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Effects of Semantic Associational Strength and Verbal Sequence Length on the Auditory Comprehension of Aphasic Adults

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AN ABSTRACT OF THE THESIS OF Laurel J. Brown for the Master of Science in Speech Pathology and Audiology presented November 27, 1973.

Title: Effects of Semantic Associational Strength and Verbal Sequence Length on the Auditory Comprehension of Aphasic Adults.

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The purpose of this study was to investigate the effects of semantic associational strength (SAS) upon adult aphasics' auditory comprehension abilities. Twenty-eight adult aphasics (25 males and 3 females) and 12 normal control subjects were presented three experimental tasks, each containing 45 items. Experimental task 1 contained single word picture sets of high SAS, moderate SAS, and low SAS words. Experimental task 2 contained two word picture sets of high, moderate, and low SAS words, and experimental task 3 contained three word picture sets of high, moderate, and low SAS words. Subjects heard one, two,

and three word verbal sequences for experimental tasks 1, 2, and 3, respectively, and pointed to the appropriate picture sequence. Level of SAS was determined on the basis of the two most frequently occurring word associations of 50 normal individuals to 195 words selected from the most frequently occurring 3,000 English words.

The findings in this study revealed that aphasics had substantially more difficulty auditorily selecting picture sequences of high SAS words than sequences of moderate and low SAS words, and more difficulty auditorily selecting picture sequences of moderate SAS words than sequences of low SAS words. Results further indicated that, irrespective of degree of SAS between words, aphasics' retentional ability was adversely influenced by an increase in verbal sequence length. The presence of a significant interaction between the SAS and length factors negated the support for an interaction hypothesis that degree of SAS would differentially affect aphasics' comprehension as message length increased. Aphasics' performance on the experimental task was highly related to their overall communicative ability as assessed by the Porch Index of Communicative Ability.

EFFECTS OF SEMANTIC ASSOCIATIONAL STRENGTH AND VERBAL SEQUENCE LENGTH ON THE AUDITORY COMPREHENSION OF APHASIC ADULTS

by

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CHAPTER I

INTRODUCTION

A great deal of clinical and experimental investigation has centered on the identification and description of the language problems of aphasic adults. While there is general agreement that adult aphasia is a language deficit that results from brain damage, opinions vary as to whether aphasic adults simply manifest different degrees of aphasia or in fact illustrate different types of aphasia. Schuell et al. (1965) for example, defined aphasia as "a general language deficit that cuts across all language modalities that may or may not be complicated by other sequalae of brain damage." Others, however (Weisenburg and McBride, 1935; Wepman et al., 1960; Geschwind, 1972), have categorized aphasic patients on the basis of the differences in their language behavior and, in some instances, have related these differences to areas of damage in the cortex. In spite of this controversy, the evaluation and treatment of the aphasic adult have continued to focus on describing and, whenever possible, improving the patient's functioning in the primary language modalities of speaking, writing, reading, and listening.

One area of particular interest to the aphasia clinician has been the auditory comprehension deficits that aphasic adults exhibit secondary to brain damage. Smith (1971) has pointed out that the severity of the patient's comprehension deficit in aphasia generally reflects the severity of the overall language impairment, and techniques designed to improve the aphasic's auditory comprehension skills form the foundation of many treatment programs. Schuell et al. (1965) felt all aphasics to have a reduced available vocabulary and a reduced verbal retention span. She suggested a highly auditory treatment approach for the aphasic based on intensive repetitive auditory stimulation.

There is good reason to believe that aphasic adults' ability to encode and decode verbal symbols varies inversely with the difficulty of the linguistic task. Porch (1967) has in fact defined aphasia as "a negative shift on the language response continuum" and most test batteries used to assess the aphasics' language functioning contain tasks of graduated difficulty so as to determine the level of functioning for the individual patient in each language mode (Eisenson, 1954; Wepman and Jones, 1961; DeRenzi and Vignolo, 1962; Schuell et al., 1962; Porch, 1967; Taylor, 1969; Spreen and Benton, 1969). With respect to the assessment of the auditory comprehension problems of the aphasic, attention has primarily focused on the patient's ability to discriminate, retain, and understand the meaning of verbal messages.

It has been clearly illustrated that aphasics have difficulty retaining messages of increasing length. This has been shown on tasks such as digit and sentence repetition, direction following, and pointing to items named serially. In each instance the result has been that when message length is increased the aphasic's retentional impairment becomes more obvious (Filby et al., 1963; Schuell et al., 1965; Shewan and Cantor, 1971). At the same time recent research suggests that aphasic patients also have considerable difficulty differentiating messages on the basis of their phonetic, structural, or semantic variation (Schuell et al., 1961; Schuell and Jenkins, 1961; Spinnler and Vignolo, 1962; Cohen and Edwards, 1964; Schuell et al., 1965; DeRenzi and Vignolo, 1966; Ebbin and Edwards, 1967; Parisi and Pizzamiglio, 1970; Pizzamiglio, 1971; Shewan and Cantor, 1971; Boller and Green, 1972; von Stockert, 1972; Carpenter and Rutherford, 1973). In other words, when the aphasic must do something as simple as to distinguish between phonemically varying words such as "cat" and "bat," syntactically varying structures such as "The girl drinks" and "The girl will drink," or semantically related words such as "pen" and "pencil," he may have considerable difficulty selecting the appropriate stimulus.

Two primary factors appear to have emerged from the literature with respect to the aphasic adult's comprehensional ability. One is that aphasics have difficulty understanding the meanings of words they hear and therefore tend to confuse words and structures related in meaning. The second is that they have difficulty retaining the words they hear for a sufficient length of time for them to be processed.

It is unfortunate that the effects of word relatedness and message length upon aphasics' comprehension have for the most part been investigated separately. Studies that have demonstrated that aphasics have difficulty distinguishing between semantically related words such as "hat" and "coat" (Schuell and Jenkins, 1961; Pizzamiglio, 1971) have employed single word stimuli. No attempts have been made to determine the effects of the semantic relationship between word stimuli in messages of increasing length. Furthermore, while it has been illustrated that aphasic adults tend to confuse words related in meaning (DeRenzi and Vignolo, 1963; Schuell et al., 1965; Boller and Green, 1972; Rinnert and Whitaker, 1973) the relationship between word stimuli has usually been implied rather than specified. It would seem reasonable that the more closely associated semantically word stimuli are, the more difficulty the aphasic will have distinguishing between them.

Accordingly, the purpose of this investigation is to determine the effects of semantic associational strength (SAS) upon the aphasic adult's auditory comprehension of three verbal sequence lengths. Specific research questions asked are as follows:

1. Does the degree of SAS between verbal stimuli influence aphasic adults' auditory comprehension ability?

2. Does verbal sequence length influence aphasic adults' auditory retention ability?

3. Does degree of SAS differentially influence aphasic adults' auditory retention of:
   a. One word sequences?
   b. Two word sequences?
   c. Three word sequences?

4. Does a relationship exist between auditory comprehension ability and overall language ability?

CHAPTER II

REVIEW OF THE LITERATURE

For several years clinical aphasiologists have studied the language behavior of aphasic adults and have attempted to quantify and qualify specific language deficits in this brain-injured population. Adult aphasia is generally considered a disturbance in language behavior, affecting all language modalities that may or may not be complicated by accompanying sensori-motor and/or perceptual deficits (Schuell et al., 1965). Several authors (Berry and Eisenson, 1956; Wepman et al., 1956; Schuell et al., 1961; Osgood and Murray, 1963; Van Riper, 1963) have pointed out that aphasia is an impairment of symbolic formulation and expression and that aphasics have difficulty relating the symbol to the experience represented by that symbol. Schuell et al. (1965) have considered reduction of available vocabulary and reduced verbal retention span to be the two major problems of all aphasics.

In their text, "Aphasia in Adults," Schuell et al. (1965) suggested that all aphasic patients show demonstrable impairment of the auditory processes. They observed that even patients with mild aphasia show problems of auditory discrimination on tasks such as pointing to letters of the alphabet and reduced verbal retention span when asked to repeat digits and sentences, or to point to items named serially. According to Schuell, patients with moderate aphasia usually have further difficulty with rhyming or associating by sound. At more severe levels of impairment, Schuell has indicated that patients sometimes fail to recognize common words, confuse semantically associated words, have difficulty making phonemic discriminations, and have marked difficulty in responding to messages of increased length.

The importance of the auditory system in learning language and of the intensive stimulation of this system in reinstituting language in aphasics has been stressed by many investigators (Wepman, 1951; Schuell et al., 1961). Porch (1967), Schuell et al. (1965), and Brookshire (1972) have delineated several variables that may affect aphasics' auditory processing and have indicated that aphasics may fail to comprehend for a variety of reasons. Aphasics are felt to follow a pattern in the reacquisition of words similar to that seen in language acquisition of children. Wepman et al. (1956), Filby et al., (1963), Schuell et al., (1965) and others have stressed frequency of occurrence of words as an important factor in reestablishing language usage. Aphasics tend to reacquire vocabulary on the basis of the utility of the word, word length, and its frequency of occurrence. They tend to make fewer errors on common words of high immediate utility for all parts of speech. Many investigators (Filby et al., 1963; Sefer and Henrikson, 1966; Perry and Boswell, 1971; Shewan and Cantor, 1971; Tikofsky, 1971) have compared the receptive vocabulary abilities of normals and aphasics on tasks requiring a non-verbal (pointing) response to a pictured representation of an auditorily presented stimulus and found the level of aphasics' performance to be well below that of the normal subjects.

In summary, there is general agreement that all aphasics have some degree of auditory processing difficulty and that this ability is probably related to overall language ability (Schuell et al., 1965; Smith, 1971).

Phonetic Discrimination in Aphasia

A number of investigations have dealt with the ability of the aphasic adult to discriminate phonemes. Luria (1958) proposed that the breakdown in the understanding of speech in aphasia was affected by disintegration of the complex auditory function and produced an inability to utilize the systematized language code. He suggested that the aphasic loses phonemic analysis and may be unable to take in words and differentiate their meanings. Simultaneous synthesis, necessary for understanding, would therefore be impaired by the aphasic's inability to combine isolated elements into a single unit. More recently Luria (1970) pointed out that the aphasic's inability to discriminate perceived sounds can produce a profound impairment of the entire auditory system.

