposites

- | | |
|--------------|--------------|
| 1. far | 9. oldest |
| 2. beginning | 10. pull |
| 3. less | 11. stand |
| 4. found | 12. remember |
| 5. different | 13. clean |
| 6. answer | 14. dry |
| 7. often | 15. give |
| 8. oldest | |

XII. Initiating Series (Score based only on ability to start)

1. Let me hear you count up to ten.
2. How do you recite the alphabet.
3. What are the days of the week?
4. Recite the months of the year.
5. (After whistling the beginning of the Star Spangled Banner and verifying that subject recognizes it)
"How do the words go?"
6. Same procedure followed with the song "America".
7. Same procedure followed with the song "Yankee Doodle."
8. What are the colors of the American flag?
9. What does the proverb say, "keeps the doctor away?"
10. What are the last three letters of the alphabet?

XIII. Continuing Series (expected response word is given in parentheses)

- | | |
|---|--|
| 1. Seven, eight, <u>(nine)</u> . | 9. Of thee <u>Ë</u> (sing). |
| 2. Ten, eleven, <u>(twelve)</u> . | 10. D, E, <u>(F)</u> . |
| 3. Nine, eight, seven, <u>(six)</u> . | 11. X, Y, <u>(Z)</u> . |
| 4. Oh, say can you <u>(see)</u> . | 12. March, April, <u>(May)</u> . |
| 5. By the dawn's early <u>(light)</u> . | 13. October, November, <u>(December)</u> . |
| 6. Tuesday, Wednesday, <u>(Thursday)</u> . | 14. An apple a day keeps <u>(the doctor away)</u> . |
| 7. Saturday, Friday, Thursday, <u>(Wednesday)</u> . | 15. Yankee Doodle came to town riding on a <u>(pony)</u> . |
| 8. My country, 'tis <u>(of thee)</u> . | |

XIV. Part-Whole Associations.

The tabulated frequency of each response is given after each of the ten stimulus words.

- | | |
|-----------|---|
| 1. Point | pencil-19; pen-9; needle-6; pin-5; knife-4; spear-1; dagger-1; punch-1; failed-12. |
| 2. Button | clothes-16; shirt-12; coat-10; suit-5; dress-4; pants-3; jacket-2; shoes-1; failed-5. |
| 3. Handle | door-16; hammer-11; knife-9; bicycle-4; shovel-3; axe-2; suitcase-2; bucket-2; rake-1; broom-1; failed-6. |
| 4. Wheel | car-15; auto-13; wagon-12; vehicle-4; bicycle-4; cart-1; wheelbarrow-1; scooter-1; buggy-1; failed-6. |
| 5. Pocket | pants-16; coat-12; clothes-9; suit-6; shirt-4; trousers-5; failed-6. |
| 6. Stem | watch-16; pipe-11; flower-11; plant-5; blossom-4; tree-3; rose-1; vegetable-1; leaf-1; fail-5. |
| 7. Bone | body-13; animal-11; human-8; skeleton-6; meat-6; leg-4; head-1; failed-6. |

8. Entrance house-14; building-10; room-9; theatre-8;
doorway-7; yard-1; porch-1; failed-8.
9. Switch electricity-12; house-9; light-7;
circuit-3; railroad-4; tree-3; building-2;
motor-2; elevator-1; failed-15.
10. Spark plug auto-14; car-11; motor-11; engine-9;
machine-5; failed-8.

