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**MEMORY FOR SENTENCES IN BRAIN-DAMAGED ADULTS**

*City University of New York*

**PH.D. 1981**

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MEMORY FOR SENTENCES IN BRAIN-DAMAGED ADULTS

by

PAULA M. IPPOLITO

A dissertation submitted to the Graduate Faculty in  
Psychology in partial fulfillment of the requirements  
for the degree of Doctor of Philosophy, The City  
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1981

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## Abstract

### Memory For Sentences In Brain-Damaged Adults

by

Paula M. Ippolito

Adviser: Dr. Louis Gerstman

In order to distinguish general memory functioning from linguistic memory functions in aphasics, the Peterson and Peterson (1959) technique for preventing rehearsal was superimposed on the Shewan and Canter (1971) design.

Forty seven adults within 5 groups participated in the study: 10 normals hospitalized for non neurological conditions, 10 right brain-damaged (RBD), 5 left brain-damaged without aphasia (LBD-NA), 14 fluent aphasics and 8 non-fluent aphasics.

The stimuli consisted of 96 sentences each indexed to a four-fold picture selection task. A quarter of the sentences were responded to immediately after being read (0 delay), the remainder after one of three delay intervals (6, 12, 18 seconds) during which the subject continuously responded to the Peabody Picture Vocabulary Test. Half of the sentences contained 3 critical items and 7 syllables (L<sub>1</sub>), the other half having 5 critical items and 11 syllables (L<sub>2</sub>). Half the critical items were obtained from the thousand most frequent Thorndike-Lorge (1944) words (V<sub>1</sub>), the other half from the 25-40 words per million range (V<sub>2</sub>). Both of these linguistic factors were completely crossed with six exemplars in each cell.

Following administration it was found that the six items in any

cell varied enormously in difficulty as a consequence of variations in picture salience, i.e., the prominence of the discriminandum required to make a correct choice. Reliability analyses identified the four most consistent exemplars in each cell, which thereupon became the final data base.

Each subject's scores were next examined at each delay interval to determine where performance dropped to chance, defined as the point where two of the four cells ( $L_1V_1$ ,  $L_1V_2$ ,  $L_2V_1$ ,  $L_2V_2$ ) had less than two correct choices. By this criterion 4 RBD, 2 LBD-NA, 6 non-fluents and all 14 fluents failed to complete the experiment. A total score was posted for each S up to the point of departure into chance.

Group contrasts established that the performances of both non-aphasic groups were indistinguishable, as was also the case for both aphasic groups. In final contrasts it was found that the aphasic performances were significantly inferior to the non-aphasic performances which were in turn significantly inferior to the normals, who made essentially no errors in the whole experiment.

Analyses of variance of performances at zero delay established that the fluent aphasics were influenced by the vocabulary variable but not the length variable, and only then at the shorter sentence length. Conversely, the non-fluent aphasics were influenced by the length variable but not the vocabulary variable. These disparities confirm the prior findings of Caramazza and Berndt (1978).

A score was computed for each fluent aphasic expressing his personal responsiveness to the vocabulary variable, which was indeed found to correlate highly negatively ( $r = -.741$ ) with total performance, indicating

that the worse one's non-linguistic memory the worse one's performance with low frequency words. When an influence of length effect was computed for the non-fluent aphasics it was found not to correlate with total performance. In both groups, not surprisingly, total score correlated positively with the Peabody task on which the experiment was modeled, but paradoxically, for the non-fluents total score was related to aphasia test performance while for the fluents it was not.

It was concluded that all the aphasics had a general memory deficit more severe than the deficits of the non-aphasic brain-damaged. In the fluents this deficit was correlated with a linguistic factor in the task but not with those in an aphasia test. In the non-fluents the correlation was with the aphasia test but not with the task.

In loving remembrance of my grandmother  
Rosaria Del Bagno  
--- a courageous woman

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Lessons learned are like  
bridges burned  
You only need to cross them but once.  
Is the knowledge gained  
Worth the price of the pain?  
Are the spoils worth the cost of the hunt?

Dan Fogelberg 1977

## The Problem

This study attempted to distinguish general memory functioning from linguistic memory in aphasics. Aphasia has been viewed as a disturbance in linguistic abilities consequent to cerebral damage, affecting both the expressive and receptive aspects of language. The hypothesis that a memory disorder may be responsible for the language impairment of aphasics is a recent development, with the majority of prior work concentrated on the expressive impairment of aphasics.

In the present research an attempt was made to evaluate an aphasic's sentence memory. The Peterson and Peterson (1959) technique was superimposed on the paradigm of sentence comprehension developed by Shewan and Canter (1971): the factors of sentence length and semantic difficulty were varied and presented to the subject over a series of time-filled delay intervals. These three variables were postulated to be representative of specific cognitive processes: semantic difficulty and length were thought to be linguistic factors differentially affecting fluent and non-fluent aphasics, respectively; while delay was considered representative of a general memorial factor, potentially affecting all aphasics equally.

## INTRODUCTION

This chapter will examine literature pertinent to this study. After briefly specifying the distinctions used in aphasic symptomatology, a review of sentence comprehension in aphasics will follow. Thereafter, memory functioning in aphasics will be explored. Finally, a set of inferences and the hypotheses for this study will be presented.

Aphasics have traditionally been divided into groups according to their ability to produce speech. Those who have effortful, static speech processes are called non-fluent aphasics while those who produce smooth speech with good prosody are called fluent aphasics (Benson, 1970). Paradoxically, those whose speech production appears to be most impaired comprehend verbal material better than those with little expressive difficulty. This distinction in comprehension abilities has been found to be highly correlated with specific lesions of brain tissue, such that fluent aphasics have posterior left hemisphere damage and non-fluent aphasics have incurred anterior left hemisphere damage (Benson, 1970).

### Sentence Comprehension in Aphasia

Until recently, language comprehension deficits were sparingly investigated, since the bulk of research was performed on anterior (non-fluent) aphasics. Lately, attempts have been made to clarify the language comprehension disturbance found in aphasics.

Under certain conditions the aphasic's comprehension performance has been shown to diminish when excessive demands are made. The difficulty increases with sentence length (Saffran and Marin, 1975;

Caramazza et.al., 1978). Schuell and her collaborators (Schuell and Jenkins, 1961; Schuell, Jenkins and Landis, 1961) stated that difficulty in comprehension of words for an aphasic is related to the frequency of their occurrence in English. Rocheford and Williams (1965) reported similar findings in their study of naming by aphasics, as well as Howes (1957) in his study on comprehension by normal subjects. Goodglass, Gleason and Hyde (1970) partially support the contention that an aphasic's ability to comprehend a specific feature (e.g., contentive words) of language is related to his ability to produce that feature in speech (Alajouanine, Lhermitte, Ledoux, Renaud and Vignolo, 1964). Gainotti, Ibba and Caltagirone (1975, cit. Boller, Kim and Mack, 1977) found a high correlation between semantic paraphasia and semantic disorders of comprehension in their patients. A detailed investigation of semantic discrimination was carried out by Pizzamiglio and Appicciafuocco (1971) which demonstrated poorer performance by aphasics than right-brain damaged or normal subjects. Goodglass and Baker (1976) found that an aphasic's ability to produce or recognize associates of a given word or picture is related to his ability to produce names.

Using the more natural context of sentences, Gardner, Albert and Weintraub (1975) studied the comprehension of single words by varying several aspects of the sentence in which the words were presented. They concluded that an aphasic's comprehension was facilitated by providing redundant information that afforded additional cues to the patient. Thus, general agreement appears to exist among researchers that some kind of semantic disturbance is involved in comprehension deficits (Goodglass and Geschwind, 1976).

Studying the receptive components of aphasic language disorders, Shewan and Canter (1971) devised a paradigm which contrasted syntactic structure, level of difficulty of vocabulary, and sentence length. This research will be explored in detail, since it forms the basis of the present research. Shewan and Canter (1971) wanted to minimize the influence of expressive language processes; therefore, their subjects were asked to respond to a sentence read aloud by pointing to one of four pictures. One picture corresponded to the stimulus sentence, the other three differed from the correct choice on one critical item. The authors hypothesized that the extent of disruption in performance of the various subgroups of aphasics would be differentially affected by manipulations of these factors (length, semantics and syntax). Variation in syntactic difficulty was accomplished by using a simple declarative sentence, a negative or a passive transformation. Vocabulary difficulty was determined by selecting words at three levels of the Thorndike-Lorge (1944) frequency count and at two age levels on a number of vocabulary tests. Finally, sentence length was varied by increasing the number of content, or key, words from three to seven and, simultaneously, increasing the total number of syllables from seven to fifteen.

As expected, the results indicated that aphasics performed more poorly than normals. Further, aphasic subgroups differed one from the other, such that, amnesic, Broca's and Wernicke's displayed progressively greater impairment, in the order cited. All aphasics demonstrated difficulty with syntactic variations, less difficulty with length manipulations and the least difficulty with the vocabulary parameter. These authors concluded that there were no qualitative

comprehension differences among the aphasic groups.

In the present research, the Peterson and Peterson (1959) technique for short-term memory will be superimposed upon this paradigm. In this way, the confounding effects of expressive language dysfunction may be limited, while simultaneously, providing a more natural context for language, that is, sentence stimuli. The simultaneous use of these procedures may give us the means of separating general memory functioning from linguistic memory functions. That is, performance may be separated into memory for sentences with and without the addition of delay-- a non-linguistic memory load. The details for the modification of these techniques for the investigation of sentence memory will be discussed in the following chapter.

Recent work performed by Zurif and his colleagues are pertinent to this discussion of comprehension deficits in aphasia. The theoretical orientation pursued by this group suggests that qualitative differences in the patterns of performance of aphasics may be uncovered depending upon the site of lesion (anterior vs. posterior) (Zurif et.al., 1972, 1976). Caramazza and Zurif (1976) performed a study in which they showed that anterior (non-fluent) aphasics attain a relatively high level of sentence comprehension through the use of lexical and heuristic processes. This result supports the notion that the anterior aphasic employs a semantic interpretation to a sentence in order to comprehend it. Further research (Caramazza and Zurif, 1976) assessed both kinds of aphasics on a comprehension task. This task utilized a sentence-picture matching procedure in which the subject was read a sentence and asked to choose the one of two pictures presented which depicted the statement read. The research showed that aphasic

patients had difficulty comprehending single object-relative sentences, e.g., "The dog that the boy is chasing is fat;" and, in particular, Broca's aphasics were unable to discriminate these sentences when all semantic cues were kept constant, such that comprehension depended solely on syntactic cues. Thus, the literature pertaining to language comprehension is divided into two camps. The inferences employed in this research will rely on the notion that qualitative differences may be found in the performance of an aphasic depending on the site of lesion.

#### Memory in Aphasia

The investigation of sentence comprehension in aphasia has led to some speculation concerning whether a memory disturbance, as such, might not contribute to the aphasic's difficulty. Its relationship to aphasics in general was put forth by Albert (1976) and Caramazza, Zurif and Gardner (1978); and specifically with regard to conduction and Broca's aphasics, by Warrington and Shallice (1969), Saffran and Marin (1975), Hellman, Scholes and Watson (1976) and Shallice and Butterworth (1977).

The investigators of memory functioning have concentrated on the expressive impairment of aphasics; specifically, the repetition impairment in conduction aphasics and the halting speech in Broca's syndrome. These disturbances have been attributed to deficits in retrieval from short-term memory (STM) but not from long-term memory (LTM). The form these deficits assume when memory is implicated are characterized by a limited memory structure (or process) that represents information in a relatively exact format.