Carpenter and Rutherford (1973) studied acoustic cue discrimination of aphasic adults and found that aphasics could not adequately discriminate the basic components of phonemes of which word-symbols are constructed. Similarly, Schuell (1953), Cohen and Edwards (1964), and Ebbin and Edwards (1967) have suggested that the aphasic's basic difficulty in deciphering language may be a deficit in discrimination of sounds and sound sequences, with impairment becoming more profound as length of the auditory pattern increases.

Auditory Retention in Aphasia

In order to comprehend verbal material it is necessary to store (retain) the message for a sufficient period of time for it to be processed. Researchers have indicated that auditory retention span has a major influence upon comprehension. The ability of normal adults to understand messages has been shown to be influenced by sentence length (McMahon, 1963) and word difficulty (Nichols, 1965). Howes (1957) and Savin (1963) found that the frequency of occurrence of words influences comprehension. Others (Filby et al., 1963; Sefer and Henrikson, 1966; Swinney and Taylor, 1971; Perry and Boswell, 1971; Tikofsky, 1971) have found that aphasics performed more inferiorly than both children and normal adults in their ability to retain messages.

Shewan and Cantor (1971) specifically investigated the relationship between comprehension and message length. In their study, 27 aphasic and 9 normal adult subjects were given an auditory comprehension test consisting of 42 sentences which varied in the parameters of length, vocabulary difficulty, and syntactic complexity. They found that aphasic patients demonstrated poorer auditory comprehension than normal controls. Aphasics' mechanism for understanding language appeared to be much the same as normals; however, they seemed to employ this mechanism with reduced efficiency. This evidence parallels that of others (Filby et al., 1963; Sefer and Henrikson, 1966; Perry and Boswell, 1971; Tikofsky, 1971) who have indicated that aphasics differentiate themselves from normals by their slower speed and frequently their lower levels of performance, but not by their inability to perform.

Comprehension of Word Meaning in Aphasia

The ability to recognize meanings of words develops relatively early in childhood and represents one of the most stable language functions (Luria, 1958, 1970). Schuell and Jenkins (1961) have illustrated that aphasics have reduction of available vocabulary in all modalities. In this classic study, Schuell and Jenkins investigated reduction of vocabulary comprehension, reduction of naming vocabulary, reduction of reading vocabulary, and reduction of writing vocabulary in aphasia. Their experimental stimuli consisted of the test word, an object whose name rhymed with the test word, an object closely associated with the test object, and an unrelated object, i.e., "chair, stair, table, apple." The test word was spoken by the examiner and the subject was required to point to one of the four pictures on the stimulus card. They found that associational errors were the most common error type and constituted the greatest proportion of errors for patients with mild impairment. Confusion of words associated in meaning or experience was common to all modalities at all levels of impairment however. They also found an inverse relationship between association errors and total errors.

To investigate aphasics' ability to recognize meaningful sounds, Spinnler and Vignolo (1966) administered a sound recognition test to normal subjects, subjects with cerebral lesions without aphasia, and subjects with cerebral lesion with aphasia. They presented ten familiar and meaningful sounds over a tape recorder. After listening to the sound the subjects indicated (by pointing) which of the four pictures represented the sound. The four picture choices consisted of (1) the natural source of the sound, such as "the grunting of a pig," (2) a sound acoustically similar, such as "a capstan pulling an anchor," (3) a sound belonging to the same semantic category, such as "a sheep bleating," and (4) a sound with no relationship, such as "a man whistling." Errors were then classified as acoustic errors, semantic errors, or odd errors. Their findings indicated that a sound recognition deficit in aphasics was associated with problems of auditory verbal comprehension. The performance of the aphasic group differed from that of the other groups with respect to type of error in that they made significantly more semantic than acoustic or odd (unrelated) errors. Similar to Schuell's data, these findings strongly suggested that aphasics' failure to recognize meaningful sounds is not due to an acoustic-perceptual impairment as much as it is their inability to associate the perceived sound with its correct meaning.

Schuell and Jenkins (1961) have reported that the error responses of aphasics are similar to free association responses given by normals. There are also other indications that simple associative processes play an important part in many aspects of normal language behavior. Rinnert and Whitaker (1973) compared word pairs confused by aphasics with various tables of word association norms and found that these confusions were by no means random substitutions but could be categorized on the basis of their semantic association. Cramer (1968) has conducted numerous word association investigations with subjects having various types of organically based pathologies. His findings support reports of severe restriction in the number of associative pathways which can be activated by a stimulus in a brain-injured adult. He concluded that the brain-damaged have a marked reduction in the number of responses available to any one stimulus.

Some investigators have attempted to study the auditory associational responses of aphasics. Pizzamiglio (1971) constructed a test to measure the ability of aphasics to understand the exact meaning of the words perceived. A multiple choice test with words grouped into clusters of four words with a high associative overlapping was presented to sixty aphasic and thirty normal subjects. The stimulus word presented in each case was the word with the highest associative overlapping and this was taken as an index of the semantic similarity between words. Four picture-sets containing stimuli such as "hand, foot, leg, finger" were presented visually and subjects were required to point to the appropriate stimulus word presented auditorily. Aphasics were found to confuse words that had a high degree of associational overlap and made significantly lower scores than the normal subjects. Schuell et al. (1961) have reported that aphasics tend to auditorily confuse words related in meaning or experience. Boller and Green (1972) have also proposed that for detailed comprehension, the aphasic must attend more closely to the semantic properties of the words and their intimate structural relations.

In summary, aphasics have been found to demonstrate problems of phonemic discrimination, auditory retention, and vocabulary comprehension. Semantic or associational confusions appear to be observed with all aphasics regardless of level of impairment and it would appear that the more closely associated in meaning two words are, the more difficulty the aphasic is likely to have understanding them. Unfortunately, no attempts have been made to determine the effect of degree of associational strength on aphasics' comprehension performance. If the degree of association between words does adversely influence comprehension, one might expect this problem to be manifest regardless of the length of the message.

It is the purpose of this study to determine the effects of semantic associational strength and length of message upon the auditory comprehension of aphasic adults.

CHAPTER III

METHODS AND PROCEDURES

Subjects

Subjects for this study were 28 aphasic adults (25 males and 3 females) and 12 normal adult controls. All aphasic subjects were (1) diagnosed as aphasic by an experienced speech pathologist, (2) currently receiving or had previously received speech therapy, (3) between 25 and 75 years of age, with a mean of 51 years, (4) aphasic as the result of cerebral vascular accident (CVA), (5) had suffered no more than one medically documented CVA, and (5) at least three months post CVA. Severity of aphasia for the 28 subjects was determined on the basis of subjects' percentile rankings on the Porch Index of Communicative Ability (PICA) (Porch, 1967). Only aphasics who fell between the 25th and 95th percentiles on the PICA were used as subjects. The aphasic subjects are further described in Table I.

Twelve normal adults (6 males and 6 females) were selected as control subjects. These subjects were considered to have normal language abilities as judged by the experimenter from their conversational speech and reported no previous or present history of neurological involvement. The control group was comparable with the aphasic group in terms of chronological age. Their ages ranged from 26 to 67 years, with a mean of 47 years.

TABLE I

DESCRIPTION OF APHASIC SUBJECTS

SUBJECT #	SEX	AGE	MONTHS POST ONSET	PICA %-ile
1	M	47	24	76
2	M	55	14	75
3	M	68	15	50
4	M	43	36	64
5	M	48	18	50
6	M	41	27	70
7	M	53	50	78
8	M	57	45	50
9	F	41	43	95
10	F	44	59	77
11	M	74	12	64
12	M	56	27	45
13	M	55	156	50
14	M	70	74	37
15	M	57	15	71
16	M	39	7	74
17	M	25	21	89
18	M	56	7	59
19	M	38	67	46
20	M	48	71	41
21	M	53	66	52
22	M	55	7	88
23	M	49	76	55
24	M	49	24	94
25	M	60	156	78
26	M	58	15	75
27	F	47	18	49
28	M	50	4	46

Procedure

Three experimental tasks, each containing 45 items, were administered to the subjects. In each task, subjects selected (by pointing) a picture or sequence of pictures in response to an auditory stimulus. In experimental task 1 (Figure 1) the subjects viewed three pictures, heard one stimulus word, and pointed to the appropriate picture. In experimental task 2 (Figure 2) subjects viewed three two-picture sequences, heard two stimulus words corresponding to one of the sequences, and pointed to the appropriate picture sequence. In experimental task 3 (Figure 3) subjects were presented three three-picture sequences, heard three stimulus words corresponding to one of the sequences, and pointed to the appropriate sequence of pictures. Figures 1, 2, and 3 also illustrate the means by which the same stimuli (pictures) were employed in all three experimental tasks and that each picture or picture sequence was presented as the stimulus on one occasion.

As in Figures 1, 2, and 3, all pictures and picture sequences were pictorially displayed with 2" x 2" black and white drawings on 8½" x 11" white cards. A strip of magnetic recording tape was affixed to the base of each card and a Standard American speaking male recorded the appropriate word or word sequence for each card over the recording system of an Electronic Card Reader (ECR). This allowed all subjects to hear the same stimulus presentations. All stimuli were presented individually over the playback system of the ECR unit.

