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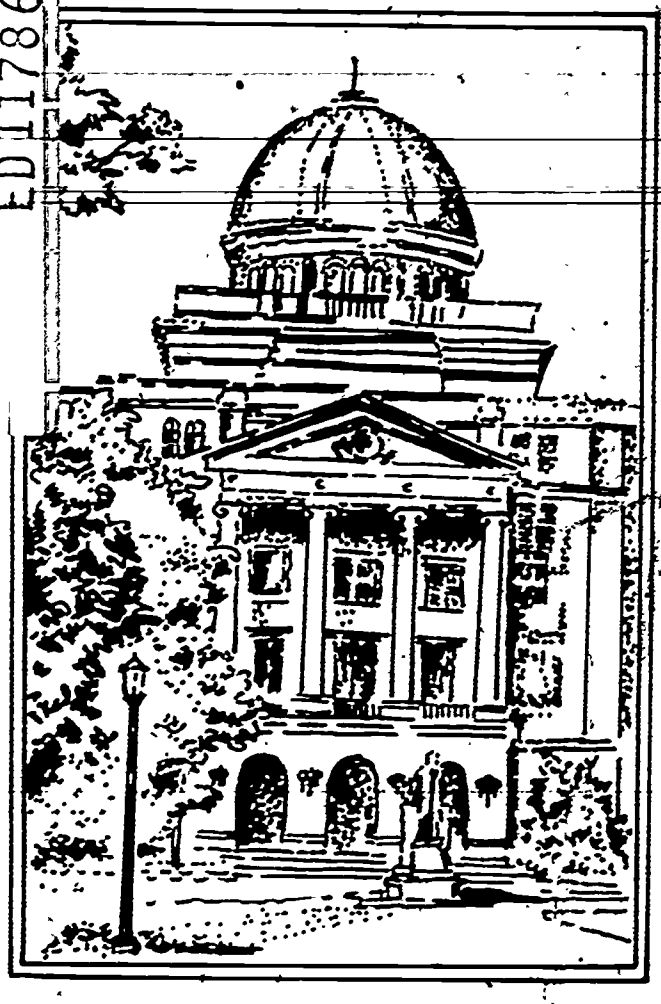
ABSTRACT

Volume 1 of the final report of Project FAST consists of reports on 13 experiments concerning: (1) the application of associative learning strategies to the development of a basic sight vocabulary among mentally retarded children and adults, and (2) the development of text reduction techniques designed to facilitate comprehension and recall of written materials among visually handicapped and hearing impaired subjects. Six experiments with educable and trainable mentally retarded children cover topics such as the application of associative strategies to word recognition, the effect of reinforcement on word knowledge, the effect of pictorial stimuli on word recognition, and the effects of animation on word memory. Seven studies investigate such topics as the effect of a subjective deletion scheme on reading performance of Braille and regular print readers, the application of a subjective deletion scheme to film captioning for the deaf, and a comparison of two deletion schemes on three types of prose among blind and deaf students. Major conclusions reported are that learning and retention in word recognition tasks can be facilitated by the use of associative learning strategies; and that telegraphic prose is a viable alternative to traditional educational materials for the blind, but results were not as favorable with the deaf. (LS)

volume I



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PROJECT F.A.S.T.

(FACILITATING ACADEMIC STUDY TECHNIQUES

FOR HANDICAPPED CHILDREN)

2

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education
National Institute of Education

Final Report

Project No. 232479
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(FACILITATING ACADEMIC STUDY TECHNIQUES FOR HANDICAPPED CHILDREN)

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The research reported herein was performed pursuant to a contract with the National Institute of Education, Department of Health, Education, and Welfare. The opinions expressed herein, however, do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement by the National Institute of Education should be inferred.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
National Institute of Education

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The one person who has contributed most to this project has been Ms. Beth Scott, the project secretary. Her devotion, hard work, and exceptional ability has provided the continuity which was essential to a project of this magnitude. Special acknowledgment should be given to Dr. Carolyn Bassin, Dr. Ta-Lin Liau, and Mr. Dennis Seal for their diligent and scholarly contributions. Others who have contributed to this project have been: Ms. Carol Sheffield, Mr. Andrew Chitwood, Mr. Ron Martin, Mr. Charles Pantalion, Mr. Sam Bays, Dr. Tudy Rhone, Ms. Ruth Ann Powell, Ms. Peggy Hope, and Mr. Lou Loutrel.

I would finally like to acknowledge the very special encouragement and hope provided by my wife, Barbara. Her confidence in me and the concepts embodied in this research has had a profound influence.

C.J.M.

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CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

STRATEGY PHASE

This phase of the project was concerned with the application of associative learning strategies to the development of a basic sight vocabulary among mentally retarded children and adults. Martin (1967) demonstrated that associative learning could be facilitated among retarded children if they were taught to use efficient memory strategies. Although this research was based upon paired-associate (PA) methodology, learning to recognize new words among beginning readers is similar to PA learning and thus may be facilitated in much the same fashion as PA learning. More specifically, when children begin to read, they are often presented words one at a time and are expected to memorize them so that when the words are encountered again they will be recognized and recalled. This look-and-say learning of whole words involves forming an association between a printed stimulus term (word) and an oral response term (saying the word).