Caramazza, Zurif and Gardner (1978) attempted to address this topic

by presenting a modified memory probe paradigm to anterior and posterior aphasics. This task was thought to be especially sensitive to the structure of the internal representation of the sentence; since a correct performance requires the patient to retain a representation of the surface structure (Chomsky, 1965). Active, passive and embedded sentences were presented to the subjects; and the effects of the following factors upon memory were explored: the number of words in a sentence, the number of propositions in a sentence, and the syntactic arrangement of these propositions.

No differences were found between aphasic groups indicating that Broca's and Wernicke's aphasics did not differ in their memory capacity for sentence material on the task employed. Additionally, no significant interactions were found between aphasic type and the part of the sentence retrieved, suggesting that the internal representation of the sentences are similar for both groups of aphasics. Functor words appear to be less stable than content words for both aphasic groups with the pattern of errors markedly different from the usual pattern obtained with normals. Comparison of the three types of sentences revealed no significant difference in overall aphasic performance across sentence types. The authors suggested that earlier reports of differences between sentence types (i.e., simple, complex) may have been due simply to the length of the sentence. Linguistic factors may have been irrelevant.

Conclusions drawn from this research suggest aphasics (both anterior and posterior) possess a limited capacity storage system for verbal material. Aphasics could not consistently make use of syntactic information in processing sentences or in constructing memory

representations. Specifically, their memory for function words was impaired, and consequently, subjects demonstrated inability to process syntactically relevant information. To the extent that comprehension or memory of sentences would require processing of grammatical morphemes, the performance of an aphasic would be adversely affected.

The studies reported above reflect the broadening of the theory of memory disruption in aphasia beyond that demonstrated in conduction aphasia. They permit concluding that: (1) the use of a non-verbal response should give a better assessment of the stored information possessed by an aphasic; (2) the length of the sentence material appeared to be a major factor in an aphasic's performance on a sentence memory task; and (3) the use of functor words did not appear to affect an aphasic's performance on a modified sentence memory task. These factors, along with the propositions put forth by Shewan and Canter (1971), led to a decision in the present research to manipulate the number of content words and length of the sentences while holding syntax constant (active declarative), and requiring a non-verbal pointing response.

Shewan and Canter's (1971) research provided a starting point for this research. The task utilized here was developed by selecting those sentence-picture pairs of Shewan's which met the criterion put forth below; and, by composing additional sentence-picture pairs according to Shewan's criteria (1969). The presentation of filled-delay conditions between the stimulus and response was grafted to Shewan's original procedure. These filled-delay conditions were expected to prevent rehearsal of the stimulus material (Peterson and Peterson, 1959). Four delay conditions were used -- zero, six, 12 and 18 seconds.

Performance at the zero delay condition (where rehearsal was not interrupted) was compared to performance at the delay conditions. In this way the effects of non-rehearsal upon sentence memory could be compared with uninterrupted performance (zero delay), in an attempt to separate the relevant aspects of memory -- both linguistic and non-linguistic.

#### Inferences and Hypotheses

The most salient aspects of the literature review concerning memory and language functioning are as follows: memory is not unidimensional but may be differentiated into modality specific processes. Within the realm of language disorders, individuals may be classified as either fluent or non-fluent, reflecting the quality of their spontaneous speech.

These groups have been found to be differentially affected by semantic and syntactic (or length) variables (Caramazza and Berndt, 1978; Caramazza and Zurif, 1978; Zurif et.al., 1972, 1976a, 1976b). Since these groups do not consistently differ in their response to variations in syntax (e.g., on memory tasks), it has been suggested (Caramazza, Zurif and Gardner, 1978) that this finding may have been due to the length of the sentence. Thus, patients with anterior brain damage (those with relatively intact comprehension) are believed to be deficient in their ability to integrate correctly understood lexical items into certain types of syntactic frames (Caramazza and Zurif, 1976). In contrast, those patients with posterior brain damage (those exhibiting poor comprehension) are said to lack an understanding of individual lexical items but to have retained an

implicit understanding of the syntactic rules for combining words into grammatical sentences (Caramazza and Berndt, 1978; vonStockert, 1972). Although lexical disturbances are present, they are rarely total (Goodglass & Geschwind, 1976) and, as such, are amenable to further investigation.

Therefore, the fluent group was suggested to be more sensitive to variations in semantic difficulty, while the non-fluent group was suggested to be more sensitive to variations in the length of the sentence. Comprehension difficulties can be demonstrated for both of these groups. In addition, a proposal has been set forth suggesting that aphasics may demonstrate a verbal memory disorder. Specific task requirements were proposed to aid in the discovery of those variables most pertinent to sentence memory; some of these are the number of content words comprising a sentence, the length of a sentence, the level of semantic difficulty of the content words, and the employment of standardized procedures for memory investigation.

The experimental manipulation considered to be representative of a general factor of memory was the filled-time delay between the presentation of the stimulus and the recognition response. The linguistic variables were the vocabulary (level of semantic difficulty) variable and sentence length. An experimental task developed with these variables was used to explore the performance of aphasics (fluent and non-fluent), left brain-damaged non aphasics (LBD-NA), right brain-damaged (RBD) and normals (non-brain-damaged).

The following hypotheses were generated:

1: The normal subjects' performances were not expected to be influenced by manipulation of the variables.

II: The non-aphasic brain-damaged (both RBDs and LBD-NAs) subjects performances were expected to be inferior -- though similar -- to those of the normals.

III: The aphasic subjects' performances were expected to be the poorest of all the subjects.

IV: Within the aphasic group, the fluents' performances were expected to demonstrate greater differences from the non-fluents' performances according to the degree of linguistic loading of that particular parameter; i.e., these two groups were not expected to differ in their response to delay; they were expected to differ in their response to vocabulary, such that, the performance of the fluents would be affected by vocabulary; and, they were expected to differ in their response to length, such that, the performance of the non-fluents would be affected by length.

## METHODS

This chapter will first consider the methods employed to select subjects and then define the tasks they performed. Finally, the administration of all instruments will be described.

### Subjects for the Study

Thirty-seven brain-damaged subjects were chosen for the study. They included 22 aphasics with left brain-damage (LBD), chosen by two speech pathologists and this examiner to fit the characteristic symptom complexes of the fluent and non-fluent aphasic syndromes (Benson, 1970). The speech pathologists were staff members of the hospitals mentioned in this section. All three judges had to agree on the diagnosis for a subject's admission to the study. The basic criteria employed and the identifying signs for each patient can be found in Appendix 1. There were also 5 non-aphasic left brain-damaged, 10 non-aphasic right brain-damaged (RBD), and 10 normal subjects, the latter to be described in a later section.

The patients were selected from the medical and rehabilitation services of New York City's Goldwater Memorial Hospital and Byrd S. Coler Home for the Aged. A summary of each subject's background was compiled. This included data on their sex, age, achieved educational level, time elapsed since onset, etiology, and in the case of brain-damaged, paralytic status. This information is presented for each case in Appendix 2.

All patients demonstrated some sensory or motor weakness as assessed by the staff neurologist. Among the RBD subjects, 9 demonstrated a left-hemiplegia and one demonstrated left-sided weakness. Four of the

left brain-damaged non-aphasic subjects were hemiplegic on the right side of the body and the fifth demonstrated weakness on that side. Of the 22 LBD aphasic patients, 17 demonstrated a right hemiplegia; the remaining had significant weakness.

Etiology of the disorder was classified as either cerebrovascular (CVA), surgical for tumor or surgical for brain abscess, with only one each in the latter two categories. Patients had received complete neurological workups, including some or all of the following diagnostic procedures: EEG, angiogram, pneumoencephalogram, and CAT scan. The etiologies were diagnosed from combinations of those procedures.

In order to be included in the study each subject was required to meet the following criteria:

Neurological Stability: It has been established that the performance of an aphasic patient vacillates and undergoes progressive changes in the early post-traumatic period following the neurological insult. Much of the spontaneous recovery in aphasia will occur in the first three months post-trauma (Schuell, 1965). Consequently, only patients with an aphasic disorder of at least three months were utilized. The same constraint applied to RBD patients. The elapsed time since onset ranged from three months to nineteen years, with the mean being 4 years, 3 months.

Auditory and Visual Capacities: A series of screening tests were administered to all brain damaged subjects to insure at least minimal competency for auditory sensitivity, auditory discrimination of single words and simple sentences, as well as visual perception. All brain damaged subjects were required to demonstrate competency on these tests,

each of which will be described in a later section.

Acquired Rather Than Congenital Deficits: All the brain damaged subjects had suffered a neurological insult during their adult life. One patient had become aphasic at 17 years of age, and was considered an adult since she had normal language experience prior to the acquired deficit. Prior to the insult the subjects demonstrated normal speech and were free of any language disorder, as assessed by history presented by the family and patient.

Language Background: In an effort to control as many extraneous factors as possible influencing the measurement of sentence memory, an attempt was made to control for the influence of linguistic background. Consequently, only subjects whose native language was English were included in the sample.

Additionally, the LBD patients were tested with the Boston Diagnostic Test of Aphasia (1972), to determine if they were aphasic; and if so, classified as fluent or non-fluent. This determination was made in accordance with the view proposed by Goodglass and co-workers,

... the most significant difference between the major groups of (aphasic) patients resides in the character of their speech production and not, as commonly assumed, in the opposition between the functions of language intake and language output (1964, p. 133).

Aphasic type was evaluated from recorded speech samples and patient interviews. Speech pathologists from each institution, experienced in clinical work with aphasics, judged the language production of each aphasic.

Normal Control Subjects: Ten normal subjects were selected from the same hospitals as the brain damaged patients. Each of them was

hospitalized for non-neurological reasons (e.g. cardiac insufficiency, paraplegia) and subjected to the same screening tests as the brain damaged patients, except that no necessity was discerned for an audiological examination, considering their uniformly high performance on the word and sentence discrimination tests. They were chosen to be comparable to all brain damaged groups in respect of age, time since onset of illness, and educational level. Table 1 presents means and standard deviations for all three variables for all groups. Non-significant analyses of variance confirmed the compatibility of the groups.

#### Screening Tests

The nature of the auditory comprehension and auditory short-term memory tests administered in the present study necessitated that particular sensory and perceptual abilities be relatively intact. Significant auditory sensitivity difficulties would interfere with adequate performance on an experimental task utilizing spoken language. Further, since the task involved picture identification, visual perceptual abilities also had to be intact. Finally, it was essential that subjects be able to understand simple words and sentences if their data were to be meaningful. Accordingly, all BD subjects were pretested audiometrically, and together with normals, were tested on three additional tasks.

Audiometric Test: At both hospitals certified audiologists tested each ear separately at 500, 1,000 and 2,000 HZ and assessed each patient according to norms provided by the National Health Survey (1965). All subjects were affirmed to have normal hearing appropriate to their age levels.

Table 1

Means and Standard Deviations for Demographic  
Variables for Each Group of Subjects

Variables		Groups				Non-Fluents <sup>c</sup>
		Normals	RBD <sup>a</sup>	LBD-NA <sup>b</sup>	Fluents <sup>c</sup>	
Age	$\bar{x}$	48.80	52.30	63.00	60.29	53.00
	s.d.	18.02	14.14	11.51	10.36	19.09
Onset (months)	$\bar{x}$	76.80	26.60	50.00	51.43	84.38
	s.d.	75.51	54.72	47.89	71.48	75.34
Education (years)	$\bar{x}$	11.70	10.50	10.80	11.07	9.63
	s.d.	3.56	3.89	2.28	3.39	4.31

a RBD = Right Brain-Damaged

b LBD-NA = Left Brain-Damaged Non-Aphasic

c Fluents, Non-Fluents = Aphasic types

Visual Perception Test: Visual-perceptual skills were analyzed using the Raven's Coloured Progressive Matrices (1956). This test was used to get an estimate of each patient's ability to use and conceptualize non-verbal stimuli, as well as to acquaint each subject with a pointing response task. Additionally, this task has been used with brain damaged patients (Costa et al , 1969; Costa, 1976; Gainotti et al, 1977) demonstrating qualitatively similar performance for left brain-damaged and right brain-damaged subjects.