During administration of the three tasks the subject and the experimenter sat at a large table in a quiet room facing the ECR unit and a loudspeaker through which all stimuli were played. Stimuli were

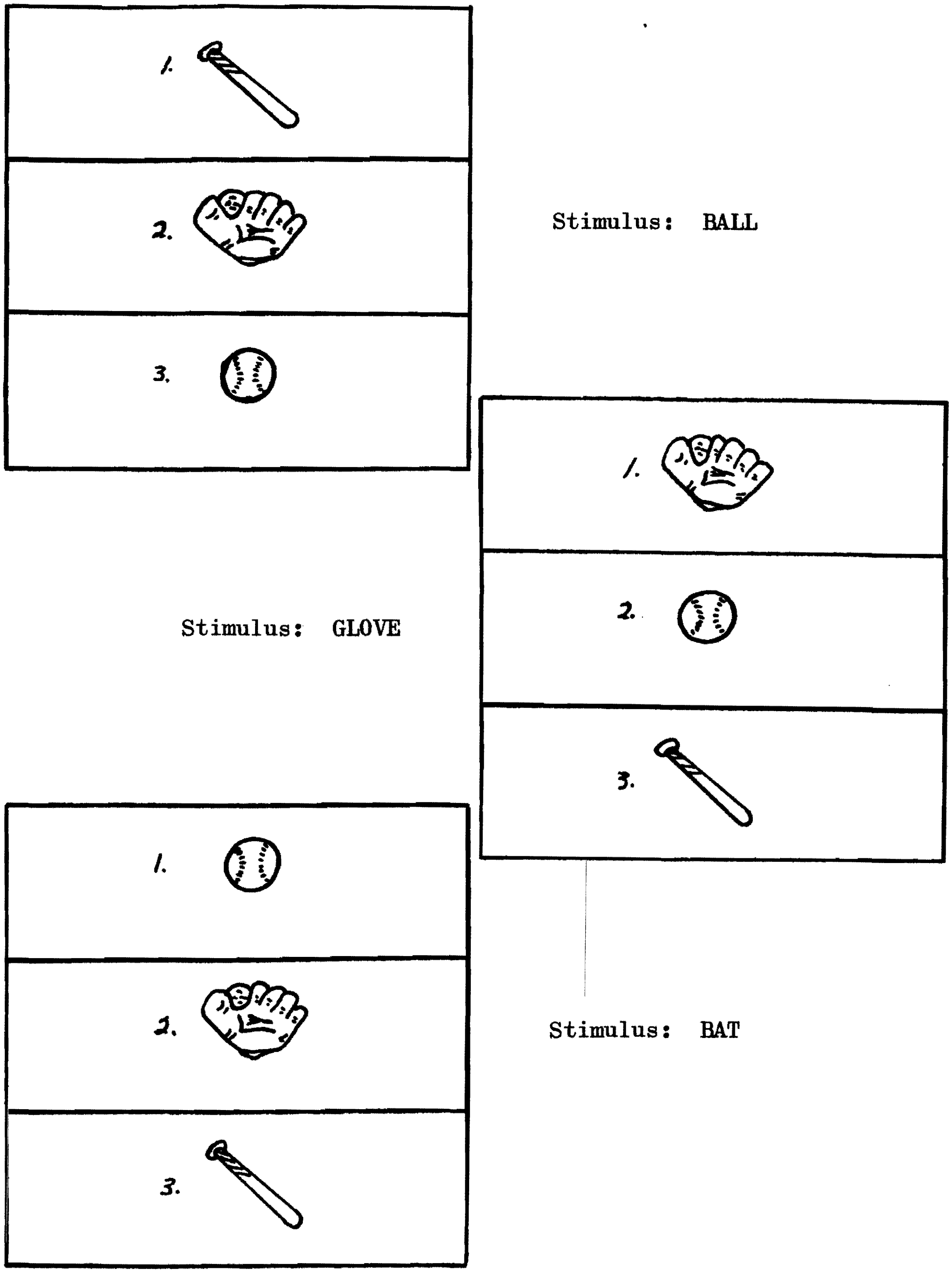


Figure 1. Example of single word picture sequences.

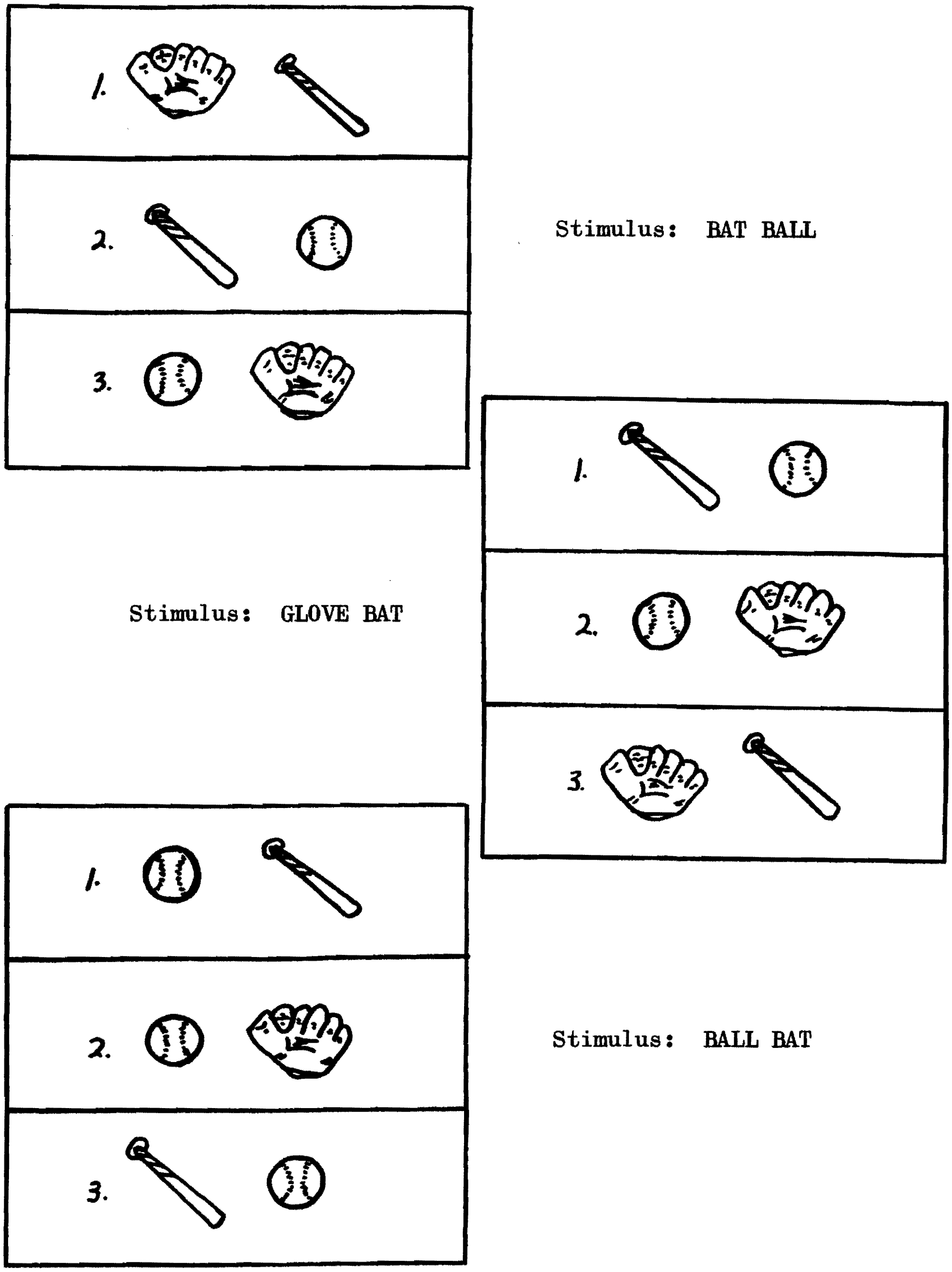
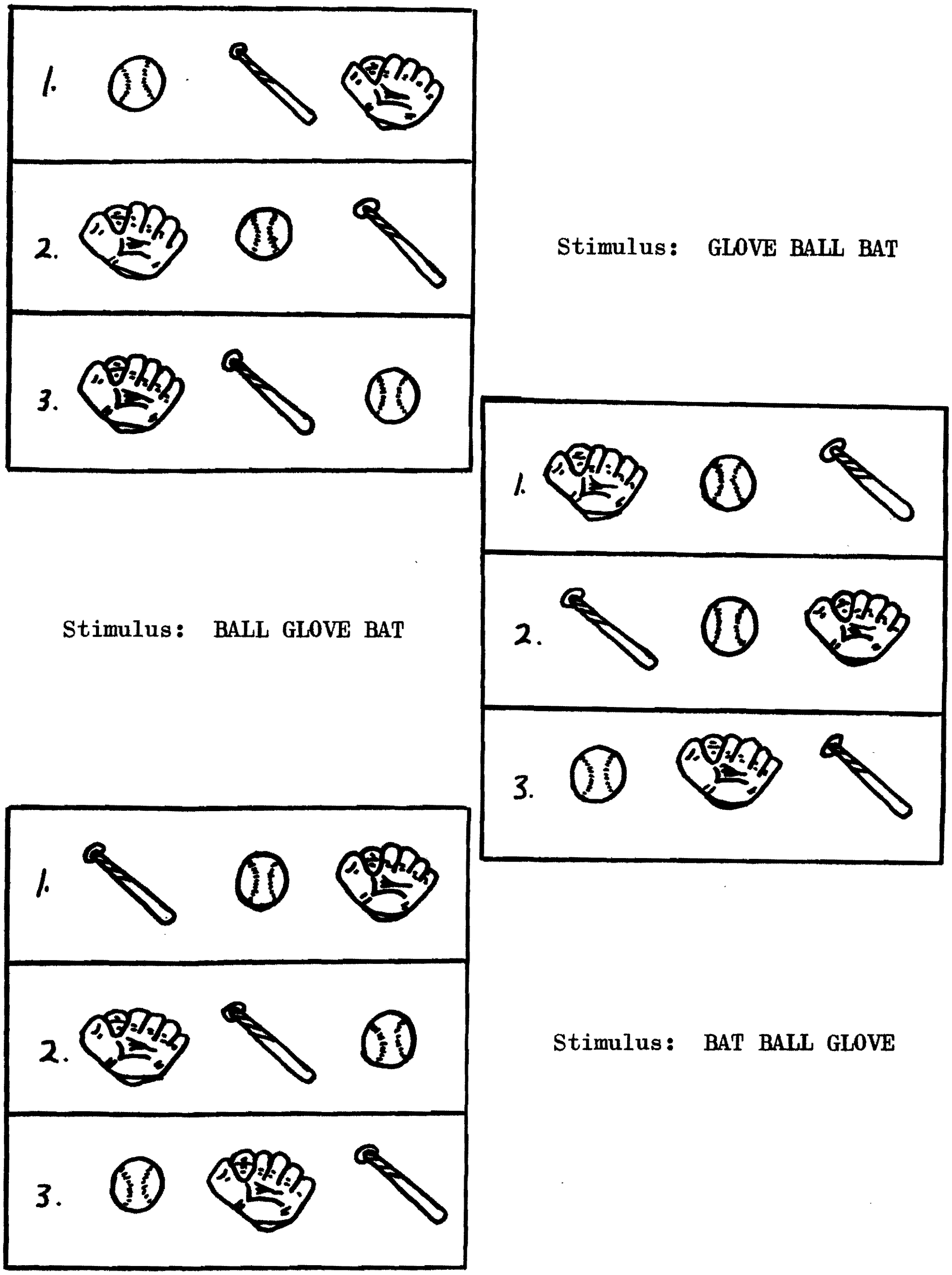


Figure 2. Example of two word picture sequences.