Psychological research investigating the functional value of memory devices has been renewed within the past decade. Those studies which have examined the various strategies that one might use in a learning situation have been mostly of the PA type. In PA experiments it is the subject's task to learn an association between two verbal units, commonly referred to as the stimulus (S) and response (R) items. Attention has particularly been directed at isolating the associative mechanisms of the stimulus-response (S-R) pairs which contribute to the retrieval of the R-item when the S-item is presented alone.

Noble's (1952) measure of meaningfulness (m) is perhaps the most frequently used association index at the present time. Noble's operational definition of the meaningfulness of a word was specified as the average number of continuous written associations given to the item in a standard time period (in his original study, one minute) by a group of subjects. Other measures that have been investigated and appear to be related to association value have been objective frequency, familiarity or subjective frequency, and pronunciability (Hall, 1971). Objective frequency has been defined as the number of times that a given verbal item appears in printed material or in the subject's oral repertoire. Hall (1971) assumed that objective frequency reflects the experience each subject has had with the material. The Thorndike-Lorge (1944) frequency count presents frequency values for common English words.

Noble (1953) defined familiarity as a "stimulus attribute which is some increasing function of the frequency of occurrence of a given stimulus." Noble's measurement operation consisted of asking subjects

how often they had come in contact with certain words. This measure could also be described as a subjective frequency measure.

The experimental work of Underwood and Schulz (1960) has provided strong support for the position that pronunciability represents an important attribute of verbal material. Underwood and Schulz measured the pronunciability of verbal items by presenting subjects with various three-letter combinations. Subjects rated each combination as to its relative ease or difficulty of pronunciation.

Experimental evidence suggests that performance during a PA learning task can be facilitated by proper manipulation of the various word characteristics. Carroll (1964) has suggested that the understandability of text material is directly related to the same verbal characteristics. That is, when a reader faces an unfamiliar word possessing one or more of the above verbal properties (e.g., meaningfulness-familiarity) he will begin to search for the different associative cues available and select that one which will most readily elicit recognition.

Although many characteristics of verbal items have been identified, it is still unclear how the reader (and experimental subject) forms associative cues for learning new words. It was assumed that those strategies which an experimental subject constructs during a PA task are of the same nature as those used during the reading of an unfamiliar passage.

An additional set of measures, more currently reviewed in relation to associative learning and memory, is related to the ease with which a word can arouse an image. These measures include imagery, concreteness, vividness and specificity (Paivio, 1971). The latter three measures share a common core of meaning in that all refer to objects, material or sources of sensation that are relatively direct to sense experience. The terms "image" and "imagery," however, require further qualification.

The concept of imagery has had two theoretical functions in relation to learning and memory (Paivio, 1970). In the context of the ancient wax tablet model of memory, the image was the equivalent of the memory trace. This theory, as expressed by Plato (Gomulicki, 1953), stated that perceptions and thoughts are impressed on the mind as on a block of wax, to be remembered and known as long as the image lasts (Paivio, 1971). The second and related theoretical view was that of the image as an associative mediator. This conception can be traced back approximately 2500 years to a mnemonic system originated by a Greek poet, Simonides, and which has come down to us through Latin teachers of rhetoric (Yates, 1966). The technique involved a system of well-ordered memory places, or loci, such as the walls and rooms of a familiar house, which were committed to memory. The ideas that one wanted to remember, such as the main points of a speech, were symbolized as images of objects, and were visualized in the various locations. From there they were to be

retrieved by mentally retracing the places in their natural order, and these place images, in turn, called to the mind the images located there, or so it was suggested (Paivio, 1970).

Paivio (1968) defined imagery as a word's capacity to arouse nonverbal images. Specifically, Paivio (1971) referred to concrete imagery as nonverbal memory representations of concrete objects and events, or nonverbal modes of thought (i.e., imagination) in which such representations are actively generated and manipulated by the individual. The operational definition of imagery in Paivio's research was the mean of subject's ratings, on a seven-point scale, of the ease with which a word arouses sensory images. For example, Paivio's subjects rated the word "horse" as having high imagery content (mean scale value = 6.80) while the word "inanity" received low imagery ratings (mean scale value = 1.83).

Numerous studies have indicated reasonably high correlations among many of the aforementioned verbal attributes. The correlation between imagery and dichotomous abstractness-concreteness was found to be .77 (r) for a sample of 152 nouns in one study (Paivio, et al., 1966). The correlation between imagery and seven-point concrete ratings for 96 nouns in another study was .88 (r) (Paivio, in press). The r's between imagery and meaningfulness for the two samples were .59 and .78.

Factor analytic studies have been conducted in an effort to reduce the number of word attributes to clearly independent measures. In one study by Frincke (1968), 70 English nouns were randomly selected from 1791 nouns comprising a source list prepared by Gorman (1961) in her examination of concreteness. Gorman's list included all noncapitalized nouns in the Thorndike-Lorge word count with G-count frequencies of seven or more occurrences per million words. Frincke examined the following attributes of these nouns: (1) Noble's (m), (2) rated meaningfulness (m'), (3) imagery, (4) concreteness, (5) Thorndike-Lorge frequency count, and (6) familiarity or subjective frequency. A free-recall score was obtained by providing seven trials during which each word was presented for 2.6 seconds. Following each trial, a 50-second interval was provided. At the end of the seventh trial, the subjects were given 10 minutes to write down all of the words they could remember. The free-recall score for each word was obtained by counting the number of subjects recalling that word.