Given six choices, the subject was required to select the one that best completed the geometric pattern. Each subject was given the standard instructions; if the patient demonstrated confusion the investigator simplified them and explained the first item on Set A.

Vocabulary Test: The Peabody Picture Vocabulary Test (Dunn, 1959) was used to evaluate each patient for competency with single words on a pointing response task. The subject was required to point to one of four pictures which best showed the meaning of a particular word. Because aphasics frequently have difficulty understanding directions, the test started with item #1 rather than estimating a basal point. For non-aphasics the test began at the basal level as required by test procedures. If the subject showed any signs of confusion, the investigator simplified the instructions and explained the sample items.

Simple Sentence Comprehension Test: Test sentences were taken from Shewan and Canter's (1971) investigation of auditory comprehension in aphasics. Each subject was required to respond correctly to three out of five sentences administered. The patient was required to point to one of four pictures which corresponded to a simple sentence read by the examiner. These five sentences were short in length and used high

frequency vocabularies. These sentences corresponded to the simplest sentences ( $L_1V_1$ ) in the experimental test to be described below.

Performance Criteria: Scores on the three preceding tasks were retained for eventual comparison with performance on the experimental task. In addition, for the brain-damaged patients, scores that were markedly below normal were used as a basis for subject rejection. Consequently, 2 RBD and 20 LBD patients were rejected before the present sample was achieved. The failures, not surprisingly, were hemisphere specific, RBD's on the Raven's test, LBD's on the Peabody or Sentence Comprehension test. Appendix 3 presents the three scores for each patient.

#### Experimental Test

The experimental task was created by grafting the Peterson and Peterson memory paradigm (1959) onto the Shewan and Canter auditory comprehension experiment (1971). Concretely, each subject responded to 96 sentences divided equally into two parts, wherein the first 12 stimuli were simple comprehension tasks, while the remaining 36 were sentence memory tasks, randomly requiring either 6, 12 or 18 seconds of distracting activity before responding.

The use of counting as a distractor task has been suggested by Peterson and Peterson (1959) as a means of controlling the rehearsal of the stimulus. However, after repeated, unsuccessful attempts with a verbal-response distractor, it was decided to try a non-verbal pointing response task. The task chosen was a modification of the Peabody Picture Vocabulary Test and led to the most consistent pilot data. Further, Pelligrino et al (1976) stated that the effects of the distractor task operates within modalities, suggesting that the maximum effect would be

obtained by using an interference task that requires similar processing to that employed on the experimental test. Thus, this task was chosen as the distractor for the experimental test.

For the comprehension task as well as each of the three states of memory delay, the 12 stimuli represented three versions each of a four-fold variation in sentence length and vocabulary complexity within a constant syntactic framework of active declarative sentences. The length and vocabulary parameters followed Shewan and Canter's (1971) constructional criteria as follows:

Length Parameter: Sentence length was controlled in two ways: (a) number of critical items and (b) total number of syllables. Critical items were defined as content words necessary for comprehension of the sentence - nouns, adjectives, verbs, adverbs and pronouns. (Articles, demonstrative adjectives, possessive pronouns, prepositions, conjunctions and interjections were not classified as critical items because they did not provide essential information toward the identification of the correct response.) In the following sentence the critical items are underlined: "The boy runs across the street." and "The farmer is picking the fruit." Sentences were constructed using three and five critical items. This procedure was first utilized by Miller (1962) and subsequently by Shewan and Canter (1971).

The total number of syllables for each sentence was constant. Sentences constructed with three critical items had seven syllables, those with five critical items had 11. The factor of sentence length was designated as  $L_1$  and  $L_2$  respectively.

Semantic Difficulty Parameter: Schuell (1965) has stated that aphasic's errors tend to increase as word frequency decreases. Spreen

(1968) demonstrated that both normals and aphasics demonstrate greater difficulty in comprehension and naming of low frequency words. Sentences were constructed with two levels of word usage frequency:

Vocabulary level 1 ( $V_1$ ): the words were chosen from the 1,000 most frequent words in the general count of Thorndike and Lorge (1944).

Vocabulary level 2 ( $V_2$ ): words with usage frequencies of between 25 and 40 occurrences per million on the Thorndike-Lorge's general count and those words on the Peabody Picture Vocabulary Test (Dunn, 1959) with an age equivalent between 6.5 and 8.5 years on the test.

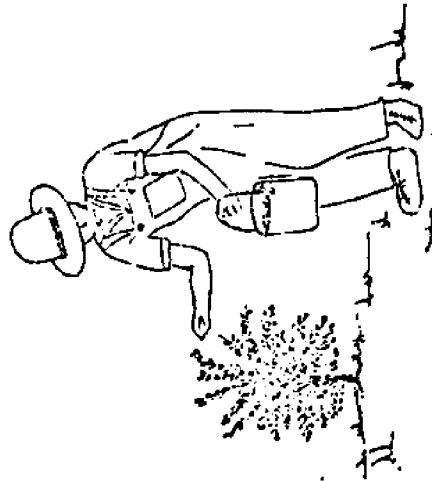
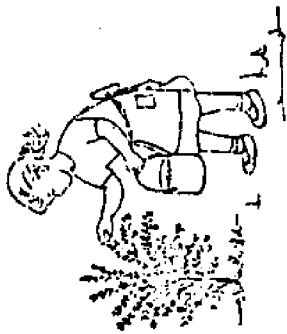
The vocabulary items were selected from the Thorndike and Lorge general list because this investigator judged it to be the best source of word counts available. Also, it should be noted that the need of choosing picturable and drawable words limited the range of the words, e.g., all noun phrases referred to concrete objects. However, not all nouns were listed in the Paivio, Yuille and Madigan norms (1968). Another limitation was the avoidance of vocabulary words whose depiction would require fine visual discrimination.

The length and vocabulary parameters were fully crossed, yielding four sentence types:  $L_1V_1$ ,  $L_1V_2$ ,  $L_2V_1$ , and  $L_2V_2$ . The test sentences are presented in Appendix 4, together with the screening sentences described previously. It will be noted that Shewan and Canter sentences were only employed in the comprehension test and even there provided no  $L_2V_2$  exemplars.

Picture Materials for the Test: Four line-drawing pictures were drawn on 8 1/2 x 11" white bond paper. A plate of four pictures was made for each of the 78 sentences developed by the investigator. The remaining 18 plates were taken from Shewan and Canter. One of the four choices

**Figure 1**

**Picture plate for the sentence: The farmer is picking the fruit.**



depicted the correct representation of the sentence stimulus introduced by the investigator; the other three were diversion items. To avoid a position-response bias the correct choice appeared in each quadrant approximately an equal number of times. Quadrant #2 was correct 25 times, #1 23 times and #3 and #4 24 times each.

For sentences containing three critical items, each of the three diversionary pictures were drawn to represent a contrast with a critical item. In the sentence, The farmer is picking the fruit, one diversion item contrasts girl with farmer, another contrasts eating with picking and the third corn with fruit. Figure 1 illustrates these contrasts.

In the sentences with five critical items an effort was made to represent all possible confusions among classes of critical items - nouns, verbs and adjectives. Some diversionary pictures were contrasted from the correct picture on more than one critical item. This occurred where it was not possible to draw a picture contrasting only one item or because a picture with such minimal contrast was too similar to the correct item in visual representation.

Administration of the Tests: The Peabody Picture Vocabulary Test was given to provide the subjects with an orientation to a pointing-response task. Since the Peabody and the examiner's Experimental test required pointing to the correct one of four alternative pictures following auditory stimulus, it was felt that practice with the Peabody would be beneficial to any subject who might have difficulty understanding instructions. Subjects were aided on all items until they demonstrated an understanding of the task by an unaided correct response. An item was repeated upon demand by the patient - whether oral or gestural. Items which were aided by the examiner were not included in the subject's

final score.

Following the administration of the Peabody, the simple sentence comprehension screening test was given. Five simple sentences of the L<sub>1</sub>V<sub>1</sub> form were presented to each subject. The instructions were slightly modified from those used by Shewan and Canter (1971) the variations being underlined in the following statement:

I am going to say some sentences. I will say each sentence once, then I want you to point to the picture which best tells the meaning of the sentence. Some of the sentences are more difficult than others. I don't expect you to get them all right but I want you to try your best. Look at all the pictures. Point to the picture which best tells the meaning of ...

All subjects who reached the criterion of three out of five sentences correct on the screening test were given the auditory comprehension test. Upon completion of this portion the sample sentences for the auditory short-term memory subsection were administered. These sentences were used to train the subjects for the memory section. The directions for the memory task are as follows:

I am going to ask you to do two tasks. First, I am going to say a sentence, then I am going to ask you to point to some unrelated pictures. After that, I will show you some pictures, one of which will tell the meaning of the sentence. I want you to point to the picture which best tells the meaning of the sentence. Some of the sentences are more difficult than others, I don't expect you to get them all right, but I want you to try your best. Look at all the pictures. Here is the first sentence.

In general, the investigator used a conversational manner in the administration of the exam. Tape recorded sentences were not used. Bolter and Green (1972) have found that aphasics' performance on an auditory comprehension task decremented when presentation of the stimuli was tape recorded. In addition, it was the investigator's judgement that

personal contact in a conversational manner would establish and maintain better rapport with the subject. Each sentence was read aloud using normal intonation patterns. No attempts were made to segment the sentences into short phrases or to emphasize critical items, since either behavior might have provided additional cues for the subject. However, the rate of presentation was somewhat slower than normal, approximately two to three syllables per second.

Each sentence was presented once, without repetition. In cases where a subject was unable to recall the stimulus sentence sufficiently to respond, he was instructed to guess. Therefore, each subject would have 96 responses, thus keeping the total number of responses constant for all subjects.

After the sentence was read by the tester, no further assistance was given to the subject. The subjects were not permitted to repeat the sentence after the examiner. This requirement was employed for two reasons: (1) the subject may repeat the sentence incorrectly and then base his response upon this error (Luria, 1966) or (2) the subject may repeat the sentence in an effort to rehearse it, so that the distractor is not attended to.

Part 1 of the Experimental tests was administered to half the subjects first, followed by Part 2 on a separate occasion. The other half of the subjects were tested in the reverse order. Some subjects fatigued rather quickly so that it was not possible to administer the entire section at one sitting. However, in each case that section which was to be administered first was completed before the second section was administered. In practice, normal subjects completed the tasks in two 90-minute sessions, while the brain-damaged patients typically required

five 45-minute sessions.

For each of the 96 stimuli the experimenter noted the quadrant chosen whether correct or not.

## RESULTS

The task employed in this research utilized six sentences to describe each cell (e.g. L<sub>1</sub>V<sub>1</sub> at zero delay). To our surprise, performance by the brain-damaged subjects was highly variable within any set of six stimuli. Comparisons of the picture choices for easy versus hard sentences suggested that the variability inhered in uncontrollable variations in picture salience, i.e. the prominence of the discriminandum required to make a correct choice.