<u>Figure 3</u>. Example of three word picture sequences.

presented individually by the experimenter who placed the card in the ECR unit, allowed the subject to visually scan the pictures on the card, and depressed the playback button of the ECR unit causing the playback head to move across the tape and activate the auditory stimulus. Order of experimental task presentation was randomized for each subject, and subjects were given a ten-minute rest period between the second and third tasks.

Subjects were trained individually prior to administration of each task. Three stimulus cards (containing pictures other than those used in the actual experimental tasks) were used for training on each task. Subjects were given instruction, and if necessary, demonstration until training was accomplished. Subjects who were unable to demonstrate that they understood how to respond to the tasks were excluded from the study.

Stimulus Selection

Experimental task stimuli (pictures) were selected on the basis of 50 normal adults' responses to a 195-item word association task. These 195 words (Appendix A) were all picturable nouns selected from the 3,000 most frequently used English words (Thorndike and Lorge, 1964). The 50 normal adults were instructed to write beside each of the 195 words the noun they most commonly associated with that word. Based on the frequency of their responses to the 195 words, 15 words and the two most frequently occurring picturable noun responses to them were selected as stimuli for the experimental tasks. Five of these words and their responses were designated as having a high degree of semantic associational strength (high SAS), five a moderate degree of semantic associational strength (moderate SAS), and five low semantic associational strength (low SAS) (Table II). For the high SAS stimuli, the two words most frequently elicited from the original stimulus words comprised at least 70 percent of all responses. For the moderate SAS stimuli, the two words most frequently evoked in response to the original stimulus word comprised at least 18 but not more than 46 percent of all responses. Low SAS stimuli were composed of words (selected by the experimenter) that were never given in response to the original stimulus word.

High SAS, moderate SAS, and low SAS stimuli were randomized within each of the three experimental tasks. Appendices B, C, and D show the stimulus order for experimental tasks 1, 2, and 3, respectively.

Scoring of Responses

Subject's responses to each task stimulus were scored with a modified multidimensional scoring system similar to the 16 point system described by Porch (1971). Scores for the multidimensional system were: 5 for an accurate, responsive, prompt response; 4 for an accurate, delayed response; 3 for a self-corrected response; 2 for an accurate response with one repeat; 1 for an accurate response with two repeats; and 0 for an error. Criteria for scoring judgments were:

5 CORRECT - an accurate, responsive, prompt response following stimulus presentation.

4 DELAY - an accurate response made with hesitation, after significant time lapse or any verbalizations from the subject to assist in stimulus recognition.

TABLE II

STIMULI SELECTED FOR THE EXPERIMENTAL TASKS

Original High SAS Stimulus Word	Frequency of Response Occurrence		Combined Percent of Total
BOY	GIRL(43)	MAN(3)	92%
BAT	BALL(42)	GLOVE(3)	90%
FORK	KNIFE(30)	SPOON(15)	90%
TOE	FOOT(35)	FINGER(4)	78%
TABLE	CHAIR(31)	DESK(5)	72%

Original Moderate SAS Stimulus Word	Frequency of Response Occurrence		Combined Percent of Total
SHIRT	PANTS(14)	TIE(9)	46%
DOOR	WINDOW(13)	HOUSE(8)	42%
APPLE	ORANGE(8)	PEAR(6)	28%
BED	BLANKET(8)	PILLOW(5)	26%
CAR	TRUCK(6)	BUS(3)	18%

Original Low SAS Stimulus Word	Frequency of Response Occurrence		Combined Percent of Total
GLASS	SHOE(0)	MOON(0)	-
COW	TREE(0)	BRUSH(0)	-
BOAT	STAR(0)	KING(0)	-
CUP	BOOK(0)	DOG(0)	-
HAT	PEN(0)	EGG(0)	-

3 SELF-CORRECTION - an accurate response correcting a previously committed response that was in error.

2 REPEAT # 1 - an accurate response made after one repetition of the stimulus, when requested by the subject.

1 REPEAT # 2 - an accurate response made after two repetitions of the stimulus, when requested by the subject.

0 ERROR - an incorrect response or no response.

Scorer Reliability

To determine interscorer reliability, nine of the subjects were administered the experimental tasks with the experimenter and one trained observer scoring simultaneously. The additional scorer sat behind and to the left of the subject, with an adequate view of the stimulus cards. Scoring reliability was measured as the percentage of agreement between the experimenter and the scoring observer.

CHAPTER IV

RESULTS AND DISCUSSION

I. RESULTS

Performance of Normal Control Subjects

The 12 normal control subjects exhibited no difficulties whatsoever with the three experimental tasks. All responses given by normal subjects were accurate, responsive, and prompt and received scores of 5 on the modified multidimensional scoring system. For this reason no comparisons of the performance of controls and aphasics were attempted since such comparisons would be meaningless in light of the relative simplicity of the three auditory tasks for the normal group.

Interscorer Reliability

Of the aphasic group 1215 individual responses (135 from each of 9 subjects) were simultaneously scored by the experimenter and the scoring observer. Using the 0 - 5 point modified multidimensional scoring system the experimenter and the scoring observer achieved perfect agreement on 94.5% of all responses scored. The overall interscorer correlation for the experimenter and the observer was .995. On the 5.5% of the responses on which the experimenter and observer disagreed, the majority (5.1%) involved disagreement between a 4 (delayed) and a 5 (correct) response. Only .4% of the responses did not involve a 4 - 5 judgment, and disagreement was greater than one number for only .16% of all responses scored.

Effects of SAS upon Auditory Comprehension

One of the primary questions raised for this study was whether the degree of semantic associational strength (SAS) between words would influence aphasic subjects' comprehension. Group means (N=28) for the aphasic subjects plotted in Figure 4 show that aphasics have substantially more difficulty auditorily selecting a picture sequence of high SAS words than a sequence of moderate SAS or low SAS words, and more difficulty selecting a picture sequence of moderate SAS words than a sequence of low SAS words. Group means for the low, moderate, and high SAS stimuli (Figure 4) were 4.49, 4.07, and 3.71 respectively (F=29.23; df=2,54; p .001) suggest that the higher the degree of SAS between words the more adversely aphasics' comprehension will be influenced.

Effects of Sequence Length upon Auditory Retention

A second question asked in this investigation dealt with the effects of message length upon aphasic subjects' auditory retention ability. In this light results are highly supportive of previous investigations that show aphasics' retention ability to be adversely influenced by an increase in message length (Filby et al., 1963; Schuell et al., 1965; Shewan and Cantor, 1971). Figure 5 shows that the aphasic groups' means (N=28) for one, two, and three word sequences, irrespective of degree of SAS between words of a sequence, were 4.56, 3.92, and 3.79 respectively (F=33.52; df=2,54; p .001). These data suggest that aphasics have relatively little difficulty retaining

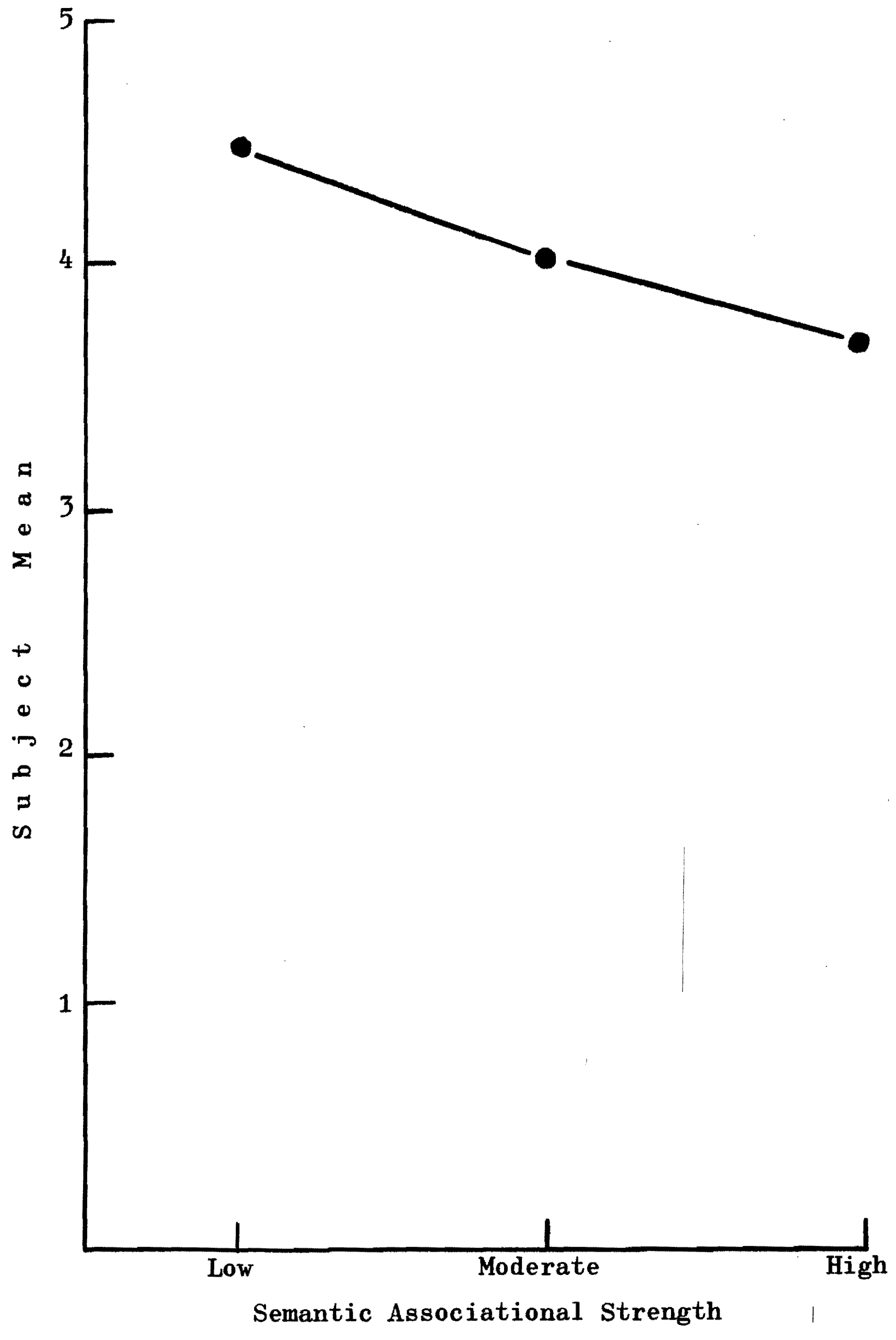


Figure 4. Aphasic subjects' means for low, moderate, and high SAS stimuli.