APPENDIX III

Details of Color and Form Sorting and Color Matrices Tests

TABLE XXXVIII

Procedure for Administering and Scoring Color and Form Test

Item No.	Stimulus	Remarks	Scoring
Part I-a Sample	Two sample cards, one having an assortment of colored cut-outs; the other an assortment of achromatic ones.	Patient must show acceptance of distinction between "colored" and "uncolored" cut-outs by pointing out "colored ones on request. If explanation fails, proceed to part I-b.	Sample is not included in scoring.
1 to 3	Three square cut-outs; one colored, two achromatic. Ask, "Which is the colored one?"	<u>1st level of difficulty.</u> Items 2 and 2 given only if subject hesitates on first item. Different colors used each time. Skip to part I-b if failed entirely.	Performance rating for each item is scored as: Normal Difficult Failed
4 to 6	Five triangle cut-outs of which two are colored, the others achromatic. Ask, "Which are the colored ones?"	<u>2nd level of difficulty</u> Items 5 and 6 are given only if subject hesitates on 4. Colors are varied for each successive item.	Remarks for each item indicate:
7 to 9	Three assorted shapes of which only one is colored. Say, "pick the colored one."	<u>3rd level of difficulty.</u> Items 8 and 9 to be skipped if performance on 7 warrants. Both shapes and colors to be varied at will in items 8 and 9.	C- Conceptual. Succeeds without referring to sample card. M.-Matching. Success only when permitted to match to upturned sample card. Loss of Goal- Distraction from designated criterion of selection. Defr. Narrowing or broadening criterion of selection, after initially accepting it as defined. e.g., including black among "colored" cut-outs.
10 to 12	Five assorted forms of which two are colored. Say, "Pick out the colored ones."	<u>4th level of difficulty</u> Both color and form are varied in items 11 and 12, which may be omitted at examiner's discretion.	
13	Thirty assorted pieces of all shapes and colors. Say, "Pick out all the colored ones."	<u>5th level of difficulty.</u>	
Part I-b 14-15	Three pieces of same shape, different colors. Ask for one color.	Vary both shapes and colors in item 15.	(Point credits are given in second half of this table)
16-17	Five pieces of different shapes and colors.	Vary shapes and colors in item 17.	

Table XXXVIII (Concluded)

Item No.	Stimulus	Remarks	Scoring
Part <u>II-a</u>	Sample cards.	Samples of all shape categories are first presented with explanation.	<u>Part I-a</u>
18-20	Three green cutouts on a card. One star, two other shapes. Say, "Which is the star?"	1st level of difficulty. 3-, 4-, and 5-pointed stars are used in successive trials.	At least one item correct in this part. Score 1 At least one correct at each of first 4 levels of difficulty. Score 2 In addition to preceding, no recourse to matching. Score 3. In addition to above, 5th level of difficulty solved in principle. Score 4. No irrelevant moves. Score 5.
21-23	Four green cutouts on card, each having different numbers of points. Ask successively for 3-, 4-, and 5-pointed pieces.	2nd level of difficulty- Examiner should be sure that piece to be selected is not a star, to avoid spurious success by perseveration of preceding set.	<u>Part I-b</u>
24-25	Card of 12 green cutouts of all shapes. Ask for 3-pointed, then for rounded ones.	3rd level of difficulty. There are three pieces of each category to be located on the card.	No. positive credit. Deduct one for each item failed.
26-27	Three cutouts of different colors, including a star and a rounded figure, which are asked for, successively.	4th level of difficulty. Subject must resist distraction by color.	<u>Part II-a</u>
28-30	Thirty pieces of all shapes and colors. Ask successively for "stars", 3-, and 5-pointed figures.	5th level of difficulty. Subject must find nearly all pieces of designated category. Any systematic omissions constitute failure of the item.	At least one correct. Score 1. At least one correct at each of 1st four levels. Score 2. No recourse to matching. Score 3. In addition to above, 5th level of difficulty solved in principle. Score 4. No irrelevant moves. Score 5.
Part <u>II-b</u>	Three green cut-outs, including square and 5-pointed star, which are asked for successively.	Ask successively for circle and for triangle, which should be among the five items exposed.	<u>Part II-b</u>
31-32	Five pieces of assorted colors and shapes.	Thirty pieces of all shapes and colors. Ask for 4-pointed stars	No positive credit. Deduct one for each item failed.
33-34	Thirty pieces of all shapes and colors. Ask for 4-pointed stars		

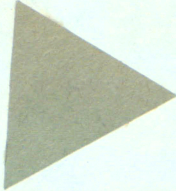
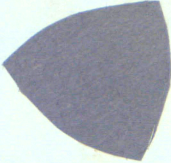
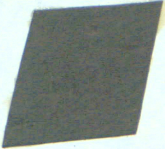