To overcome this variability, each set of six responses was subjected to screening for internal consistency by means of the SPSS Reliability procedure (Hull and Nie, 1979). Normal subjects were excluded from these analyses since they had too few errors, and would have only diluted the findings. For the 16 scales (2 vocabulary states X 2 length states X 4 delay states), Cronbach alphas ranged from .35 to .50 with a mean of .42 and average inter-item correlations of .21. Fortunately the cited SPSS Program indicates the relative improvement obtainable if any item were deleted. Inspection of the 16 scales suggested that substantial improvements in consistency would accrue from deletions of the two least consistent items in each set. Accordingly, such items were deleted and the analyses were performed again. Now the alphas ranged from .50 to .65 with a mean of .57 and average inter-item correlations of .36. The initial and final items and alphas for each scale are shown in Appendix 5 and the final sentence and picture choices are presented in Appendix 6.

Each subject's performance was now converted into 16 sums, each ranging from 0 to 4 and examined at each delay state for any evidence

of having slipped into the range of chance. A subject was declared to have entered chance mode if two of his four response sets fell to one or zero correct responses out of four. By this criterion only 11 of the 37 brain-damaged subjects remained above chance through the whole experiment. Table 2 indicates the point of departure for subjects in each brain damaged group, wherein it is noteworthy that no fluents survived the whole experiment. Clearly, the Peterson and Peterson task devastated the performance of most brain damaged subjects.

One normal subject fell to chance at the six second delay and her data was not considered further. For the remaining nine subjects, the overall error rate was just under 8% randomly dispersed over the delays and the linguistic factors (vocabulary and length). These subjects will no longer be dealt with as their performance reached a ceiling level.

For each brain-damaged subject a total score was computed describing his or her performance up to that delay interval where performance dropped to chance. This information is shown in Appendix 7.

#### Group Comparisons

To assess the relevance of the linguistic factors unconfounded by the effects of delay, separate analyses of variance were performed on each of the four brain-damaged groups. Table 3 presents the means for each condition. In the case of the RBD subjects, only the length factor was significant,  $F(1,8) = 7.11, p < .05$ , while for the LBD-NA subjects neither factor was significant. For the non-fluents, length was highly significant,  $F(1,6) = 15.00, p < .01$ , while for the fluents both vocabulary and the interaction were significant:  $F(1,12) = 4.98$

Table 2

Brain-Damaged Subjects Available  
For Analysis At Each Value of Delay

Diagnosis	Original Sample	None	6 Sec.	Delay 12 Sec.	18 Sec.
RBD	10	9	9	8	6
LBD-NA	5	5	3	3	3
Fluents	14	13	6	1	0
Non-Fluents	8	7	2	2	2

Table 3

Mean Performance of Each Group For All  
Sentence Types At the Zero Delay Condition

	N	L <sub>1</sub> V <sub>1</sub>	L <sub>1</sub> V <sub>2</sub>	L <sub>2</sub> V <sub>1</sub>	L <sub>2</sub> V <sub>2</sub>	Total
RBD	9	3.78	3.33	3.11	2.67	3.22
LBD-NA	5	3.80	3.20	3.20	3.20	3.35
Fluent	13	3.46	2.46	3.00	2.85	2.94
Non-Fluent	7	3.29	2.57	2.14	1.57	2.39

and 6.31, respectively, both  $p < .05$ . In post hoc Scheffe comparisons it became clear that the main effect was spurious, since the only significant discrimination was between  $L_1V_1$  and  $L_1V_2$ . On the basis of these findings an additional score was computed for each aphasic group for purposes of further analyses. In the case of the non-fluents, it was an L% score expressed as  $100 \times (L_1 - L_2) / (L_1 + L_2)$ . For the fluents it was a V% score expressed as  $100 \times (L_1V_1 - L_1V_2) / (L_1V_1 + L_1V_2)$ . These scores are posted for each aphasic in Appendix 7.

In a further analysis, the brain-damaged groups were contrasted for total score with one another and with the normals. Summary statistics are shown in Table 4. Considering the wide range and small sample sizes, the contrasts were performed by means of Mann-Whitney U Tests. In these analyses it was found that the two non-aphasic groups were not discriminable, nor were the two aphasic groups, which were, accordingly combined.

In final contrasts, the normals were highly discriminable from the non-aphasic brain-damaged (U = 10,  $Z = 3.14$ ,  $p < .001$ ) who were in turn highly discriminable from the aphasics (U = 35,  $Z = 3.67$ ,  $p < .001$ ).

#### Aphasic Comparisons With Screening Tests

As previously indicated, for all aphasic subjects two scores were created, one of them (Total) describing overall performance, the other, diagnosis specific, describing susceptibility to vocabulary demand in the case of fluents (V%) and length demand in the case of non-fluents (L%). Table 5 indicates the relationship of these variables to the Screening Tests, wherein substantial group departures emerge. For the fluents there is a significant relation between total and V%, indicating that the more a fluent was influenced by the vocabulary variable the

Table 4

## Total Scores for All Groups

Group <sup>a</sup>	N	Median	Range	Mean	S.D. <sup>b</sup>
Normal	9	60	55-64	59.0	5.1
RBD	9	46	23-57	42.6	11.1
LBD-NA	5	42	11-61	36.0	22.9
Fluent	13	12	8-33	17.5	8.5
Non-Fluent	7	11	6-47	19.1	17.6

a RBD = Right Brain-Damage

LBD-NA = Left Brain-Damage Non-Aphasic

b S.D. = Standard Deviation

Table 5

Spearman Correlations of Aphasic Task  
Performance With Screening Tests

Screening Test <sup>a</sup>	Fluent (N=13)		Non-Fluent (N=7)	
	Total Score	V%	Total Score	L%
P.P.V.T.	.828 <sup>***</sup>	-.832 <sup>***</sup>	.714 <sup>*</sup>	-.750 <sup>*</sup>
Ravens	.431	-.520 <sup>*</sup>	.679 <sup>*</sup>	-.321
B.D.T.A.				
Discrim.	.345	-.308	.750 <sup>*</sup>	-.179
Comp. Idea.	.447	-.473	.649	-.306
Word Repeat.	-.085	-.306	.805 <sup>*</sup>	-.056
Phrase Repeat.	-.061	-.128	.847 <sup>*</sup>	.000
Resp. Naming	-.007	-.157	.775 <sup>*</sup>	-.487
Vis. Naming	-.175	-.402	.750 <sup>*</sup>	-.036
Total	-	-.741 <sup>**</sup>	-	-.214

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

- <sup>a</sup> P.P.V.T. = Peabody Picture Vocabulary Test  
 B.D.T.A. = Boston Diagnostic Test of Aphasia  
 Discrim. = Discrimination  
 Comp. Idea. = Complex Ideational Material  
 Word Repeat. = Word Repeating  
 Phrase Repeat. = Phrase Repeating  
 Resp. Naming = Responsive Naming  
 Vis. Naming = Visual Naming

sooner his performance fell to chance under the delay conditions. Not surprisingly, both variables correlate with the Peabody test on which the task is modeled, but paradoxically, not with any of the aphasia classification variables. Conversely, for the non-fluents there is no relationship between susceptibility to the length variable and tolerance for delay, and indeed L% relates only to PPVT, while Total relates to almost all of the aphasia classification tests.

## DISCUSSION

We will now address our findings to the hypotheses posed in the introductory portion of this work. We will then proceed to a review of the correlations and, finally, an exploration of the possible avenues for future research.

### Review of the Hypotheses

The hypotheses presented an expected ordering of the groups in response to the experimental manipulations. The first hypothesis suggested that normal subjects would not be affected by the manipulations of this task. The second hypothesis suggested that both non-aphasic brain-damaged groups (RBD and LBD-NA) would perform similarly though not as well as the normals. The third hypothesis indicated that the aphasic's performances would be the poorest of all groups. Finally, a disparity in the responsiveness of the fluent and non-fluent subjects to the linguistic manipulations was postulated. That is, the the fluents were believed to be most sensitive to the influence of the vocabulary parameter, with the non-fluents most responsive to the influence of the length parameter.

An examination of the relevant data pertaining to the first hypothesis suggested that one of our "normals" was actually experiencing significant difficulty with this experimental task. An examination of her history revealed that she had been maintained on steroids for over 25 years to control her rheumatoid arthritis. It is not clear what the prolonged effects of such medication are on an individual's cognitive processes; but, in the absence of any known neurological abnormality it might be suggested that this individual's

poor performance was secondary to her prolonged medication. She performed as if she had acquired brain damage, and, as such, she was eliminated from our pool of "normals". The remaining nine subjects were noted to perform as had been expected -- reaching a ceiling level.

Hypothesis 2 suggested that the RBD and LBD-NA groups would perform similarly though not as well as the normals. The performance of the LBD-NA groups appears to confirm the hypothesis in that there was no significant influence at zero. In contrast, the effect of the delay condition was such that its introduction at 6 sec. either caused a subject's performance to drop to chance level or the subject's performance remained viable throughout the delay condition. This last finding might suggest that this is a heterogeneous group. The RBD group did not perform as expected. A significant effect of the length variable was noted at the zero delay condition. Here, again, is found a disparity in the subject's response to the delay factor, leading to the suggestion of a heterogeneous population. Thus, the non-aphasic brain-damaged group approximates confirmation of the hypothesis, with a deviation due to the small length effect in the RBD group.

The third hypothesis suggested aphasics would perform the most poorly of all groups. As expected, this hypothesis was confirmed. And, finally, the last hypothesis postulated a dissociation between the performances of the two aphasic groups -- fluents would be more sensitive to the manipulations of the vocabulary variable, while non-fluents would be more responsive to the manipulations of the length variable. This hypothesis was confirmed by the data analysis provided

at the zero delay condition. The second half of the hypothesis suggesting that subjects in these groups would be similar in their response to delay was, on the surface, confirmed. However, examination of the data suggests that if a non-fluent subject survived the impact of the time-filled delay condition at 6 sec., he would stay in the sample through to the 18 sec. delay. In contrast, of those fluents who survived the introduction of the delay condition at 6 sec. not one remained above chance performance at the 18 sec. delay condition. The qualitative aspects of these results indicate that these groups perform differently. Thus, these data support the notion that aphasia is a multifactored disorder, and the descriptors employed encompassed multiple syndromes.

Data analyses revealed that neither the two non-aphasic groups nor the two aphasic groups were discriminable one from the other. These results indicated that the normals were highly discriminable from the non-aphasic brain-damaged groups, who were in turn highly discriminable from the aphasics. These suggest a staircasing of the effects of the experimental task.

The finding that the length parameter differentially affected the experimental groups is in contrast to those findings of Shewan and Canter (1971). In particular, in their research the length variable was found to be significant for all aphasic groups (amnesics, Broca's and Wernicke's), as well as, for normals. In the present research, the length parameter was found to affect the performance of the RBD (though only a weak effect) and non-fluent groups, but not the LBD-NA fluent and normal groups. Contrary to Shewan and Canter's findings, our data suggest this task was too easy for the normals. There are

some possible explanations for this discrepancy, one of which was our use of a reliability analysis ensuring that we measured like factors with each group of sentence-picture pairs. In this way, random responses and/or unfounded responses could potentially be eliminated.

Additionally, our findings demonstrate a differential effect of the vocabulary parameter upon our aphasic groups - vocabulary affecting fluents but not non-fluents. This again was in contrast to Shewan and Canter's findings. Their research demonstrated a significant vocabulary effect on all aphasic groups. Perhaps, here again the use of a reliability analysis allowed us to discriminate the main effects for each group more clearly.

The most important aspect of our results was the dramatic influence of the delay intervals upon a language impaired patient's performance. The fluent and non-fluent groups were found to be overwhelmed by the increase in processing load required by the introduction of a filled-delay condition. This finding confirms those data obtained by Caramazza, Zurif & Gardner (1978) from which they concluded that aphasics (both anterior and posterior) possess a limited capacity storage system for verbal material.