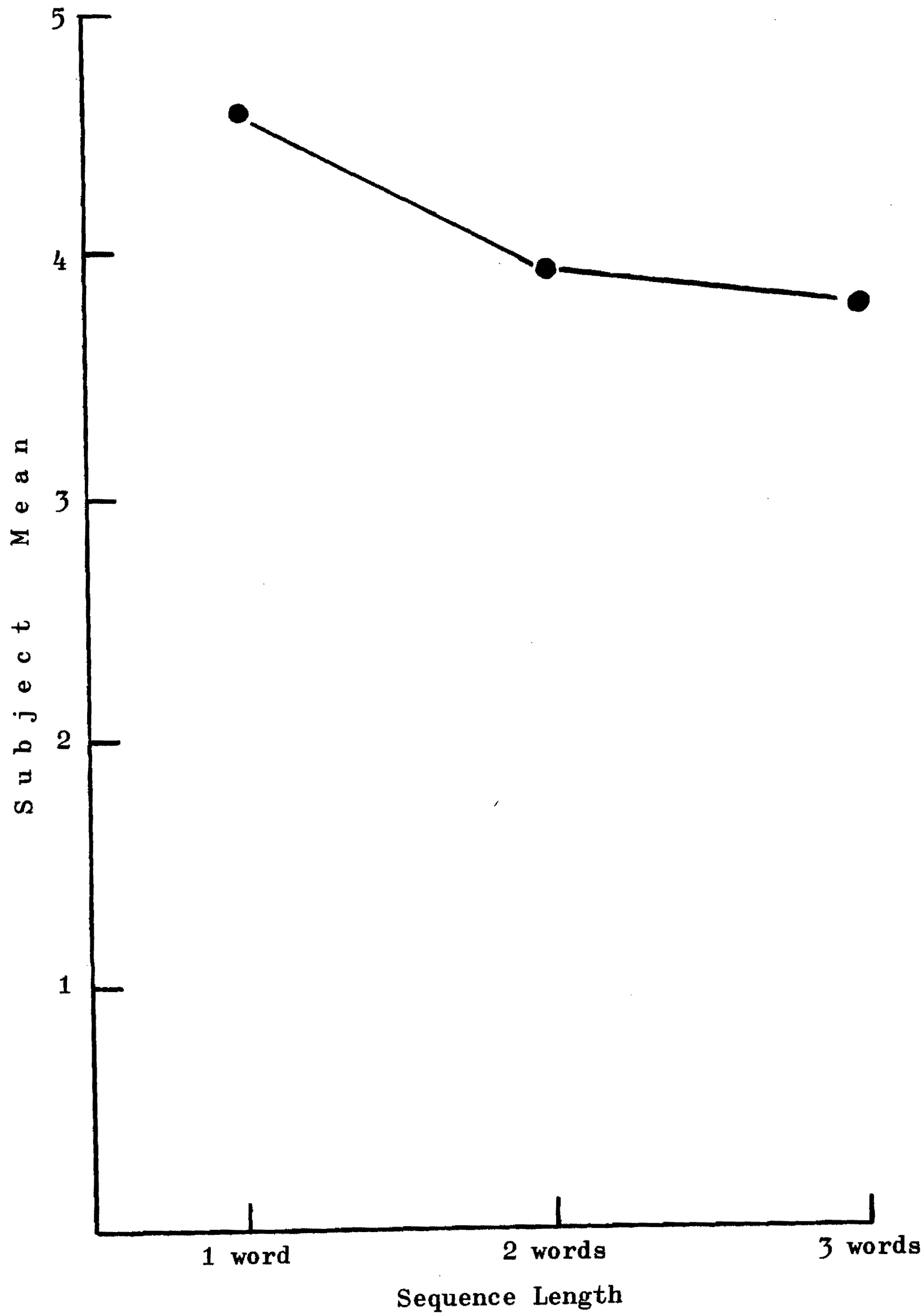


Figure 5. Aphasic subjects' means for one, two, and three word verbal sequences.

single words; their retentional ability for two and three word sequences, however, is substantially below that for single words and they have almost as much difficulty remembering two word sequences as they do three word sequences.

Effects of SAS upon Auditory Retention of One, Two, and Three Word Sequences

A third question asked in the study centered on the differential effects of degree of SAS upon aphasics' ability to retain one, two, and three word sequences. Figure 6 shows aphasic subjects' means for high, moderate, and low SAS stimuli at each of the three verbal sequence lengths. To determine whether a significant interaction existed between the factors of SAS and sequence length a 3 x 3 factorial analysis of variance was applied to the data. Visual observation of the data in Figure 6 clearly points out the existence of a significant interaction between the SAS and length factors (F=5.0769; df=2,54; p .001). Further inspection of Figure 6, however, suggests that this interaction was primarily the result of subjects' performance on the moderate SAS stimuli. Surprisingly, subjects performed differently in terms of their ability to retain moderate SAS than high or low SAS sequences. While they had relatively little difficulty retaining moderate SAS single word sequences, they illustrated an inordinate decrement in their ability to retain moderate SAS two word sequences. Figure 6 illustrates that the aphasic subjects in this study performed approximately the same on the moderate SAS two word sequences as the

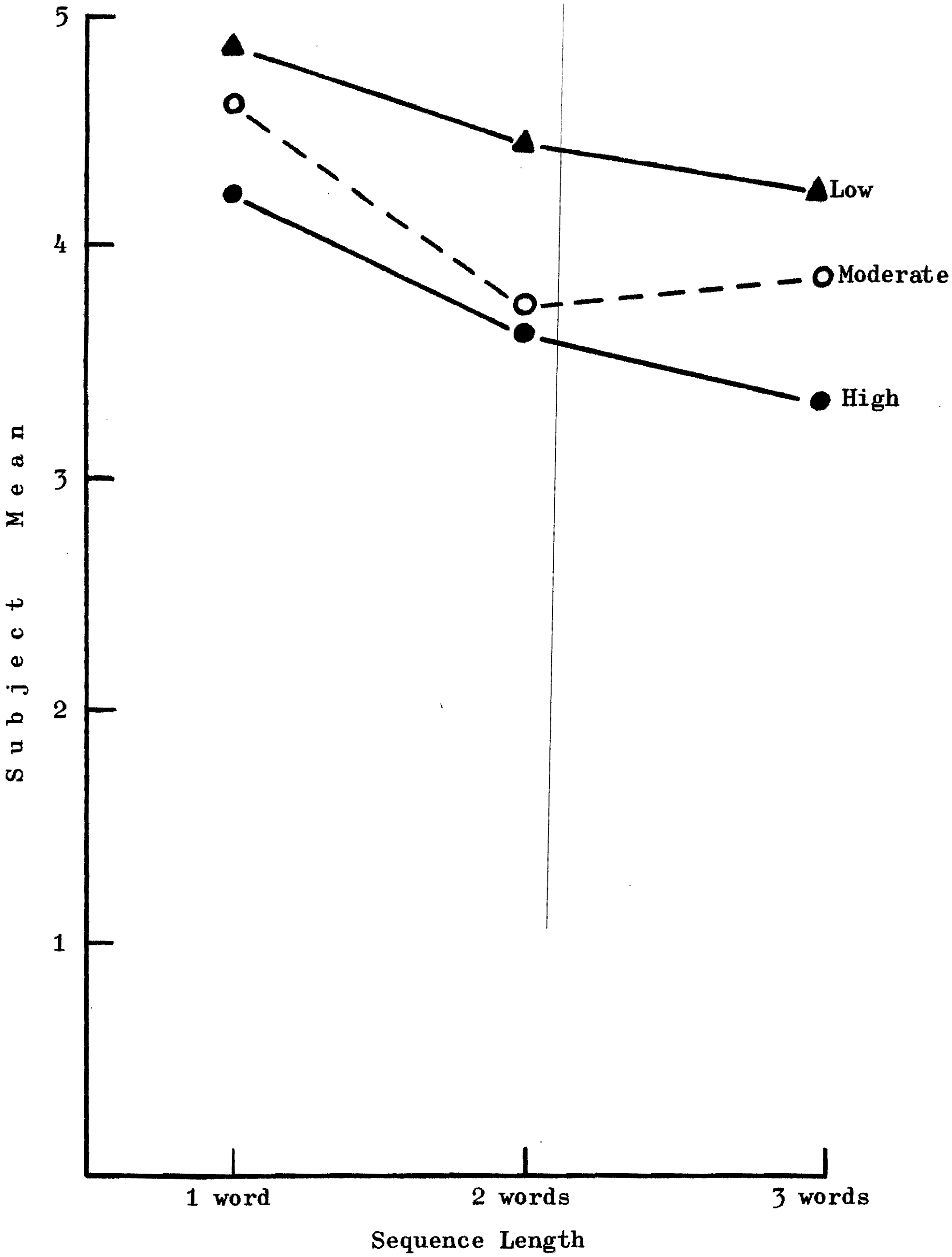


Figure 6. Aphasic subjects' means for low, moderate, and high SAS stimuli at three verbal sequence lengths.

high SAS two word sequences, and in fact had a slightly lower group mean for the moderate SAS two word sequences than the moderate SAS three word sequences.