Factor analysis of the free-recall scores and the varying word attributes revealed two common factors. One was tentatively identified as meaningfulness-familiarity, since rated meaningfulness and familiarity loaded highly on it while moderate loadings of Noble's (m) and the Thorndike-Lorge frequency count were also found. The second factor was classified as imagery-concreteness, since imagery had a very high loading on this factor (Frincke, 1968).

A second factor analytic study by Paivio (1968) has provided somewhat more complex, but parallel findings. Thirty different

measures were obtained from each of 96 nouns comprising his experimental population of words. Although it is not possible to detail all of the measures that were obtained, it did include PA and free-recall learning scores, Thorndike-Lorge frequency count, meaningfulness, and ratings on such scales as the ease of imagery, familiarity, abstractness-concreteness, etc. The corpus of words were not randomly selected but had been used in an earlier study (Paivio, 1966), in which 48 words were classified as "concrete" and 48 as "abstract." A variety of subject populations were used to secure the varying measures.

Paivio's results, supporting Frincke's (1968) findings, indicated a concrete-imagery factor. High loadings were obtained from rating scale scores that measured both the vividness of images formed by each of the words and the difficulty with which such images were formed. Surprisingly, a second factor designated as specificity emerged. This factor had substantial loadings obtained from two rating scales that measured both specificity and preciseness. No meaningfulness-familiarity factor was obtained. Meaningfulness, as measured by Noble's (m) (1952), loaded substantially on the first factor, concreteness-imagery; familiarity or subjective frequency ratings loaded on a third factor that Paivio termed familiarity.

Both Paivio's (1968) and Frincke's (1968) factor analytic studies indicated there are two attributes of the isolated verbal item that are primarily related to learning, one of which Frincke calls imagery-concreteness. These results as well as those from other experiments (Lambert, 1955; Paivio, Yuille, & Madigan, 1968; Spree & Schulz, 1966), all share extensive implications regarding the functional significance of nonverbal imagery and verbal processes in associative meaning, mediation, and memory (Paivio, 1969). These studies, which have examined separate verbal items, subsequently established a foundation for Paivio's (1971) theoretical approach to verbal associative meaning in which mental images and words are regarded as major psychological reactions to objects and verbal items. Consequently, the study of imagery (more cautiously, the study of effects of inferred imagery) has once again become not only respectable in psychology, but also relatively popular (Reese, 1970).

A number of investigators recently modified the traditional PA learning paradigm in order to examine visual modes of representation. However, before reviewing these studies it is necessary to first analyze certain verbal mechanisms related to the concept of imagery, specifically, those which increase the associational value of the stimulus-response pairs.

One of the best established facts about PA learning is that it is easier when the stimulus and response items are meaningful words than when they are nonsense syllables. Kohler (1929) has explained this as resulting from the ease of forming visual images of interactions between meaningful PA's and the difficulty of forming such images for nonsense materials. The visual image, according to Kohler, "organizes" the material, in the Gestaltist sense of "organization,"

and organized material is easier to remember (Reese, 1970).

Research emanating from Paivio's laboratories has demonstrated that Kohler's explanation is tenable. Paivio (1968) presented evidence suggesting that the mediational function and arousal of imagery are theoretically coordinated to an abstract-concrete dimension of stimulus meaning, which he defines in terms of directness of sensory experience. Additional studies conducted in a PA learning situation have demonstrated that the higher the concreteness of stimulus items, the more likely they are to evoke sensory images that can function as mediators of associative learning and memory (Epstein , Rock, & Zuckerman, 1960; Paivio, 1965; Winnick & Kressel, 1965). This appears to be a logical argument since the stimulus member of a pair serves as a "conceptual peg" (a term first introduced, without reference to imagery, by Lambert and Paivio, 1956) to which its associate is hooked during learning trials when stimulus and response members are presented together, and from which the response member can be retrieved on recall trials when the stimulus is presented alone. Therefore, assuming that imagery can serve a mediating function, as the imagery technique suggests, it follows that the ease of learning the stimulus-response association will depend partly on the image-arousing capacity of the individual nouns and of the stimulus member in particular (Paivio, 1969). Paivio further stated that the imagery value of both the stimulus and response would contribute to the formation of a compound, consisting of images evoked by the individual items when the two are presented together, thereby affecting the formation of the mediated association. On the recall trials, however, when the stimulus is presented alone, its image-arousing value would be particularly important, for the stimulus member must serve as the cue that reinstitutes the compound image from which the response component can be retrieved and recoded as a word (Paivio, 1969). This hypothesis by Paivio led to the prediction that a positive effect of noun imagery would be greater on the stimulus, rather than on the response side of the PA items.

The above hypothesis was tested (Paivio, 1969) using 16 pairs of nouns, four of each possible combination of stimulus and response abstractness-concreteness. Paivio predicted that the ease of learning four stimulus-response combinations constructed from concrete and abstract nouns would be in the following order: concrete-concrete, concrete-abstract, abstract-concrete, and abstract-abstract, thus reflecting the greater potency of concreteness on the stimulus side. Paivio's results were exactly as predicted, with abstractness-concreteness of the stimulus members accounting for eight times the variance attributable to response concreteness.