However, our data allowed us to pursue the analysis one step further, that is, a comparison of overall performance for each aphasic with their respective influential factor at the zero delay. Results demonstrated significant disparities between each group's overall performance and their most influential factor; such that, the greater the influence of vocabulary upon a fluent's responses the sooner his performance fell to chance under the delay conditions, but, for the non-fluents there was no relationship between susceptibility to the length

variable and tolerance for delay. Thus, the more a fluent subject was affected by the factor in his group the greater was the affect of delay upon his performance. Thus, it appears that all aphasics experience a general memory disturbance, with the fluents difficulty correlated with linguistic factors but not the non-fluents.

### Correlations

Examination of the correlations between overall performance and screening tests further support a differentiation of these aphasic subgroups by this task. In this task, not surprisingly, total score correlated positively with the PPVT; but, paradoxically, for the non-fluents total score was related to the subtests of the BDTA, while for fluents it was not. For the fluents it appears that whatever factor was defining the differences in performance on the BDTA, this factor did not pick up the residual language integrity needed to perform this experimental task. The one subtest of the BDTA which approximated this was the Complex Ideational Material subtest and the Ravens (non-verbal test of general intelligence) came in next. In terms of the fluents this experimental task appeared to have properties predicted by tasks with similar response demands but not by the BDTA, in general. These findings suggested that the fluent groups were internally coherent to the extent that the linguistic factor of this task relates to a general memory disturbance.

In contrast, the total score for the non-fluents was significantly related to the task demands of the BDTA. These subtests of the BDTA were predicting the performance of this group on the experimental task. In terms of the non-fluents this task has properties predicted by any test of cognitive functioning. This finding may, in part, be due to the

heterogeneity of the group.

Some general conclusions may be drawn from these data. They are as follows: aphasics had a general memory deficit more severe than the deficits of the non-aphasic brain-damaged. The fluents were found to be most sensitive to the vocabulary manipulation of this experimental task, while the non-fluents were found to be most sensitive to the length factor. Further, these data dispute the proposition implying no qualitative differences between aphasic subgroups championed by Schuell, et al. (1961, 1964, 1965) and supported by Shewan and Canter (1971). They do, however, support the work of Zurif, et al. (1972, 1976a, 1976b) and Caramazza, et al. (1976, 1978, 1980) which implicates a differentiation of language disruption dependent upon site of lesion which is highly correlated with speech production.

Finally, it should be noted that the standard device for procuring non-verbal responses in aphasics - the four-fold picture selection task - is fraught with difficulties based upon uncontrolled differential discriminability among the four choices. All future studies employing these materials would be well advised to prescreen them for equivalent difficulties, a step taken belatedly in this study.

## Appendix 1

## Bases for Classification of Aphasic Subjects

Clinical Groups of Aphasia and Their  
Corresponding Symptoms As Evaluated  
By Ten Speech Characteristics

<u>Speech Characteristic*</u>	<u>Clinical Group</u>	
	<u>Fluent</u>	<u>Non-Fluent</u>
1. Rate of Speech	normal or rapid	slow
2. Prosody	normal	disturbed
3. Articulatory agility	normal	disturbed
4. Phrase Length	normal	short
5. Effort	little or absent	present
6. Press	present	absent
7. Paraphasia	present	absent
8. Connected jargon	present	absent
9. Word choice	predominantly interstitial	predominantly substantive
10. Word finding difficulty	present	present

\* A description of each term is presented in the following pages.

### Descriptions of Speech Characteristics

1. Rate - The rate of speech is determined by the number of words uttered per minute, with three descriptive subcategories: (1) "Slow" - fifty words per minute or less, (2) "Normal" - fifty to 150 words per minute, and (3) "Rapid" - more than 150 words per minute. Non-fluent aphasics generally have "slow" speech rate, while fluents would be termed "normal" to "rapid" (Benson, 1970).
2. Prosody - May be defined as the texture, or quality of the speech with regards to its' rhythm, intonation and stress patterns. Non-fluents often demonstrate very uneven, halting speech, with stress placed on the wrong syllables or the speech is a flat monotone devoid of inflection. Fluent aphasics do not generally demonstrate these traits. (Benson, 1970; Goodglass and Geshwind, 1976; and Goodglass, Quadfasel and Timberlake, 1964).
3. Articulatory Agility - Refers to the degree of difficulty, or ease with which an aphasic initiates speech. The articulatory agility of non-fluents is generally disturbed, with speech initiation appearing to be hesitant or distorted. Fluents do not generally manifest the same degree of difficulty, but may show some disturbance in spontaneous speech or on a picture naming task. (Benson, 1970).
4. Phrase Length - Describes the number of words an aphasic subject can group together to form phrases. Non-fluents generally speak in short phrases of one or two words. Fluents can group five or more words into phrases, a more normal approximation of regular speech patterns. (Goodglass, Quadfasel and Timberlake, 1964).
5. Effort - Refers to the energy required to produce speech. Non-

fluents showed marked difficulty, often demonstrating body contortions and facial grimaces as they struggle to produce speech. Fluents usually initiate speech easily but may have difficulty prolonging it. (Benson, 1970; Benson, 1967; and Goodglass and Geshwind, 1976).

6. Press - Defines a characteristic generally limited to fluent aphasics - that is - the patient appears disinclined to stop speaking, often continuing to speak when told to stop or adding unnecessary sentences, phrases or words to their discourse. (Benson, 1967).

7. Paraphasia - Refers to characteristics generally found in fluents but rarely seen in non-fluents. (Goodglass and Geshwind, 1976). The subject can demonstrate three types of paraphasia: (1) the literal substitution of a word from the same word class for another, (2) phonemic substitution across, or within word classes or (3) neologisms, the substitution of meaningless or unintelligible sounds for a word. It has been suggested that these sounds are the result of severe phonemic distortion of the target word. (Kertesz and Benson, 1970).

8. Connected Jargon - Another characteristic generally limited to fluent aphasics. It refers to the stringing together of words (or neologisms) into phrases, without any regard for compatibility or meaning. (Goodglass and Geshwind, 1976).

9. Word Choices - Refers to whether substantive or interstitial words predominate the speech output. Non-fluents' speech is characterized by an overabundance of information-carrying, substantive words, sometimes to the extent that the speech may become "telegraphed." On the other hand, fluents demonstrate speech that contains little information and a high proportion of interstitial words; e.g. relational words with very

few information-carrying words appearing in the speech. (Benson, 1967).

10. Word Finding Difficulty - Refers to the inability to retrieve specific words, either in recall, spontaneous speech or confrontation naming. The word is not irrevocably lost to the patient, but simply can not be retrieved at the time of the task. (Goodglass and Geshwind, 1976).

## Appendix 1

Subjects and Their Corresponding Symptoms  
As Evaluated by Ten Speech Characteristics,  
On the Basis of Which Ss 26-39 Were Declared  
To Be Fluent and the Remainder Non-fluent

<u>Ss #</u>	<u>Speech Characteristics</u>									
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
26	N	N	N	N	A	P	P	P	PI	P
27	N	N	N	N	A	P	P	P	PI	P
28	N	N	N	N	A	P	P	P	PI	P
29	N	N	N	N	A	P	P	P	PI	P
30	N	N	N	N	A	P	P	P	PI	P
31	N	N	N	N	A	P	P	P	PI	P
32	N	N	N	N	A	P	P	P	PI	P
33	N	N	N	N	L	P	P	P	PI	P
34	N	N	N	N	L	P	P	P	PI	P
35	N	N	N	N	A	P	P	P	PI	P
36	N	N	N	N	A	P	P	P	PI	P
37	N	N	N	N	A	P	P	P	PI N	P
38	N	N	N	N	A	P	P	P	PI	P
39	N	N	N	N	A	P	P	P	PI N	P
40	SL	D	D	SH	P	A	A	A	PS	P
41	SL	D	D	SH	P	A	A	A	PS	P
42	SL	D	D	SH	P	A	P	A	PS	P

## Appendix 1 (continued)

Subjects and Their Corresponding Symptoms  
As Evaluated by Ten Speech Characteristics,  
On the Basis of Which Ss 26-39 Were Declared  
To Be Fluent and the Remainder Non-fluent

<u>Ss#</u>	<u>Speech Characteristics</u>									
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
43	SL	D	D	SH	P	A	P	A	PS	P
44	SL	D	D	SH	P	A	A	A	PS	P
45	SL	D	D	SH	P	A	P	A	PS	P
46	SL	D	D	SH	P	A	P	A	PS	P
47	SL	D	D	SH	P	A	P	A	PS	P

N = Normal   D = Disturbed   A = Absent   P = Present   SH = Short  
SL = Slow   PI = Predominantly Interstitial   PS = Predominantly  
Substantive   L = Little

## Appendix 2

## Backgrounds of Subjects For This Study

Ss' #	Sex	Age	Years Educ.	Time Since Onset (Months)	Etiology <sup>a</sup>	Paralysis <sup>b</sup>
<u>Left Brain-Damaged Fluent Aphasics</u>						
26	F	57	12	4	CVA	W
27	M	53	12	71	CVA	H
28	M	56	8	108	CVA	H
29	F	61	12	10	CVA	H
30	M	75	16	15	CVA	H
31	M	56	10	26	CVA	W
32	M	53	10	27	CVA	W
33	M	35	10	16	CVA	H
34	F	67	16	108	CVA	H
35	M	70	2	228	CVA	H
36	M	57	12	3	CVA	H
37	F	62	11	11	CVA	H
38	F	72	12	10	CVA	W
39	M	70	12	11	CVA	H

<sup>a</sup> CVA = Cerebral Vascular Accident.

<sup>b</sup> W = Weakness, H = Hemiplegia

## Appendix 2 (continued)

<u>Ss' #</u>	<u>Sex</u>	<u>Age</u>	<u>Years Educ.</u>	<u>Time Since Onset (Months)</u>	<u>Etiology<sup>a</sup></u>	<u>Paralysis<sup>b</sup></u>
<u>Left Brain-Damaged Non-Fluent Aphasics</u>						
40	F	70	11	120	CVA	H
41	M	71	1	216	CVA	H
42	F	58	10	4	CVA	H
43	F	70	10	132	CVA	H
44	M	56	10	23	CVA	H
45	M	45	16	57	CVA	H
46	F	17	7	3	SA	W
47	M	37	12	120	ST	H
<u>Left Brain-Damaged Non-Aphasic</u>						
21	F	54	12	11	CVA	H
22	M	60	14	23	CVA	W
23	F	83	8	12	CVA	H
24	M	57	10	96	CVA	H
25	F	61	10	108	CVA	W

a CVA = Cerebral Vascular Accident  
 SA = Surgical for abscess  
 ST = Surgical for tumor

b W = Weakness, H = Hemiplegia

## Appendix 2 (continued)

Ss #	Sex	Age	Years Educ.	Time Since Onset (Months)	Etiology <sup>a</sup>	Paralysis <sup>b</sup>
<u>Right Brain-Damaged</u>						
11	M	60	10	24	CVA	H
12	M	30	16	5	CVA	H
13	M	65	11	3	CVA	H
14	F	33	12	11	CVA	H
15	F	44	12	29	CVA	H
16	M	69	8	3	CVA	H
17	M	46	11	3	CVA	H
18	M	58	12	3	CVA	H
19	F	49	12	5	CVA	W
20	M	69	1	180	CVA	H
<u>Normals</u>						
1	F	69	8	60	RA	W
2	M	55	16	48	GSW	P
3	F	52	12	156	GSW	P

- a CVA = Cerebral Vascular Accident  
 RA = Rheumatoid Arthritis  
 MI = Myocardial Infarction  
 GSW = Gun Shot Wound  
 FV = Fractured Vertebrae  
 RAT = Ruptured Achilles Tendon  
 H+CA = Hypertension and Cardiac Arrhythmia