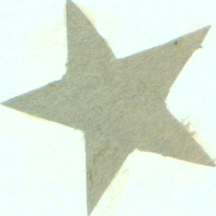
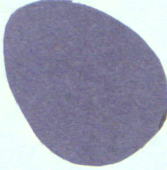

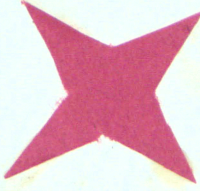
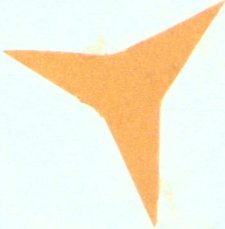
<i>Three-pointed figures</i>		
<i>Four-pointed figures</i>		
<i>Five-pointed figures.</i>		
<i>Rounded figures</i>		
<i>Stars.</i>		

Figure II Samples of Color and Form Sorting Figures.

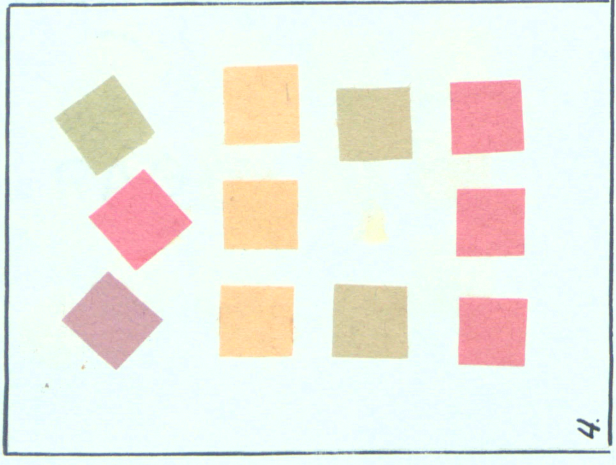
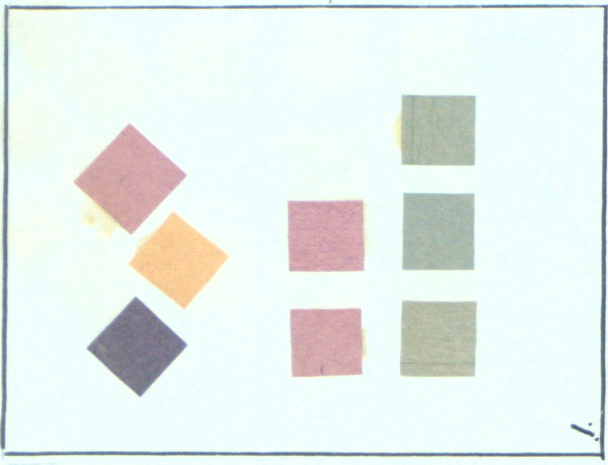
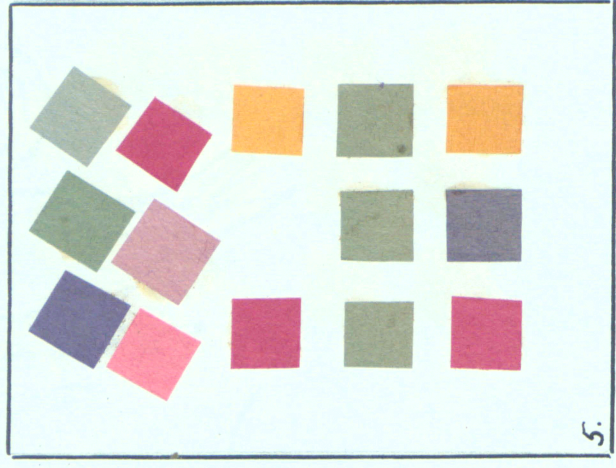
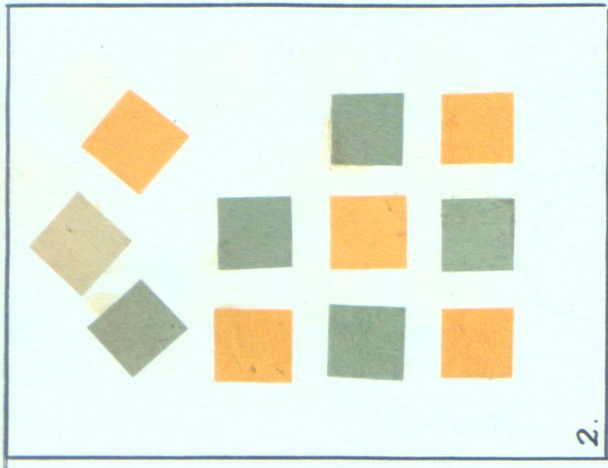
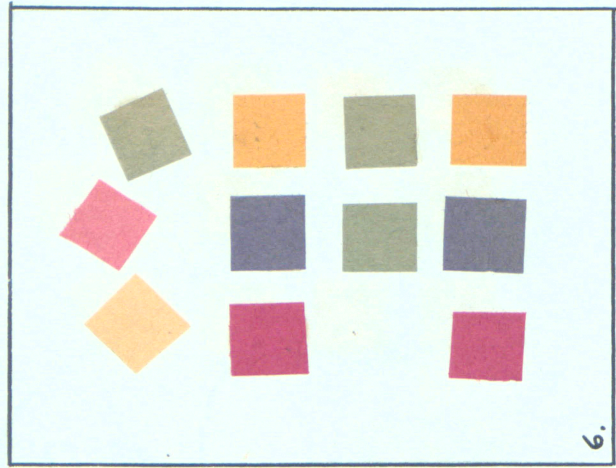
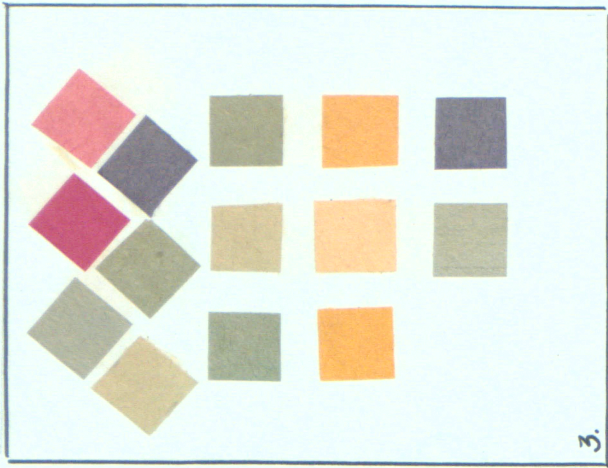