The assumption by Paivio that concrete nouns exceed abstract nouns in their image-evoking value was also confirmed by ratings obtained from a different group of subjects. Stimulus imagery scores correlated more highly than response imagery scores with PA learning (Paivio, 1969).

Other investigations have been conducted in an effort to ascertain the process of individual associations. Thus, Bugelski (1962).categorized a variety of strategies employed by subjects in learning PA's. Martin, Boersma, and Cox (1965) similarly reported seven kinds of PA learning strategies. Runquist and Farley (1964) examined temporal factors in the use of mediators, and Runquist (1965) subsequently asked subjects to "make up some way of associating" two words when shown one pair at a time. Underwood and Keppel (1963) and Underwood and Erlebacher (1965) also examined the encoding processes employed by subjects.

In most of these studies, subjects reported using verbal mediators to learn PA's and that performance was facilitated by such mediation. However, the possibility that visual imagery may have played a mnemonic role in the formation of PA's and assisted in the mediational processes had been ignored (Bugelski, Kidd, & Segmen, 1968).

Epstein, Rock, and Zuckerman (1960) made an interesting attack on the possible function of imagery in PA learning by using pictures as stimuli. Miller, Galanter, and Pribram (1960), in discussing "plans for remembering," presented some anecdotal evidence for the efficacy of visual imagery in remembering object names by using a list of previously learned words. They provided a list of words that rhyme with the numerals 1 through 10 (bun, shoe, tree, door, hive, sticks, heaven, gate, wine, hen) and indicated that these words could function as a mnemonic device for learning any other 10 words in numerical order. Bugelski, et al. (1968) replicated this study and found that subjects using a mnemonic system were able to learn the ordinal position of 10 common words quite effectively in one learning trial.

Wallace, Turner, and Perkins (1957) have shown that the use of a mnemonic system results in superior recall. They presented pairs of English words to subjects and had them, working at their own pace, form a visual image between the two words. Only one trial was given for each pair. The subjects started with lists of 25 pairs and worked up to lists of 700 pairs. Recall of the response word, upon presentation of the stimulus word, was about 99% up to 500 pairs; at 700 pairs, recall dropped to about 95%.

Similar studies by Bower (1970) and Paivio (1969) have also shown that mental imagery is a beneficial aid. In learning word-word PA's, adult subjects instructed to make up mental pictures of interactions between the referents of the words, learned the associations much faster than almost any suitable control subjects (Bower, 1970).

A number of investigators have shown that pictures and words function differently as stimuli in learning tasks (Jenkins, Neale, & Deno, 1967). Herman, Broussard, and Todd (1951), using either pictures or words to represent the same common objects, demonstrated that pictures are learned faster than words in a serial anticipation

task. Deno (1965), Lumsdaine (1949), and Paivio and Yarmey (1966) found that when pictures were used as stimuli in a PA task, learning was faster than when words were the stimuli.

The above studies have been replicated, some with minor modifications, and yet the findings substantiate the explanatory and heuristic value of the imagery concept. However, a careful observation of the methodology employed in the above studies, reveals that imagery has a greater facilitating effect upon PA learning tasks specifically when testing under the following conditions: (1) when nouns of high concrete value are used as the associates (Dukes & Bastion, 1966); (2) when concrete nouns are placed on the stimulus rather than the response side of the pairs (Paivio, 1965; Paivio, Yuille, & Smythe, 1966; Yarmey & Paivio, 1965); (3) when factors such as familiarity and meaningfulness are controlled (Epstein, et al., 1960), especially when meaningfulness is on the response side (Paivio, 1969); and (4) when older children and adults are tested rather than younger children (Milgram, 1967; Reese, 1965; Rohwer, 1970).

Although imagery processes play a significant role in PA learning, the nonverbal model obviously has its limitations. There is ample reason to suspect that subjects engaged in PA learning do more than visually represent to themselves the items to be learned. It, therefore, seems logical to suggest that an additional mediating factor is operating which also contributes to the memorability of PA items. Post-experimental interview data from a variety of sources and populations strongly suggest that subjects recode or transform the materials presented, either by reducing the content, as in stimulus selection, or by elaborating the content, as in making a sentence out of a noun pair (Bugelski, 1962; Martin, et al., 1965; Runquist & Farley, 1964). These studies offer theoretical as well as practical implications regarding the relative efficacy of presenting both verbal and visual modes of presentation.

Paivio and Yuille (1967) compared the effectiveness of both mediators using a mixed list of noun pairs, half of which were concrete and high imagery, while the other half were abstract and low imagery. One group of subjects was instructed to associate the pairs using nonverbal images ("mental pictures"), another group was told to use verbal mediators (words or phrases), and a third group was told to learn the list by repeating the pairs to themselves. Subjects in each condition were presented four alternating study and recall trials. The statistical analysis of these data revealed that both mediation groups performed considerably better than the rote repetition control, and, as expected, concrete pairs were learned better than abstract pairs. More important, theoretically, was the finding that the imagery instructions were no more facilitating than the verbal instructions (Paivio & Yuille, 1967).