- b W = Weakness, H = Hemiplegia P = Paraplegia

## Appendix 2 (continued)

Ss' #	Sex	Age	Years Educ.	Time Since Onset (Months)	Etiology	Paralysis
<u>Normals</u>						
4	M	74	13	168	RA	W
5	M	48	5	24	FV	P
6	M	36	10	192	GSW	P
7	M	59	12	120	MI	none
8	F	16	10	3	RAT	none
9	F	27	15	3	FV	P
10	F	52	16	3	H+CA	none

## Appendix 3

## Results of Screening Tests For All Subjects

		<u>Boston Diagnostic Test of Aphasia</u>								
<u>Ss</u>	<u>#</u>	<u>SSC<sup>a</sup></u>	<u>RCPM<sup>b</sup></u>	<u>PPVT<sup>c</sup></u>	<u>WD<sup>d</sup></u>	<u>CIM<sup>e</sup></u>	<u>RW<sup>f</sup></u>	<u>RP<sup>g</sup></u>	<u>RN<sup>h</sup></u>	<u>VCN<sup>i</sup></u>
<u>Left Brain-Damaged Fluent Aphasics</u>										
26	5	32	136	72.0	4	7	0	12	2	
27	3	23	90	65.5	9	10	15	26	90	
28	5	13	97	69.0	8	5	4	13	83	
29	3	11	87	67.0	4	9	8	16	83	
30	5	28	74	52.0	3	10	16	24	75	
31	4	27	97	49.0	8	10	10	30	90	
32	4	18	102	55.0	6	9	13	16	64	
33	5	18	65	57.0	12	8	11	27	78	
34	5	16	93	55.0	5	7	4	24	47	
35	3	15	77	56.5	2	8	1	2	19	
36	3	8	55	36.5	3	7	3	5	23	
37	3	7	70	60.5	4	9	14	29	63	
38	3	21	81	25.0	0	0	0	3	2	
39	4	11	85	36.0	4	8	5	19		

- a - Simple Sentence Comprehension Test  
 b - Raven Coloured Progressive Matrices  
 c - Peabody Picture Vocabulary Test  
 d - Word Discrimination  
 e - Complex Ideational Material  
 f - Repetition of Words  
 g - Repeating Phrases  
 h - Responsive Naming  
 i - Visual Confrontation Naming

## Appendix 3 (continued)

<u>Boston Diagnostic Test of Aphasia</u>									
<u>Ss' #</u>	<u>SSC</u>	<u>RCPM</u>	<u>PPVT</u>	<u>WD</u>	<u>CIM</u>	<u>RW</u>	<u>RP</u>	<u>RN</u>	<u>VCN</u>
<u>Left Brain-Damaged Non-Fluent Aphasics</u>									
40	5	23	70	55.0	8	10	15	22	46
41	5	11	72	54.0	7	7	5	27	69
42	3	6	55	43.0	2	8	9	6	24
43	3	18	58	33.5	8	5	3	0	18
44	3	10	67	36.0	5	5	0	15	15
45	3	29	100	70.5	9	10	13	22	82
46	4	12	59	71.0	6	10	9	21	89
47	3	19	66	46.5	4	3	0	8	40
<u>Left Brain-Damaged Non-Aphasic</u>									
21	5	28	130	69.5	10	9	15	30	102
22	5	23	106	68.0	11	10	13	30	89
23	4	7	56	65.0	7	10	13	30	86
24	4	19	82	64.0	11	9	14	30	93
25	3	7	59	50.5	6	8	10	27	80

## Appendix 3 (continued)

## Results of Screening Tests For All Subjects

Ss #	Simple Sentence Comprehension	Raven Coloured Progressive Matrices	Peabody Picture Vocabulary Test
<u>Right Brain-Damaged</u>			
11	5	18	113
12	5	21	124
13	5	17	109
14	5	16	85
15	5	5	98
16	5	11	115
17	5	25	98
18	4	18	97
19	5	17	90
20	5	9	89
<u>Normals</u>			
1	3	5	92
2	5	28	145
3	5	18	131
4	5	27	91
5	5	23	99
6	5	32	106
7	5	29	142

## Appendix 3 (continued)

<u>Ss #</u>	<u>Simple Sentence Comprehension</u>	<u>Raven Coloured Progressive Matrices</u>	<u>Peabody Picture Vocabulary Test</u>
		<u>Normals</u>	
8	5	27	80
9	5	34	146
10	5	31	140

Appendix 4  
Test Stimuli (Part A)

Sentence #	Delay	Length (L)	Vocab. (V)	
<u>Sample Sentences</u>				
1	0	1	1	The boy runs across the street.
2	0	1	1	The girl is writing a note.
3	0	1	1	The clothes are drying outside.
4	0	1	1	This box contains some presents.
5	0	1	1	The girl is making her bed.
<u>Auditory Comprehension</u>				
1	0	1	1	The dog is fighting a cat.
2	0	2	1	The school children listen to the sea captain.
3	0	2	2	Sorrowful Ben mourned at the modest funeral.
4	0	1	2	Sparks blasted from the furnace.
5	0	2	1	The heavy cook is measuring the fresh milk.
6	0	1	2	Locomotives transport fuel.
7	0	1	1	Father is painting the fence.
8	0	2	2	The scared pony resists adding the saddle.
9	0	1	2	The tailor mended the sleeve.
10	0	2	2	The freight transport couples with a sole caboose.
11	0	2	1	The farmers bring their fresh produce to market.

## Appendix 4 (continued)

Sentence #	Delay	Length (L)	Vocab. (V)	
<u>Auditory Comprehension</u>				
12	0	1	1	The people arrived by train.
<u>Sample Sentences</u>				
1	6	1	1	The farmer is picking the fruit.
2	6	1	1	The window glass is broken.
3	12	1	1	The knight is riding the horse.
4	12	1	1	The dog settled near the boy.
5	18	1	1	The child was very happy.
<u>Memory</u>				
13	6	1	1	Flowers grow in the garden.
14	12	2	2	Sporting competition rouses male rivalry.
15	18	1	2	Ben gestured to Margaret.
16	6	2	1	The little cat discovered a place to sleep.
17	18	2	2	The eagle flies the helpless rat to the cliff.
18	12	1	1	The doctor cared for the dog.
19	12	1	2	Carolina bade farewell.
20	6	2	2	The beloved pony has damaged his hind hoof.
21	18	2	1	The sad boy appears to have broken his arm.
22	12	2	1	The boy sat at the table reading a book.

## Appendix 4 (continued)

Sentence #	Delay	Length (L)	Vocab. (V)	
				<u>Memory</u>
23	18	1	1	The boy worked the garden.
24	6	1	2	Alice mended the blanket.
25	18	2	2	The tremendous deer herd drifts on the prairie.
26	6	2	1	The boy tried to catch the cat by his tail.
27	12	1	1	The woman sat on the chair.
28	18	1	1	The train traveled through the fields.
29	12	2	1	The teacher reads the book with the little girl.
30	6	1	2	Ben manufactures lumber.
31	6	1	1	Athletes listen to their coach.
32	12	2	2	The elder bishop thrust the beggar aside.
33	18	1	2	The mouse fled from the kitten.
34	6	2	2	Papa Ben is splitting a rail with an ax.
35	18	2	1	The pretty teacher writes letters on the board.
36	12	1	2	The attendant pumped some fuel.
37	12	2	1	The woman held the hand of the child in blue.
38	6	1	2	Everyone fled the dwelling.
39	18	1	1	The fish live in the ocean.

## Appendix 4 (continued)

Sentence #	Delay	Length (L)	Vocab. (V)	
				<u>Memory</u>
40	12	1	2	The tame elephants are caged.
41	18	2	1	Old farmers are gardening in good weather.
42	6	2	2	Carl flung the anchor into the shallow pond.
43	18	2	2	Lazy Martin was sleeping on the torn couch.
44	6	2	1	The wide river runs through the little village.
45	12	1	1	The bird lives in the forest.
46	18	1	2	The tailor altered the cape.
47	12	2	2	Bearded Carl composed tunes on the piano.
48	6	1	1	The girl was baking a cake.

Appendix 4 (continued)  
Test Stimuli (Part B)

Sentence #	Delay	Length (L)	Vocab. (V)	
<u>Sample Sentences</u>				
1	0	1	1	The girl is writing a note.
2	0	1	1	The boy runs across the street.
3	0	1	1	The girl is making her bed.
4	0	1	1	This box contains some presents.
5	0	1	1	The clothes are drying outside.
<u>Auditory Comprehension</u>				
1	0	2	2	The cheerful dwarf amused eager observers.
2	0	1	1	The girl is reading a book.
3	0	1	2	Fishermen rescue canoes.
4	0	2	1	The little village lay in the green valley.
5	0	1	1	The bear is eating the fish.
6	0	2	1	The soldier kissed the girl behind the big tree.
7	0	2	2	Robed friars proclaim the bible in chapel.
8	0	1	2	The thief clasped the merchandise.
9	0	2	1	A large crowd is gathering at the old church.
10	0	1	2	Lillies flourished in the pond.
11	0	1	1	The women are wearing hats.
12	0	2	2	The lonely pet aroused pity in Margaret.

## Appendix 4 (continued)

Sentence #	Delay	Length (L)	Vocab. (V)	
<u>Sample Sentences</u>				
1	6	1	1	The farmer is picking fruit.
2	6	1	1	The window glass is broken.
3	12	1	1	The knight is riding the horse.
4	12	1	1	The dog settled near the boy.
5	18	1	1	The child was very happy.
<u>Memory</u>				
13	6	1	1	The food sits on the table.
14	12	2	2	Ben smote the arch on the naval monument.
15	18	1	2	The frog hops over the stump.
16	6	2	1	Houses lay at the foot of the big mountain.
17	18	2	2	The pet pony is safe from snakes in the hut.
18	12	1	1	The girl stood behind the tree.
19	12	1	2	The ghost haunted the inn.
20	6	2	2	The cheerful twins crawled onto the neat blanket
21	18	2	1	Young children are playing near the country house.
22	12	2	1	The girl is getting ready to go to sleep.
23	18	1	1	The lamp sits on the table.
24	6	1	2	The buds bloomed into daisies.

## Appendix 4 (continued)

Sentence #	Delay	Length (L)	Vocab. (V)	
				<u>Memory</u>
25	18	2	2	The reckless male stalks the tiger with a spear.
26	6	2	1	The family of cats sat close together.
27	12	1	1	The gentleman held flowers.
28	18	1	1	The boy measures the trunk.
29	12	2	1	The man labored with the large bag on his back.
30	6	1	2	The pony gallops through the ditch.
31	6	1	1	The man walked in the rain.
32	12	2	2	Clever partners flourish through skilled agreement.
33	18	1	2	Elephants amuse elders.
34	6	2	2	Barrels are stacked neatly in damp cellar.
35	18	2	1	One car is traveling along the wide road.
36	12	1	2	Geese are on the shallow pond.
37	12	2	1	The boy made a small fire in the forest.
38	6	1	2	Joseph constructs the chimney.
39	18	1	1	The ship sailed on the river.
40	12	1	2	Kittens slumber in the hut.
41	18	2	1	The book lay open upon the large table.

## Appendix 4 (continued)

Sentence #	Delay	Length (L)	Vocab. (V)	
				<u>Memory</u>
42	6	2	2	The champion football player darts swiftly.
43	18	2	2	The weary mule plowed the pasture by moonlight.
44	6	2	1	The happy man in the boat has caught a fish.
45	12	1	1	The cattle stood in the grass.
46	18	1	2	Beggars bother customers.
47	12	2	2	Muscular males have dug ditches near the dwelling.
48	6	1	1	John is playing in water.