Relationship of Auditory Comprehension and Overall Language Ability

Figure 7 shows individual subject's overall means for the three auditory tasks plotted against their overall percentile scores for the PICA. It can be seen that subjects' overall rankings on the PICA ranged from the 37th to the 95th percentiles, while grand means for the auditory tasks ranged from 2.97 to 4.92. The clustering of the data points in Figure 7 along the plotted regression line suggests a high positive correlation between the auditory comprehension variables explored in this study and overall communicative ability. The correlation between subjects' auditory comprehension performance and overall communicative ability (measured by the PICA) was .793. This would appear to support earlier studies of Schuell et al. (1965) and Smith (1971) that the auditory comprehension ability in aphasics is generally reflective of the person's overall language ability.

II. DISCUSSION

The findings of this investigation substantiate results of previous studies that have shown aphasics to have difficulty comprehending the meaning of words (DeRenzi and Vignolo, 1962; Spinnler and Vignolo, 1966; Pizzamiglio, 1971) and to confuse words that are semantically related (Schuell and Jenkins, 1961). Unlike previous studies dealing with the auditory comprehension of aphasic adults, however, this study

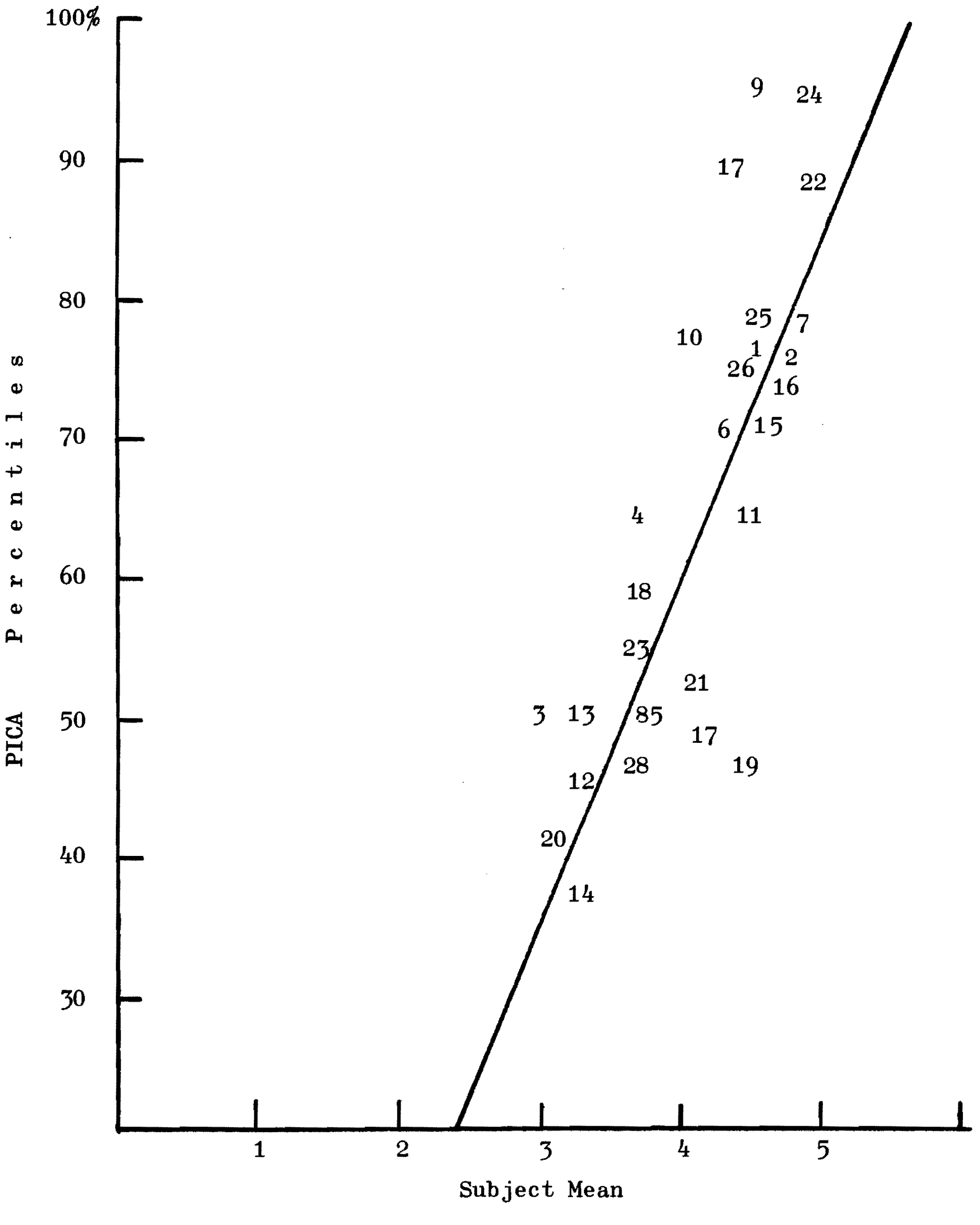


Figure 7. Regression line for aphasic subjects' grand means for the auditory tasks and overall PICA percentiles.

attempted to determine the degree of semantic associational strength (SAS) between words presented auditorily to aphasic patients. Results indicate that the stronger the semantic relationship between words the more adversely aphasics' comprehension will be affected. Aphasic subjects in this study (Figure 4) had substantially more difficulty selecting sequences of high SAS words than selecting sequences of moderate SAS and low SAS words and considerably more difficulty selecting sequences of moderate SAS words than sequences of low SAS words. It would appear therefore, as Schuell et al. (1961, 1965) and others (Luria, 1970) have suggested, that in aphasia the associational processes break down and this impairment adversely influences comprehensional ability. The fact that aphasic subjects in this study showed a decrease in comprehensional ability as relatedness (SAS) between word stimuli increased suggests that it may be possible to construct an associational hierarchy for aphasics and that a given patient's level of comprehension or ranking on this hierarchy may possibly be related to his overall level of linguistic functioning.

This study also differed methodologically from previous investigations in that an attempt was made to limit the vocabulary level of the words presented to the aphasic group. Schuell and Jenkins (1961) for example, presented subjects four pictures, "the stimulus word (chair)," "a phonetically similar word (stair)," "a semantically related word (table)," and "an unrelated word (apple)." Spinnler and Vignolo (1966) had aphasic subjects select one of four pictures associated with a sound presented auditorily and Pizzamiglio (1971) used as stimuli four words having a high degree of associational overlap from

Italian word association norms. This study used word stimuli (based on 50 normal individuals' two most frequently elicited associational responses) from the 3,000 most frequently used English words (Thorndike and Lorge, 1964). There is some reason to believe that it may be advantageous to control for vocabulary level when studying the influence of semantic association on aphasics' comprehension. First, it has been shown that aphasics retain and use words that are concrete, functional, and short (Wepman et al., 1956; Filby et al., 1963). At the same time, Keenan (1968) has pointed out that aphasics recognize words far more easily than they recall them. Inasmuch as most procedures used to assess aphasics' auditory comprehension are recognition type tasks it is probably important to increase the probability that the aphasic will recognize the words presented. If stimuli are not selected from a vocabulary that heightens the probability of the aphasic recognizing them then one cannot be sure if an impaired performance is related to lack of recognition or associational confusion. The difficulty exhibited by aphasic subjects of this study in comprehending the concrete noun words used as stimuli indicates, however, that associational processes probably suffer impairment at all levels of complexity in aphasia.

Several investigators have shown aphasics to be impaired in terms of verbal retention span (Filby et al., 1963; Schuell et al., 1965; Shewan and Cantor, 1971) and the fact that aphasic subjects in this study had substantially more difficulty retaining longer word sequences is not surprising. It is interesting however, (Figure 5) that aphasic subjects had almost as much difficulty retaining two word sequences as they did three word sequences. While subjects had little difficulty with one word sequences, there is reason to believe that increasing sequence length by one word is sufficient to markedly overtax the retentional ability of many aphasics. It is also possible that having the aphasic remember a sequence of words is more likely to identify a retentional problem than having him follow a direction, in that the latter task provides more redundancy than the former. Aphasic adults may in fact appear to retain more redundant messages quite well but display marked difficulty with non-redundant stimuli such as digits and word sequences. This has been shown in several studies using the Token Test (DeRenzi and Vignolo, 1962; Boller and Vignolo, 1966; Orgass and Poeck, 1966; Spellancy and Spreen, 1969). In these studies aphasics having no readily apparent comprehension problems for connected speech have exhibited performances which were markedly inferior to normal subjects on the minimally redundant Token Test.

An interaction hypothesis involving the SAS and sequence length factors would postulate that the greater the degree of SAS between words the more adversely would aphasics' retention be affected by an increase in message length. In this instance the amount of slope of each line connecting aphasic group means (Figure 6) for high, moderate, and low SAS stimuli at each sequence length is indicative of SAS effects as auditory load increases. To support an interaction hypothesis one would expect the most pronounced slope for the high SAS line and the least pronounced slope for the low SAS line, with the moderate SAS line falling in between. Figure 6 shows, however, the existence of a significant interaction between the SAS and length factors, primarily on the basis of subjects' performances on the moderate SAS two word sequences. This unfortunately negated the support for the interaction hypothesis reflected in the slopes of the high and low SAS lines.

The surprising performance of the aphasic group on the moderate SAS stimuli may have been due to the manner in which these stimuli were selected. Table II shows high, moderate, and low SAS stimuli selected on the basis of fifty normal individuals' word association responses. It can be seen that the two most frequent associational responses to stimulus words in the moderate SAS group occurred with almost equal frequency in many instances. Conversely, the two most frequent associational responses to words selected as high SAS stimuli illustrated a marked preference for one specific word. Luria (1972) has hypothesized that alteration in the aphasic's neurodynamic regulatory mechanism may result in an unselective organization of associations such that all possible associations have an equal probability of being selected. In other words, an incoming stimulus excites an associational matrix from which the individual must select a response. It seems reasonable that the more extensive this matrix the more difficult it will be for the aphasic to select an appropriate response. It is possible that this is what occurs with the moderate SAS stimuli in that more associational responses might be expected to occur to words like "shirt" and "bed" (moderate SAS) than words like "boy" and "bat" (high SAS) which seem to generate a limited number of words as associations.