Wood (1967) also conducted a series of experiments in which he compared the effectiveness of both types of mediators. As found in the previous study, the effects of imaginal and verbal mediation instructions did not differ.

Reese (1965) has provided evidence that seeing a pictorial presentation of an interaction between paired stimulus and response elements, or hearing the interaction described, facilitated PA learning, and seeing and hearing the interaction are equally effective. Reese (1965) offered three interpretations for these consistent patterns of results. He suggested that: (1) either verbal context and visual imagery are equally effective; (2) subjects visualized the oral descriptions; or (3) subjects verbalized descriptions of the visual interactions. Reese seemed to favor his third interpretation. He clearly suggested that there is insufficient evidence to conclude that visual images are better mnemonics than meaningful verbal statements.

Results from the mediational studies have also suggested a developmental trend, in that pictures showing interactions of the pair members are as facilitative as sentences are for older children (Paivio, 1971). With younger children, however, verbalization tends to be superior to the picture compounds (Paivio, 1971). Contrary to expectation, children as young as four years apparently strengthen initially weak associations in PA learning more effectively by repeating a sentence than by gazing upon its equivalent pictorial form (Milgram, 1967). These data constitute a strong argument against the notion that subjects profit from verbal context by virtue of their spontaneously visualizing the scene to themselves. On the contrary, a stronger case can be made for the opposite notion that facilitation in a visual compound condition probably depends upon covert encoding of the pictured interaction in verbal form (Milgram, 1967).

Age trends have been interpreted in somewhat different ways. Dilley and Paivio (1968) and Paivio (1970) suggested that young children may be able to encode pictures in terms of visual imagery; but they have difficulty in decoding such images to yield the appropriate verbal response on the test trial (Paivio, 1971). The hypothesized difficulty, therefore, is in the transformation from visual imagery to a verbal mediating process during retrieval. It appears that pictures are easier to remember than words but only when the verbal labels are constructed into a meaningful sentence form (Epstein, et al., 1960).

Rohwer (1968) has provided an interesting developmental corollary. Assume that at early age levels there is an incapacity for storing visual information simultaneously with verbal information. Also, assume that the capacity for simultaneous storage increases as a function of age; that is, assume that the advantage of picture over word stimuli is contingent upon the subject's ability and propensity for representing in storage both the image evoked by the picture and an appropriate verbal label for it. The developmental prediction that follows from this interpretation is that the superiority of picture to word stimuli will increase with age (Rohwer, 1968).

This hypothesis was tested and supported in a PA learning situation cited by Rohwer (1970). He presented kindergarten, first grade, and third grade children the following items: (a) word pairs (pairs

of nouns presented aurally while the television screen displayed a textured gray picture); (b) picture pairs (television screen presenting two objects in each pair without audio signal); and (c) combined pairs (television screen displaying a picture of two objects while the noun names of them were presented aurally). Learning was measured in terms of the mean numbers of correct responses made per trial over the two test trials administered. The analysis of results clearly indicated that the superiority of the picture pairs over the word pairs increased with each grade level. Also confirming the prediction was the difference between the combined item types and the picture item types which diminished as a function of the grade level.

In summary of the developmental interpretations and in reference to the imagery data reviewed earlier, it appears that pictures evoke images at all age levels. However, the ability to profit from the stored images, especially at the younger age levels, is contingent upon the subject's ability to store an "appropriate" verbal representation of the object along with its image (Rohwer, 1970).

Elkind (1964) reviewed evidence that supports the suggestion that young children do not "read" pictures: "When young children are shown a picture depicting a social situation, they merely enumerate the elements and say, 'a man, a dog, a house,' etc." Hence, the picture as a whole arouses no meaning, and can produce no facilitation. Supplying the child with a sentence, however, arouses the requisite imagery because the salient elements and their interaction are all explicitly named and therefore attended to by the subject (Reese, 1970).

The above literature clearly reveals the presence of some rather potent variables operating in the memorization of verbal and pictorial associations. This literature shows that the meaningfulness and the imagery provoking capability of the material greatly affect the ease of learning verbal associations. The general goal of this phase of the research was concerned with the possibility of facilitating word recognition learning among retarded children and adults by manipulating some of the same variables in word recognition tasks as have been manipulated in PA tasks. It was assumed that retarded individuals possess some deficit in their ability to store new words in memory and that the process involved in word recognition is similar to the process involved in PA learning.

The specific objectives of this phase of the project were:

1) To develop a cue word search routine designed to analyze words in terms of high-frequency occurring embedded words. This program will also have the capability of plotting distributional probabilities of the embedded cue words.

2) To develop training techniques designed to teach the mentally retarded the concept of word recognition learning strategies. This objective has as its goal teaching retarded children to search for and use cue words which may assist them in storing the criterion words in memory.

3) To develop several different techniques designed to teach educable retarded children the concept of associative learning strategies as applied to word recognition tasks. This objective has as its goal experimental assessment of different strategy training conditions in order to specify those conditions which are most effective in teaching EMR subjects the concept of learning strategies.

4) To determine the extent to which the strategy training techniques transfer to other basic sight vocabulary words and to determine the extent of transfer to the identification of the criterion words in sentence contexts.