## Appendix 5

## Internal Validity Analyses of Test Items

Scale	Initial Items	Alpha	Final Items	Alpha
<u>Zero Delay</u>				
L <sub>1</sub> V <sub>1</sub>	A1, A7, A12 B2, B5, B11	.362	A1, A7 A12, B11	.598
L <sub>1</sub> V <sub>2</sub>	A4, A6, A9 B3, B8, B10	.454	A9, B3 B8, B10	.608
L <sub>2</sub> V <sub>1</sub>	A2, A5, A11 B4, B6, B9	.366	A2, A5 B6, B9	.541
L <sub>2</sub> V <sub>2</sub>	A3, A8, A10 B1, B7, B12	.368	A8, B1 B7, B12	.527
<u>6 Sec. Delay</u>				
L <sub>1</sub> V <sub>1</sub>	A13, A31, A48 B13, B31, B48	.387	A31, B13 B31, B48	.544
L <sub>1</sub> V <sub>2</sub>	A24, A38, A38 B24, B30, B38	.457	A24, A30 B30, B38	.577
L <sub>2</sub> V <sub>1</sub>	A16, A26, A44 B16, B26, B44	.490	A16, A44 B16, B44	.614
L <sub>2</sub> V <sub>2</sub>	A20, A34, A42 B20, B34, B42	.498	A20, A42 B34, B42	.516
<u>12 Sec. Delay</u>				
L <sub>1</sub> V <sub>1</sub>	A18, A27, A45 B18, B27, B45	.438	A18, A27 B18, B27	.541
L <sub>1</sub> V <sub>2</sub>	A19, A36, A40 B19, B36, B40	.354	A19, A40 B19, B36	.563
L <sub>2</sub> V <sub>1</sub>	A22, A29, A37 B22, B29, B37	.389	A29, B22 B29, B37	.620
L <sub>2</sub> V <sub>2</sub>	A14, A32, A47 B14, B32, B47	.376	A14, A32 A47, B47	.583

## Appendix 5 (continued)

Scale	Initial Items	Alpha	Final Items	Alpha
	<u>18 Sec. Delay</u>			
L <sub>1</sub> V <sub>1</sub>	A23, A28, A39 B23, B28, B39	.469	A23, A28 B23, B28	.518
L <sub>1</sub> V <sub>2</sub>	A15, A33, A46 B15, B33, B46	.374	A46, B15 B33, B46	.648
L <sub>2</sub> V <sub>1</sub>	A21, A35, A41 B21, B35, B41	.473	A23, A28 B23, B28	.518
L <sub>2</sub> V <sub>2</sub>	A17, A25, A43 B17, B25, B43	.403	A46, B15 B33, B46	.649

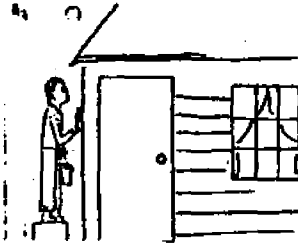
## Appendix 6

Each of the 16 following pages shows the four sentences and their accompanying figures which reliability analysis revealed to be most compatible with one another. In actual administration the sentences were read aloud and the four-fold figure choices were presented without text and enlarged to a normal (8 1/2" x 11") page format.

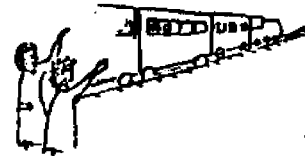
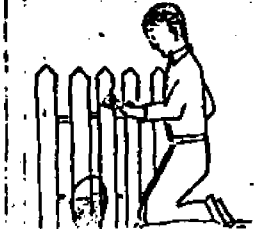
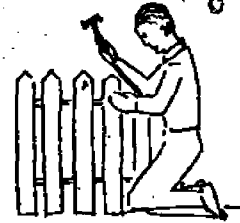
ZERO DELAY: LI VI



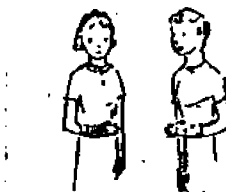
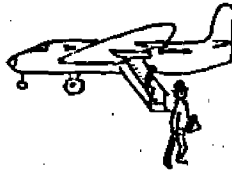
The dog is fighting a cat.



Father is painting the fence.



The people arrived by train.



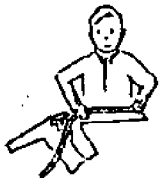
The women are wearing hats.



ZERO DELAY: LI V2



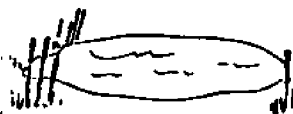
The tailor mended the sleeve.



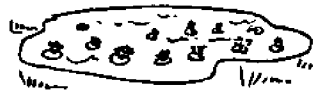
Fishermen rescue canoes.



The thief clasped the merchandise.



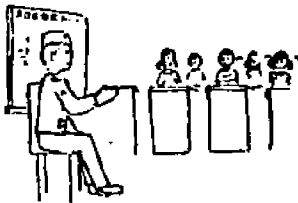
Lilies flourished in the pond.



ZERO DELAY: L2 V1



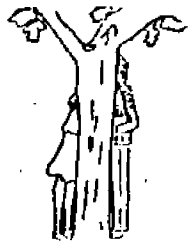
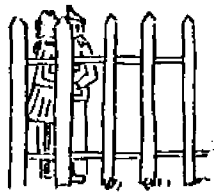
The school children listened to the sea captain.



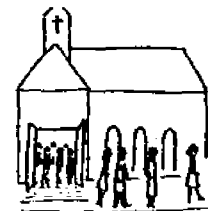
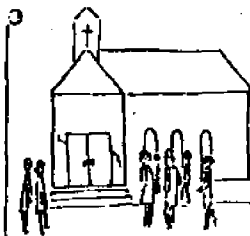
The heavy cook is measuring the fresh milk.



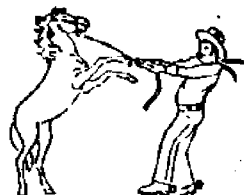
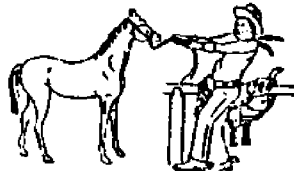
The soldier kissed the girl behind the big tree.



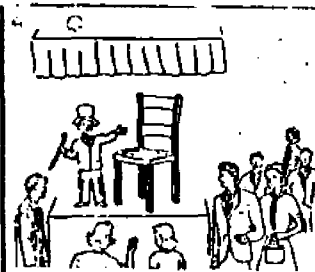
A large crowd is gathering at the old church.



ZERO DELAY: L2 V2



The scared pony resists adding the saddle.



The cheerful dwarf amused eager observers.



Robed friars proclaim the bible in chapel.



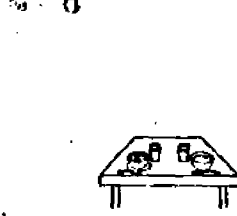
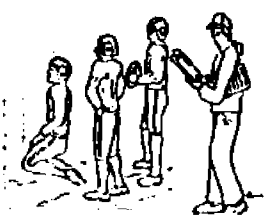
The lonely pet aroused pity in Margaret.



6 SEC DELAY: L1 V1



Athletes listen to their coach.



The food sits on the table.



The man walked in the rain.



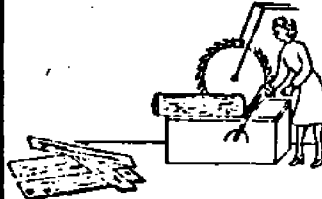
John is playing in water.



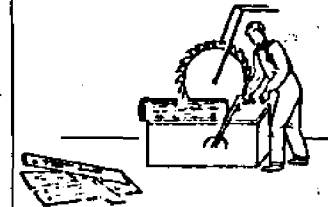
6 SEC DELAY: L1 V2



Alice mended the blanket.



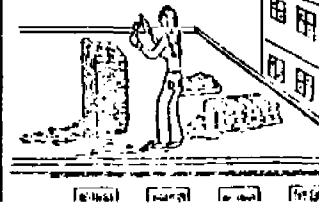
Ben manufactures lumber.



The pony gallops through the ditch.



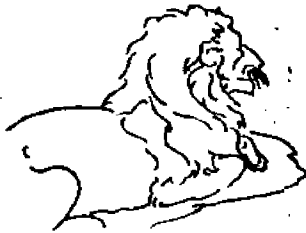
Joseph constructs the chimney.



6 SEC DELAY: L2 V1



The little cat discovered a place to sleep.



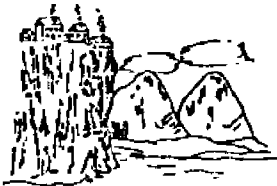
The wide river runs through the little village.



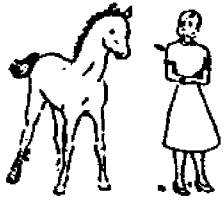
Houses lay at the foot of the big mountain.



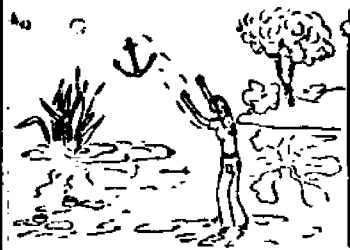
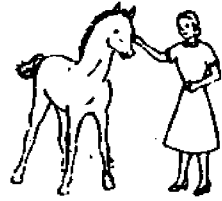
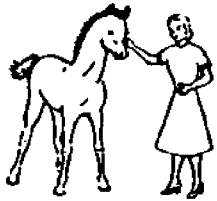
The happy man in the boat has caught a fish.



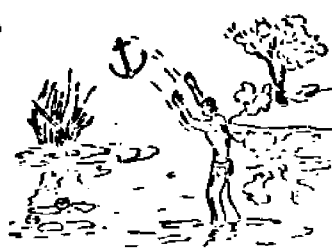
6 SEC DELAY: L2 V2



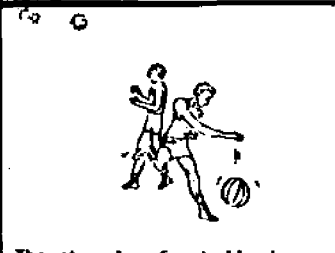
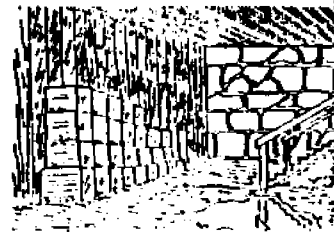
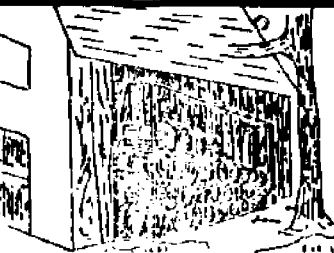
The beloved pony has damaged his hind hoof.



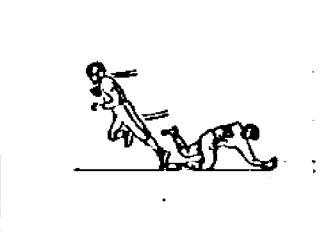
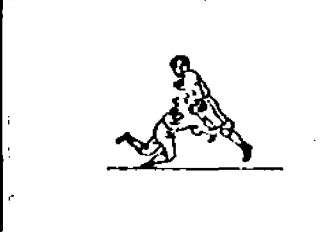
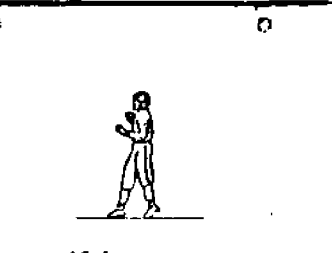
Carl flung the anchor into the shallow pond.



Barrels are stacked neatly in the damp cellar.