Plate VI Reproductions of Color Matrices : Cards 1 through 6.

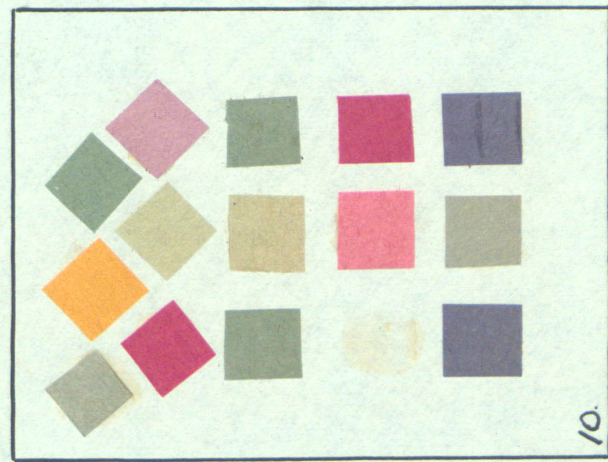
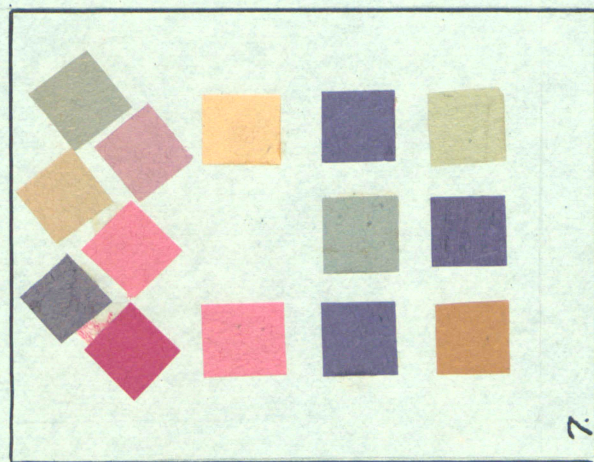
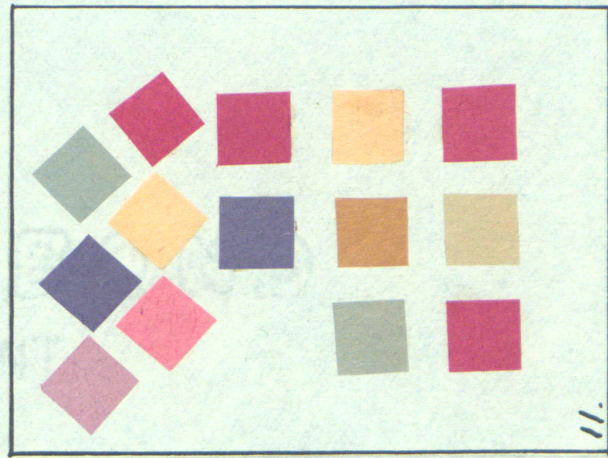
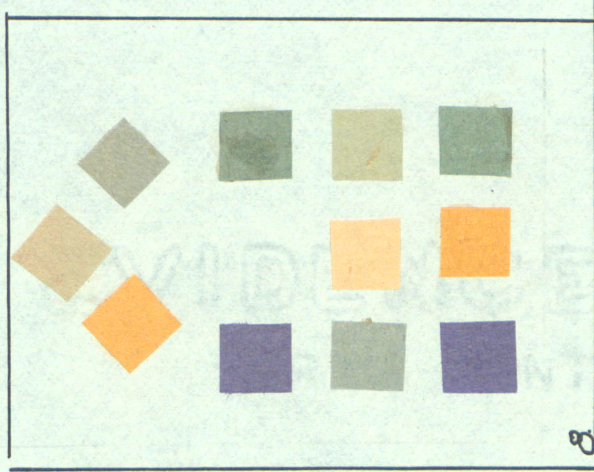
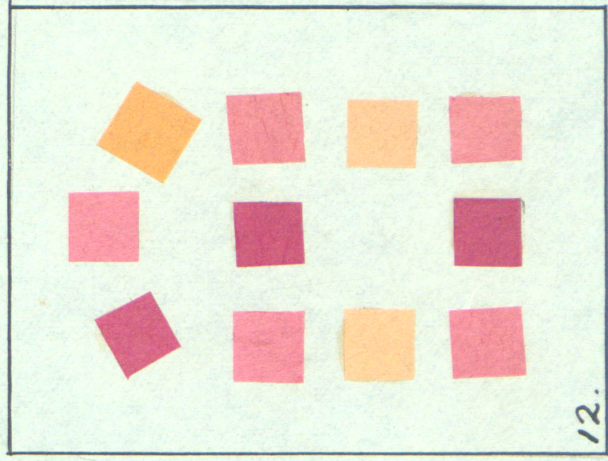
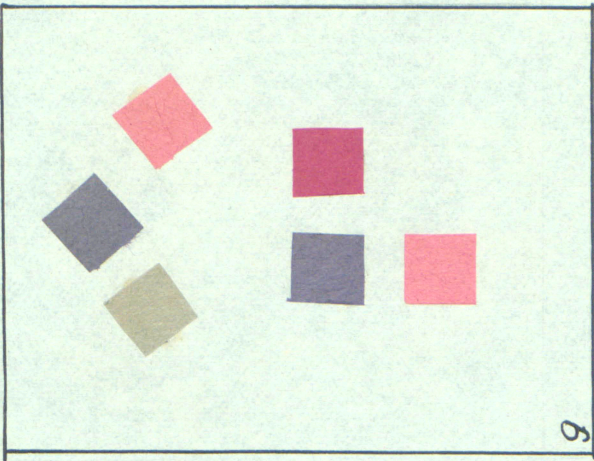


Plate VIII Reproductions of Color Matrices : Cards 7 through 12.