5) To develop a prototype instructional film which incorporates the concept of associative mnemonics in order to achieve a self-instructional capability for teaching educable retarded children a basic sight vocabulary.

CHAPTER II

EXPERIMENT I -- APPLICATION OF ASSOCIATIVE STRATEGIES TO WORD RECOGNITION LEARNING AMONG EDUCABLE MENTALLY RETARDED CHILDREN

Introduction

The purpose of this study is to test the effectiveness of experimenter-supplied (E-S) strategies in word recognition learning among educable mentally retarded (EMR) children. Martin (1967) has examined various aspects of associative strategies in the learning of paired-associate (PA) lists using an EMR population. In a series of experiments, the subject's task involved the learning of an association between two verbal units. One of the terms typically was an unfamiliar verbal unit (S-term) while the other term was a familiar word (R-term). When a number of these S-R pairs were presented to a subject in a learning session, a number of trials were required to form the correct associations. On the basis of the results obtained in the Martin (1967) experiments, it appeared that much of the learning occurred as a result of transfer of learning. This seemed especially true in the case of the higher level strategies. The learning which occurred as a result of employing these strategies appeared to be due to the transfer or use of associations which had already been formed in the past. On the other hand, the lower level strategies appeared to involve little, if any, previous learning.

The effectiveness of the high level strategies may be described in the following manner: Given the pair NEGLAN-LEADER, the subject must develop an association between these two verbal units. Rather than attempting to form a completely new association between these two units, the subject attempts to make use of previously established associations. During the early learning trials, he appears to be searching for some type of cue in the S-term which assists in the recall of the R-term. In the process of searching for such a cue, the subject may try recoding the unfamiliar S-term in several different ways. Because such recoding does not necessarily assist in making the association, new attempts at recoding are continued. Finally, the subject recodes the S-term in such a manner that a previously learned association can be employed. For example, the subject may recode the S-term (NEGLAN) to NEGRO. Since an association already exists between NEGRO-LEADER, the NEGLAN-LEADER association is mediated by the word NEGRO.

The beneficial effect of experimenter-supplied strategies in the Martin (1967) experiments was due primarily to two major factors. One factor involved the nature of the supplied strategy. For most subjects, the strategy which had been provided was one which permitted the subject to recode the S-term in such a manner that a previously learned association could be employed. The second factor was related to the time at which the strategy was provided. The strategies were supplied on the first two or three learning trials. This eliminated unsuccessful recoding attempts in the early trials.

While a great deal of learning involves the formation of new associations, the exact nature of the association may vary from task to task or from material to material. A somewhat different type of association is involved in learning to recognize a new word. For the mature reader, word recognition occurs very rapidly and creates little imposition upon memory. However, this is usually not the case for the young child. Oftentimes a number of repetitions are required before the child can finally read the word when it is presented. The association which is being developed in this situation is between a printed S-term and an oral R-term. Although little experimental evidence is available concerning the strategies which children employ in learning such associations, the fact that various types of cues are employed is undeniable.

Carroll's (1964) description of the process involved in word recognition appears to be very similar to the process involved in paired-associate (PA) learning. He states,

> When the beginning reader meets a word with which he is unfamiliar, that is, one that he cannot recognize instantly, the process of word recognition may be regarded as a case of problem-solving. Various cues are available to him; sometimes certain cues will very quickly allow him to arrive at a proper reconstruction of a word; at other times, cues must be used to suggest a series of possibilities. In this case, the learner must essentially go into a "search-routine," testing out each one of the possibilities until a satisfactory one is found. The case will vary, of course, depending upon whether the spoken word and its meaning happen to be in the child's speech repertoire. It will also vary depending upon what kind of information is available to allow the child to confirm his guess-whether, for example, there is sufficient context to test the correctness of a guess.

One of the first problems posed in the initial planning of this experiment was concerned with the manner in which associative strategies could be supplied in a word recognition task. It was assumed that since an association was being learned in both the PA and word recognition tasks, the same basic problem confronted the subject. That is, in order to make a correct response in the word recognition task, the visual presentation of the printed word must elicit the correct oral response (saying the word). The situation is quite similar in the PA task; in order to make a correct response on the test trial, the S-term must elicit the R-term. One of the beneficial effects of experimenter-supplied strategies was the fact that the strategy incorporated an element of the S-term and also incorporated the R-term. For example, the subject is presented the pair, ZUMAP-VILLAGE, and is provided the strategy, "map of the village," then, upon presentation of the S-term on the test trial, the embedded word, MAP, serves to elicit the strategy and hence the correct response.

A comparable situation was devised with a criterion list of eight words. On the learning trials, the eight words were presented visually while the experimenter pronounced each word. The test trial consisted of presenting the same words, but on this trial, the experimenter did not pronounce them and the subject was required to say the word if he remembered it. For the strategy group, it was first necessary to establish a cue in the criterion word upon which the E-S strategy could be based. This was achieved by selecting only criterion words that contained small embedded words which the subject already could read or be easily trained to read.

The above conditions made it possible to supply subjects with associative strategies. For example, in learning to recognize the word, BRACELET, pre-training on a cue word such as LET permitted the possibility of supplying the subject with a strategy. During the learning trials, subjects receiving strategy training were instructed that they could use the little word LET to learn the larger word BRACELET by remembering, "Let me have the bracelet." It was assumed that, on the test trials, the cue words and the E-S strategies would facilitate immediate recall of the criterion word.