The champion football player darts swiftly.



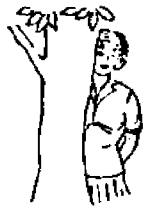
12 SEC DELAY: L1 V1



The doctor cared for the dog.



The woman sat on the chair.



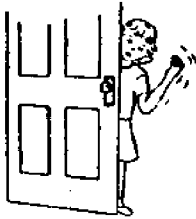
The girl stood behind the tree.



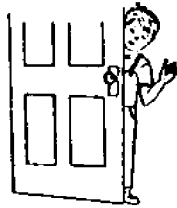
The gentleman held flowers.



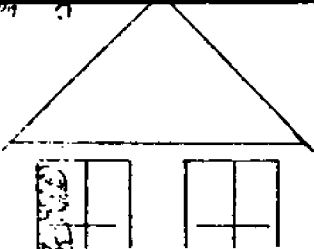
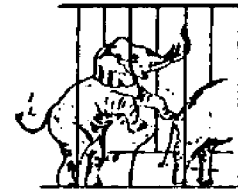
12 SEC DELAY: L1 V2



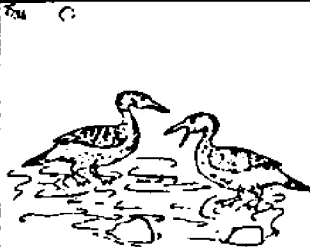
Carolina bade farewell.



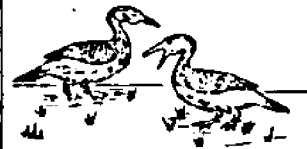
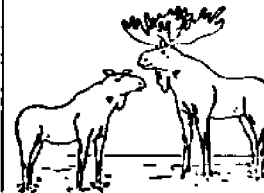
The tame elephants are caged.



The ghost haunted the inn.



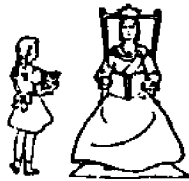
Geese are the shallow pond.



12 SEC DELAY: L2 V1



The teacher reads the book with the little girl.



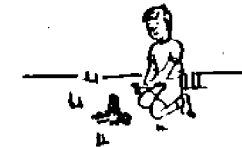
The man labored with the large bag on his back.



The girl is getting ready to go to sleep.



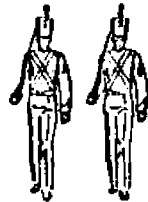
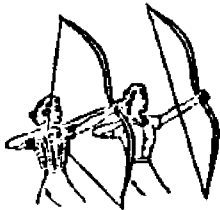
The boy made a small fire in the forest.



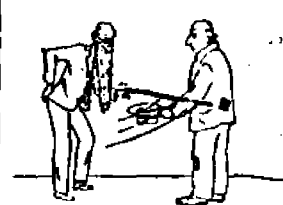
12 SEC DELAY: L2 V2



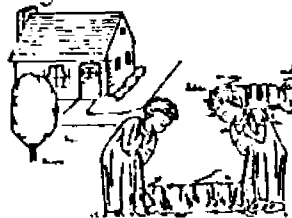
Sporting competition rouses male rivalry.



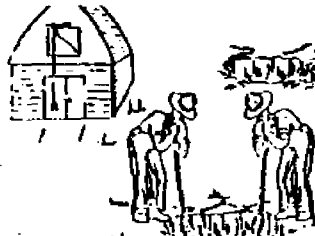
The elder bishop thrust the beggar aside.



Bearded Carl composed tunes on the piano.



Muscular males have dug ditches near the dwelling.



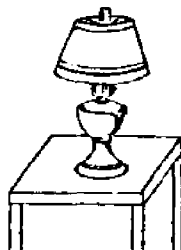
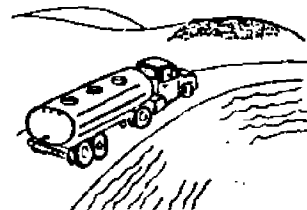
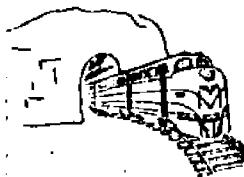
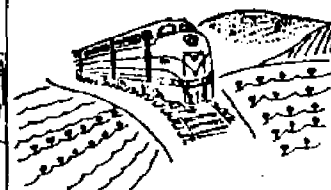
18 SEC DELAY: L1 V1



The boy worked the garden.



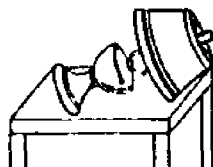
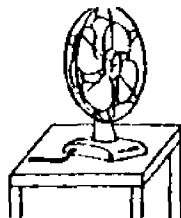
The train traveled through the fields.



The lamp sits on the table.



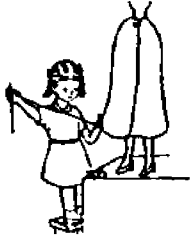
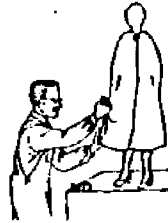
The boy measures the trunk.



18 SEC DELAY: LI VZ



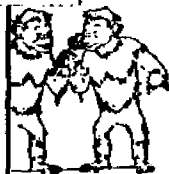
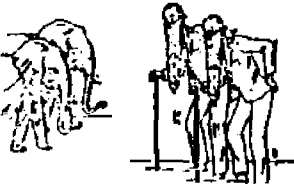
The tailor altered the cape.



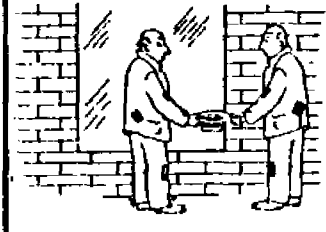
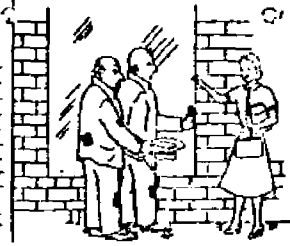
The frog hops over the stump.



Elephants amuse elders.



Beggars bother customers.



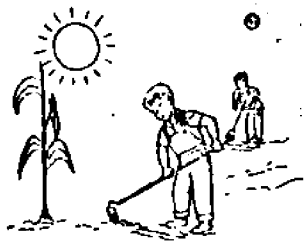
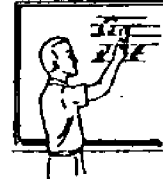
18 SEC DELAY: L2 V1



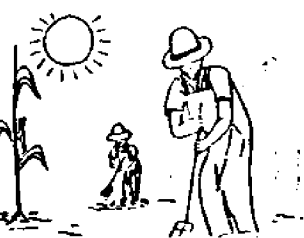
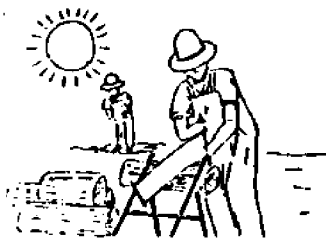
The sad boy appears to have broken his arm.



The pretty teacher writes letters on the board.



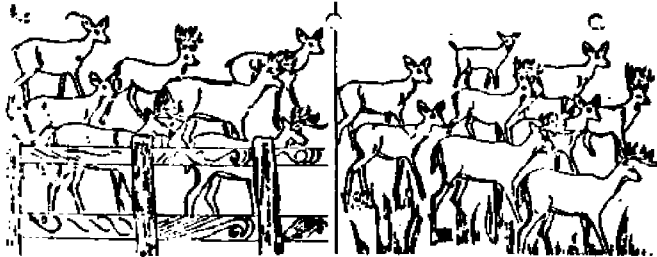
Old farmers are gardening in good weather.



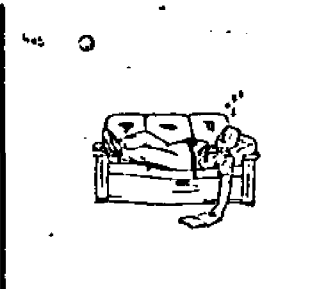
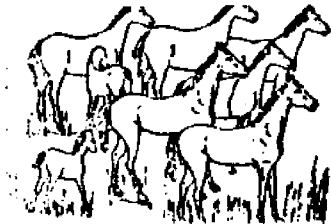
The book lay open upon the large table.



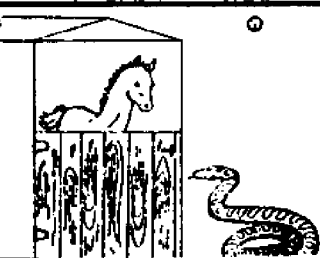
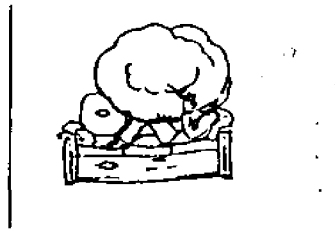
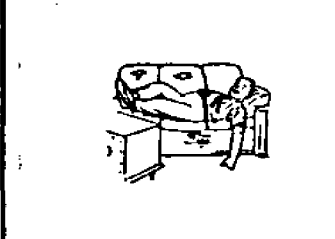
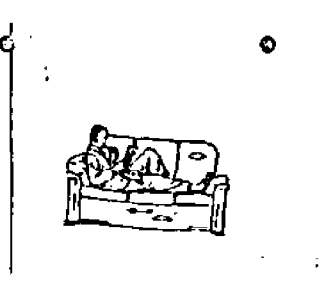
18 SEC DELAY: L2 V2



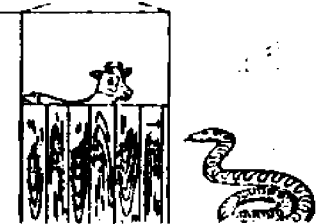
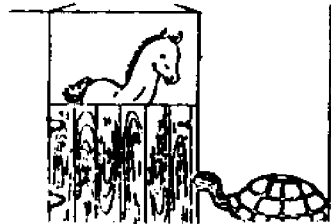
The tremendous deer herd drifts on the prairie.



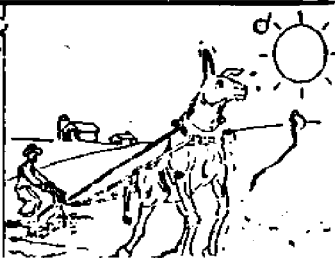
Lazy Martin was sleeping on the torn couch.



The pet pony is safe from snakes in the hut.



The weary mule plowed the pasture by moonlight.



## Appendix 7

Individual Measures of Performance  
For Brain-Damaged Subjects

Case	Point of Departure <sup>a</sup>	Total Score
Right Brain-Damaged		
11	18	35
12	C	48
13	C	50
14	C	45
15	C	46
16	C	57
17	C	50
18	12	23
19	18	29
20	0	--
Left Brain-Damaged Non-Aphasic		
21	C	61
22	C	53
23	6	13
24	C	42
25	6	11

<sup>a</sup> C = Completed Experiment;  
0, 6, 12, 18 refer to the  
delay duration at which  
performance fell to chance

## Appendix 7 (continued)

Case	Point of Departure <sup>a</sup>	Total Score	V%
Fluent Aphasics			
26	12	27	0
27	12	25	0
28	18	33	14
29	6	11	0
30	6	11	20
31	12	23	0
32	12	23	0
33	6	10	33
34	6	12	14
35	6	10	50
36	6	8	100
37	6	10	50
38	0	--	--
39	18	24	14
Non-Fluent Aphasics			
40	0	42	11
41	6	13	23
42	6	8	50

## Appendix 7 (continued)

Case	Point of Departure <sup>a</sup>	Total Score	L%
Non-Fluent Aphasics			
43	6	7	43
44	6	6	0
45	0	47	8
46	6	11	27
47	0	--	--

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