Aphasics' performance on the three experimental tasks of this study was highly related to their overall communicative ability as assessed by the PICA. This finding is highly supportive of previous studies by Schuell et al. (1965) and Smith (1971) which suggest that a patient's comprehension deficit is a good indication of his overall language impairment. As can be seen in Table I, the aphasics in this study illustrated a wide range of communicative ability as reflected in their PICA percentiles. The fact that no aphasic subject had a grand mean (Figure 7) of more than 4.92, whereas all normal controls had a grand mean of 5.00 (no errors) indicates that impairment of the auditory processes is present even with the mildest forms of aphasia. This would seem to support the contention that aphasia is a language disturbance that is reflected in all language modalities (Schuell et al., 1965). It should also be pointed out that many of the subjects who had higher overall means for the three auditory tasks (Figure 7 - numbers 7, 16, 22, 24) displayed only mild aphasic characteristics but were primarily impaired in the ability to communicate because of a concomitant apraxia and/or dysarthria. This would again seem to confirm the point of view of Schuell et al. (1965) that aphasia is a language disturbance that may or may not be complicated by other sequalae of brain damage.

CHAPTER V

SUMMARY AND CLINICAL IMPLICATIONS

I. SUMMARY

The purpose of this study was to investigate the effects of semantic associational strength (SAS) upon adult aphasics' auditory comprehension abilities. Twenty-eight adult aphasics (25 males and 3 females) and 12 adult normal control subjects were presented three experimental tasks, each containing 45 items. Experimental task 1 contained single word picture sets of high SAS, moderate SAS, and low SAS words. Experimental task 2 contained two word picture sets of high, moderate, and low SAS words and experimental task 3 similarly contained three word picture sets of high, moderate, and low SAS words. Subjects heard one, two, and three word verbal sequences for experimental tasks 1, 2, and 3, respectively, and pointed to the appropriate picture sequence. Level of SAS was determined on the basis of the two most frequently occurring word associations of 50 normal individuals to 195 words from the most frequently occurring 3,000 English words (Thorndike and Lorge, 1964).

Similar to the findings of Schuell and Jenkins (1961) and Pizzamiglio (1971) results of this study suggest aphasics will confuse semantically related words. Results also suggest, however, that the higher the degree of word relatedness (SAS) the more adversely aphasics' comprehension will be influenced. In this study aphasics had substantially more difficulty auditorily selecting picture sequences of high SAS words than sequences of moderate and low SAS words and more difficulty selecting sequences of moderate SAS words than sequences of low SAS words.

Results of this study also parallel those of others (Filby et al., 1963; Schuell et al., 1965; Shewan and Cantor, 1971) who have clearly shown that as length is increased the more difficulty aphasics have retaining what they hear. Findings indicated that increasing sequence length by one word may be sufficient to markedly impair many aphasics' retentional abilities.

It was also hypothesized that degree of SAS would differentially affect aphasics comprehension as message length increased. While the SAS factor had relatively little influence on subjects' ability to retain low SAS stimuli and a rather profound influence on aphasics' retention of high SAS stimuli, subjects' performance on the moderate SAS two word sequences paralleled that for high SAS two word sequences. This resulted in a significant interaction between the SAS and length factors and negated the support for an interaction hypothesis.

The high positive correlation between the experimental task and PICA measurement of overall communicative ability strongly supports Smith's (1971) report that the severity of the patients' comprehension deficit reflects the overall language impairment. These findings further reinforce the notion of Schuell et al. (1965) that aphasia is a general language deficit with impairment reflected across all language modalities.

II. CLINICAL IMPLICATIONS

Clinically, the findings of this study seem to support the contention of Schuell et al. (1965) that the speech clinician working with aphasics employ a highly auditory treatment approach based on intensive, repetitive auditory stimulation. Results further imply that the aphasia clinician can manipulate word relatedness, verbal sequence length, and message redundancy of stimulus presentations to facilitate programming treatment that is commensurate with each patient's level of performance.

Use of the modified 0 - 5 point multidimensional scoring system provided results that described the nature of each subject's responses in considerable detail. If appropriate stimuli are being presented, more 5 (correct) and 4 (delayed) responses, rather than 3 (self-corrected) or 2 - 1 (stimulus repetition) responses should be elicited from the aphasic. Incorporation of this type of system would enable the clinician to distinguish the accuracy, responsiveness, and promptness of all responses and could be of value in programming treatment and evaluation of aphasic's level of performance.

REFERENCES

Barry, M. F., and Eisenson, J., Speech Correction: Principles and Methods. New York: Appleton-Century-Crofts, Inc. (1956).

Boller, F., and Green, E., Comprehension in severe aphasics. Cortex, 8, No. 4, 382-394 (1972).

Boller, F., and Vignolo, L. A., Latent sensory aphasic in hemisphere-damaged patients: an experimental study with the token test. Brain, 89, 815-830 (1966).

Brookshire, R. H., Differences in auditory processing deficits among aphasic patients. 1972 ASHA Convention, San Francisco, California (1972).

Carpenter, R. L., and Rutherford, D. R., Acoustic cue discrimination in adult aphasia. J. Speech Hearing Res., 16, No. 3, 534-544 (1973).

Cohen, J. G., and Edwards, A. E., Word length and discrimination behavior of aphasics. J. Speech Hearing Res., 7, 343-348 (1964).

Cramer, P., Word Association. New York and London: Academic Press (1968).

DeRenzi, E., and Vignolo, L. A., The token test: a sensitive test to detect receptive disturbances in aphasia. Brain, 85, 65-78 (1962).

Ebbin, J. B., and Edwards, A. E., Speech sound discrimination of aphasics when intersound interval is varied. J. Speech Hearing Res., 10, No. 1, 120-125 (1967).

Eisenson, J., Examining for Aphasia. New York: The Psychological Corp. (1954).

Filby, Y., Edwards, A. E., and Seacat, G. F., Word length, frequency and similarity in discrimination behavior of aphasics. J. Speech Hearing Res., 6, No. 3, 255-263 (1963).

Geschwind, N., The language of the brain. Scientific Amer., 226, 76-83 (1972).

Keenan, J. S., The nature of receptive and expressive impairments in aphasia. J. Speech Hearing Dis., 33, No. 1, 20-25 (1968).

Luria, A. R., Brain disorders and language analysis. Language and Speech, 1, 14-34 (1958).

Luria, A. R., Traumatic Aphasia: Its Syndromes, Psychology and Treatment. Mauton: The Hauge Press (1970).

Luria, A. R., Aphasia reconsidered. Cortex, 8, 34-40 (1972).

McMahon, L., Grammatical analysis as part of understanding a sentence. Unpublished Ph. D. Dissertation, Harvard University (1963).

Nichols, J. L., Effects of three aspects of sentence structure on immediate recall. Speech Monographs, 32, 164-168 (1965).

Orgass, B., and Poeck, K., Clinical validation of a new test for aphasia: an experimental study on the token test. Cortex, 2, 222-243 (1966).

Osgood, C. E., and Murray, M., Approaches to the Study of Aphasia. Urbana: University of Illinois Press (1963).

Parisi, P., and Pizzamiglio, L., Syntactic comprehension in aphasia. Cortex, 6, 204-215 (1970).

Perry, P., and Boswell, N., The use of local norms in the study of adult aphasic vocabulary comprehension. 1971 ASHA Convention, Chicago, Illinois (1971).

Pizzamiglio, L., Semantic comprehension in aphasia. J. Commun. Dis., 3, 280-288 (1971).

Porch, B. E., Porch Index of Communicative Ability: Administration, Scoring, and Interpretation. Palo Alto, California: Consulting Psychologists Press (1967).

Porch, B. E., Multidimensional scoring in aphasia testing. J. Speech Hearing Res., 14, No. 4, 776-792 (1971).

Rinnert, C., and Whitaker, A. W., Semantic confusions by aphasic patients. Cortex, 9, No. 1, 56-81 (1973).

Savin, H. B., Word frequency effect and errors in the perception of speech. J. Acoustic Soc. Amer., 35, 200-206 (1963).

Schuell, H. M., Auditory impairment in aphasia: significance and retraining techniques. J. Speech Hearing Dis., 18, 14-21 (1953).

Schuell, H. M., and Jenkins, J. J., Reduction of vocabulary in aphasia. Brain, 84, 243-261 (1961).

Schuell, H. M., Jenkins, J. J., and Carroll, J. B., A factor analysis of the Minnesota test for differential diagnosis of aphasia. J. Speech Hearing Res., 5, 349-369 (1962).

Schuell, H. M., Jenkins, J. J., and Jinenex-Pabon, E., Aphasia in Adults: Diagnosis, Prognosis and Treatment. New York and London: Hoeber Medical Division, Harper and Row, Pub. (1965).

Schuell, H. M., Jenkins, J. J., and Landis, L., Relationship between auditory comprehension and word frequency in aphasics. J. Speech Hearing Res., 4, 30-36 (1961).

Sefer, J., and Henrikson, E. H., The relationship between word association and grammatical class in aphasia. J. Speech Hearing Res., 9, No. 4, 529-541 (1966).

Shewan, C., and Cantor, G., Effects of vocabulary, syntax and sentence length on auditory comprehension in aphasic patients. Cortex, 7, 209-226 (1971).

Smith, A., Objective indices of severity of chronic aphasia in stroke patients. J. Speech Hearing Dis., 37, 155-176 (1971).

Spellacy, F. J., and Spreen, O., A short form of the token test. Cortex, 5, 390-397 (1969).

Spinnler, J., and Vignolo, L. A., Impaired recognition of meaningful sounds in aphasia. Cortex, 2, 337-348 (1966).

Spreen, O., and Benton, A. L., Neurosensory Center Comprehensive Examination for Aphasia. University of Victoria: Neuropsychology Laboratory Department of Psychology (1969).

Swinney, D. A., and Taylor, Short-term memory recognition search in aphasics. J. Speech Hearing Res., 14, 578-588 (1971).

Taylor, M. L., The Functional Communication Profile Manual of Directions. New York University Medical Center: Institute of Rehabilitation Medicine (1969).

Thorndike, E. L., and Lorge, The Teacher's Word Book of 30,000 Words. New York: Columbia Press (1964).

Tikofsky, R. S., Two studies of verbal learning by adult aphasics. Cortex, 7, 106-125 (1971).

Van Riper, C., Speech Correction: Principles and Methods. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. (1963).