Four treatment groups were formed on the basis of the kind of training they received with respect to either cue word and/or strategy utilization. The following hypotheses were tested in this experiment:

1) A Syntactical strategy condition will result in significantly better performance than any other condition.

2) A Word Formation condition involving cue word training will result in significantly better performance than either a repetition condition involving no cue word training or a control condition which is given no special training of any kind.

3) The Syntactical, Word Formation, and Repetition groups will perform significantly better than the Control condition.

Method

Selection of Cue and Criterion Words

A computer program was developed to aid in the selection of cue and criterion words. These words were subsequently used in all experiments. The objective of the computer search program was two-fold:

1) To list all small (cue) words which are embedded in a corpus of approximately 8,000 larger (criterion) words, and
2) To obtain cue/criterion word combinations which have similar letter properties.

The program was written in the Fortran IVG computer language and execution was performed on an IBM 360/65 computer. The resulting printout listed in alphabetical order all two, three, and four letter words (cue words) which were embedded in words of five letters or more (criterion words). The 80 cue words most frequently found in the criterion words are given in Table 2.1.

The next task was to pre-test 87 subjects, 45 males and 42 females, on these 80 cue words in order to determine the most frequently recognized words. The subjects were residents of the Texas State School for the Mentally Retarded in Mexia, Texas, and were all enrolled in the EMR program.

All 87 subjects were individually presented the list of 80 cue words via a slide projector. Each word was presented at a 5-second rate and the subjects were instructed to read the words to the experimenter. Table 2.2 presents the 40 most frequently recognized words and the proportion of subjects who correctly recognized each word.

From the list of the 40 most frequently recognized words, 12 cue words were selected for the experiment. The criteria for selecting the 12 cue words were: (1) the cue word must have elicited a high percentage of correct responses during the pre-test trials; and (2) the location of the cue word must be at either the beginning or end of the criterion word. The cue words selected and their corresponding criterion words are presented in Table 2.3.

Procedure

Prior to cue word training, a total of 73 EMR subjects, ranging in age from 10 to 21 years, were pre-tested on the list of 12 cue/criterion word combinations in Table 2.3. A pre-test was administered in order to assess the subject's knowledge of the cue and criterion words.

Pre-test results were used to eliminate subjects from the experiment if: (1) a subject recognized two or more of the criterion words; or (2) if any subject displayed behavior which interfered with performance on the task (e.g., severe speech impediment, emotional outbursts, etc.). A total of 14 subjects were eliminated as a result of the pre-test data. The remaining 59 subjects, 34 males and 25 females, ranging in IQ from 45 to 75, were matched on the basis of IQ and pre-test performance among each of the four treatment conditions. The four treatment conditions were:

1) Syntactical Condition: This group received both cue word and associative strategy training. The subjects in this group were instructed in the use of embedded cue words (i.e., BE - BEHAVIOR) and also administered oral instructions in the use of syntactical strategies (i.e., Be on your best behavior).

2) Word Formation Condition: This group received only cue word training. The subjects in this group were instructed in the use

TABLE 2.1

Eighty Cue Words Most Frequently Embedded in the Criterion Words

1.	on	21.	rat	41.	act	61.	ore
2.	in	22.	her	42.	cat	62.	row
3.	at	23.	ran	43.	ill	63.	use
4.	an	24.	if	44.	tin	64.	over
5.	or	25.	the	45.	pen	65.	dent
6.	is	26.	age	46.	car	66.	tar
7.	it	27.	ten	47.	are	67.	war
8.	me	28.	do	48.	ice	68.	low
9.	as	29.	end	49.	eat	69.	sit
10.	us	30.	for	50.	imp	70.	mar
11.	he	31.	all	51.	one	71.	let
12.	to	32.	we	52.	rate	72.	port
13.	ate	33.	era	53.	go	73.	bar
14.	be	34.	den	54.	tan	74.	late
15.	am	35.	and	55.	ear	75.	rag
16.	so	36.	up	56.	out	76.	of
17.	no	37.	eve	57.	lit	77.	rap
18.	men	38.	able	58.	can	78.	ace
19.	ant	39.	art	59.	mat	79.	pat
20.	per	40.	man	60.	our	80.	son

TABLE 2.2

Forty Most Frequently Recognized Cue Words and the Proportion of Subjects Recognizing Each Word

1.	up	(.862)	21.	ten	(.621)*
2.	cat	(.851)*	22.	do	(.609)
3.	go	(.851)*	23.	can	(.609)
4.	to	(.793)*	24.	ice	(.598)*
5.	at	(.782)*	25.	out	(.586)
6.	in	(.724)*	26.	car	(.586)
7.	all	(.713)*	27.	if	(.586)
8.	so	(.701)*	28.	am	(.575)
9.	and	(.701)	29.	men	(.540)
10.	we	(.701)	30.	of	(.540)
11.	the	(.701)*	31.	eat	(.540)
12.	it	(.690)*	32.	over	(.529)
13.	be	(.690)	33.	son	(.529)
14.	for	(.678)*	34.	let	(.529)
15.	man	(.667)	35.	an	(.506)
16.	on	(.655)	36.	as	(.494)
17.	no	(.655)	37.	end	(.483)
18.	is	(.655)	38.	her	(.471)
19.	he	(.644)	39.	us	(.471)
20.	me	(.632)	40.	or	(.471)