Vignolo, L. A., Evolution of aphasia and language rehabilitation: a retrospective exploratory study. Cortex, 1, 344-367 (1964).

von Stockert, T. R., Recognition of syntactic structure in aphasic patients. Cortex, 8, No. 3, 323-334 (1972).

Weisenburg, T. H., and McBride, K. E., Aphasia. New York: Commonwealth Fund (1935).

Wepman, J. M., Recovery from Aphasia. New York: The Ronald Press Co. (1951).

Wepman, J. M., and Jones, L. V., The Language Modalities Test for Aphasia. Chicago, Illinois: Education Industry Service (1961).

Wepman, J. M., Jones, L. V., Bock, R. D., and Van Pelt, D., Studies in aphasia: background and theoretical formulations. J. Speech Hearing Dis., 25, 323-332 (1960).

Wepman, J. M., Jones, L. V., Van Pelt, D., and Bock, D. R., Psycholinguistic study of aphasia: a revision of the concept of anomia. J. Speech Hearing Dis., 21, No. 4, 468-477 (1956).

Wiig, E. H., and Globus, D., Aphasic word identification as a function of logical relationship and association strength. J. Speech Hearing Res., 14, No. 1, 195-204 (1971).

APPENDICES

APPENDIX A

ASSOCIATION TASK GIVEN TO 50 NORMAL ADULTS

1. airplane
2. clock
3. hand
4. apple
5. clothes
6. heart
7. arm
8. coal
9. hill
10. baby
11. coat
12. house
13. bag
14. corn
15. horse
16. ball
17. cow
18. ice
19. bank
20. cup
21. iron
22. bear
23. dress
24. island
25. bed
26. car
27. letter
28. bee
29. egg
30. king
31. bell
32. eye
33. milk
34. bird
35. face
36. money
37. boat
38. farm
39. moon
40. bone
41. book
42. foot
43. man
44. box
45. fence
46. mountain
47. boy
48. finger
49. mouth
50. branch
51. floor
52. neck
53. bread
54. flower
55. nest
56. cake
57. gate
58. nose
59. can
60. girl
61. pajama
62. cap
63. glass
64. paper
65. chain
66. grain
67. pen
68. chair
69. grass
70. picture
71. church
72. hair
73. plant
74. queen
75. rock
76. ship
77. tail
78. water
79. rose
80. knife
81. rain
82. shoe
83. teacher
84. window
85. ring
86. school
87. sky
88. tongue
89. wing
90. river
91. seed
92. star
93. train
94. woman
95. road
96. sheep
97. sugar
98. tree
99. wood
100. pencil
101. angel
102. stair
103. barn
104. stamp
105. card
106. wagon
107. chicken
108. belt
109. coffee
110. button
111. dish
112. candle
113. feather
114. chimney
115. flag
116. doll
117. fox
118. drum
119. goat
120. duck

121. gun
122. goose
123. fork
124. key
125. eagle
126. glove
127. needle
128. lamp
129. mouse
130. nail
131. penny
132. nut
133. purse
134. orange
135. rabbit
136. pie
137. shirt
138. pig
139. spoon
140. pin
141. swing
142. pipe
143. tooth
144. plate
145. ribbon
146. potato
147. robe
148. frog
149. hat
150. jar
151. bus
152. kettle
153. ant
154. ladder
155. apron
156. pea
157. arrow
158. peach
159. pear
160. pillow
161. comb
162. rug
163. bandage
164. balloon
165. toe
166. bat
167. turkey
168. bike
169. vest
170. cage
171. witch
172. cane
173. barrel
174. carrot
175. bubble
176. cart
177. fish
178. dart
179. crown
180. deer
181. fan
182. ink
183. insect
184. plow
185. oven
186. pail
187. soap
188. wreath
189. door
190. desk
191. sucker
192. pitcher
193. sink
194. table
195. brush

APPENDIX B

STIMULUS ORDER FOR EXPERIMENTAL TASK 1

Card Top		Card Middle	Card Bottom
1.	bat	glove	ball*
2.	star	king*	boat
3.	fork	knife*	spoon
4.	glove*	ball	bat
5.	shoe*	moon	glass
6.	ball	glove	bat*
7.	spoon*	knife	fork
8.	pen*	hat	egg
9.	chair*	table	desk
10.	dog*	cup	book
11.	truck	bus*	car
12.	girl	man*	boy
13.	cow	brush	tree*
14.	moon	glass*	shoe
15.	door	window*	house
16.	egg	pen	hat*
17.	moon*	shoe	glass
18.	tie	pants*	shirt
19.	toe	foot*	finger
20.	man	girl*	boy
21.	orange	pear	apple*
22.	man	boy*	girl
23.	tie*	shirt	pants
24.	car*	truck	bus
25.	toe*	finger	foot
26.	knife	spoon	fork*
27.	window	door	house*
28.	pillow*	bed	blanket
29.	hat	egg*	pen
30.	bus	truck*	car
31.	orange*	apple	pear
32.	house	door*	window
33.	table*	desk	chair
34.	king	star	boat*
35.	book	cup*	dog
36.	cow*	tree	brush
37.	foot	toe	finger*
38.	table	chair	desk*
39.	tree	cow	brush*
40.	pillow	blanket	bed*

41. king	boat	star*
42. cup	book*	dog
43. blanket*	pillow	bed
44. pants	tie	shirt*
45. apple	orange	pear*

*Presented as Stimulus

APPENDIX C

STIMULUS ORDER FOR EXPERIMENTAL TASK 2

	Card Top	Card Middle	Card Bottom
1.	cow tree	brush cow*	tree brush
2.	bus truck*	car bus	truck car
3.	boat king	star boat*	king star
4.	tree brush	cow tree	cow brush*
5.	egg hat	egg pen*	pen egg
6.	truck car	car bus	car truck*
7.	table chair	desk chair*	chair desk
8.	hat pen*	pen egg	egg hat
9.	moon shoe*	shoe glass	glass moon
10.	glove bat	bat ball*	ball glove
11.	cup book	cup dog*	dog book
12.	shirt pants*	tie shirt	pants tie
13.	glass moon	glass shoe*	moon glass
14.	boy man	girl boy*	man girl
15.	chair desk*	desk table	table chair
16.	hat egg	egg pen	pen hat*
17.	door window*	house door	window house
18.	glass shoe	moon glass	shoe moon*
19.	toe finger	toe foot*	foot finger
20.	tree brush*	tree cow	cow brush
21.	foot toe*	finger toe	toe finger
22.	blanket bed	bed pillow	pillow bed*
23.	bat ball	ball glove	glove bat*
24.	boy man*	man boy	boy girl
25.	car bus	truck car*	bus truck
26.	book cup*	book dog	cup book
27.	pillow bed	blanket bed*	bed blanket
28.	window door	house window*	house door
29.	ball bat*	ball glove	bat ball
30.	bed blanket*	pillow bed	blanket pillow
31.	cup dog	book cup	dog book*
32.	toe foot	foot finger	finger toe*
33.	spoon knife	knife fork	fork spoon*
34.	orange apple	pear apple*	apple pear
35.	desk table	table chair	table desk*
36.	tie shirt	shirt pants	tie pants*
37.	pear orange	orange apple	apple pear*
38.	boat star*	boat king	king star
39.	tie shirt	pants tie*	pants shirt
40.	house window	door window	window door*

41.	star king	boat star	king boat*
42.	fork knife	spoon fork*	knife fork
43.	orange apple*	orange pear	pear apple
44.	girl boy	man girl	man boy*
45.	knife fork*	spoon knife	fork knife

*Presented as Stimulus

APPENDIX D

STIMULUS ORDER FOR EXPERIMENTAL TASK 3

	Card Top	Card Middle	Card Bottom
1.	king star boat	boat king star*	star boat king
2.	tree cow brush*	cow tree brush	brush cow tree
3.	man girl boy	boy girl man	girl boy man*
4.	ball bat glove	glove ball bat*	glove bat ball
5.	car bus truck*	car truck bus	bus car truck
6.	tie shirt pants*	pants tie shirt	tie pants shirt
7.	pillow bed blanket*	blanket bed pillow	bed blanket pillow
8.	book dog cup	book cup dog*	cup dog book
9.	desk chair table	table chair desk*	chair table desk
10.	star boat king*	boat star king	king star boat
11.	book cup dog	dog cup book	cup book dog*
12.	bus car truck	car bus truck	bus truck car*
13.	pillow bed blanket	blanket bed pillow	blanket bed pillow*
14.	spoon knife fork	knife fork spoon	spoon fork knife*
15.	moon shoe glass	moon glass shoe*	shoe moon glass
16.	orange pear apple*	pear apple orange	apple orange pear
17.	man girl boy	man boy girl*	boy girl man
18.	window house door	door house window	door window house*
19.	tree cow brush	cow tree brush	brush tree cow*
20.	chair table desk	table desk chair	desk chair table*
21.	toe foot finger*	finger toe foot	foot toe finger
22.	knife spoon fork	fork knife spoon*	spoon knife fork
23.	pen egg hat	hat pen egg	egg pen hat*
24.	pants tie shirt	shirt pants tie	pants shirt tie*
25.	door window house	window door house*	house window door
26.	orange apple pear	apple orange pear	pear orange apple*
27.	house door window*	door window house	window door house
28.	king boat star	boat king star	king star boat*
29.	glove ball bat	bat ball glove	ball glove bat*
30.	pen hat egg	pen egg hat*	egg pen hat
31.	finger foot toe	finger toe foot*	toe foot finger
32.	pillow blanket bed	bed pillow blanket*	blanket pillow bed
33.	apple orange pear	apple pear orange*	pear orange apple
34.	dog cup book*	book dog cup	cup dog book
35.	hat egg pen*	egg hat pen	hat pen egg
36.	chair desk table*	desk table chair	chair table desk
37.	knife fork spoon*	fork spoon knife	spoon fork knife
38.	tie pants shirt	shirt pants tie*	pants shirt tie
39.	bus truck car	truck bus car*	car truck bus
40.	bat ball glove*	glove bat ball	ball glove bat

41.	foot toe finger	toe finger foot	foot finger toe*
42.	girl boy man*	girl man boy	boy girl man
43.	moon shoe glass	glass shoe moon	glass moon shoe*
44.	cow tree brush	cow brush tree*	brush tree cow
45.	shoe glass moon*	moon shoe glass	glass moon shoe

*Presented as Stimulus