TABLE 2.3

Cue and Criterion Words Used for the Training Tasks and the Criterion Task

Criterion and Cue Word	Syntactical Strategy
allowance	All of my allowance.
attic	At home in the attic.
bandit	It was taken by the bandit.
cargo	Go pick up the cargo.
cattle	Cat scared the cattle.
forever	For now and forever.
iceberg	Ice makes an iceberg.
mosquito	To hit the mosquito.
raisin	In the box is a raisin.
rotten	Ten apples were rotten.
soldier	So you are a soldier.
theory	The man has a theory.

of the embedded cue words for learning the unfamiliar (criterion) word (i.e., BE - BEHAVIOR). There were no instructions administered to this group concerning the formation of a syntactical strategy from the cue and criterion words.

3) Repetition Condition: The subjects in this group were instructed to repeat the criterion words three times to the experimenter as they were learning the criterion list.

4) Control Condition: This group did not receive any instruction regarding strategy formation during the learning trials of the criterion word list and were not asked to repeat the criterion words.

Cue word training. Learning trials during cue word training involved the presentation of each cue word in succession for three trials. The experimenter pronounced the cue word and the subject was instructed to repeat the word. The method of adjusted learning was employed. When a subject gave three successive correct responses for each cue word, the word was eliminated from the list. The subjects in the Repetition and Control conditions did not receive cue word training.

Strategy training. During strategy training, 4 of the 12 criterion words were presented to all subjects in the Syntactical, Word Formation, and Repetition conditions. For the Syntactical group during learning trials, the experimenter presented each criterion word while pointing out the underlined cue word. The experimenter pronounced the cue word and gave the syntactical strategy which could be used to remember the criterion word. The criterion word was again pronounced by the experimenter and each subject was instructed to repeat this sequence. On the test trials, each subject was asked to identify the cue word, repeat the syntactical strategy, and then say the criterion word. When the subject was able to repeat this sequence, the word was removed from the strategy training list.

For the Word Formation and Repetition groups, the experimenter pronounced the four criterion words three times without pronouncing or pointing out the cue words. The subjects in these two groups were then asked to say the cue word as the experimenter presented it. A test trial immediately followed in which each subject was required to read the criterion words. Although these two groups seem similar in that they both received repetition strategy training, they differed in that the Word Formation group had received cue word training on all 12 embedded words. Consequently, the Word Formation subjects were familiar with the eight cue words employed during the criterion task. As a result, this group could use the embedded cue word as a word formation strategy for the recognition of the criterion words.

Criterion task. During the criterion task, all subjects received alternately five learning and five test trials. For the

learning trials, the experimenter presented each of the eight criterion words. The cue word was underlined on all learning trials for the Syntactical group only. For this group, the experimenter pronounced each cue/criterion word combination and the syntactical strategy, and the subjects were asked to repeat this sequence. Table 2.3 presents the strategies which were used. For the Word Formation, Repetition, and Control groups, the experimenter pronounced each criterion word three times without pronouncing or pointing out the cue words and the subjects repeated each word. During the test trials, all subjects were instructed to read the criterion word. The cue words were not underlined on the test trials for any group.

Retention test. A retention task was administered to all groups approximately 72 hours following the criterion task. All subjects received one test trial, followed by two relearning and two test trials. The procedure for the test trials and two relearning trials was the same as that for the criterion task.

Results

In order to demonstrate the comparability of the four groups as a result of matching on the basis of pre-test data on the cue and criterion words, two 1 x 4 analyses of variance (ANOVAs) were performed on the total number of correct responses made to these two word lists. Table 2.4 presents the means and standard deviations for the pre-test matching data. The two F values did not approach significance at the .05 level.

TABLE 2.4

Means and Standard Deviations of the Number of Correct Responses on the Pre-test for the Cue and Criterion Words

	Syntactical	Word Formation	Repetition	Control
Cue Words				
Mean	4.22	3.88	4.11	4.36
S.D.	3.28	3.16	3.37	3.38
Criterion Words				
Mean	0.05	0.16	0.22	0.05
S.D.	0.22	0.37	0.45	0.22

Table 2.5 presents the means and standard deviations of the total number of correct responses made during the criterion task for each of the four groups. The 1 x 4 ANOVA yielded an F value which did not approach significance at the .05 level.

Figure 2.1 presents the learning curves for the four groups. Although there were 17% more correct responses made by the Syntactical group compared to the Control group, the overall F value did not approach significance. It is noteworthy that on all five test trials the performance of the Control subjects was inferior to the performance of the other three groups. The performance of the Syntactical and Word Formation groups is very similar. Each group gained an increase of approximately one correct response on each test trial.

Table 2.6 presents the mean number of correct responses made on the retention task and the total number of correct responses made on the two relearning test trials. Again, the F values based on the two 1 x 4 ANOVAs did not approach significance at the .05 level.

Discussion and Conclusions

The results of this study indicate that the experimenter-supplied Syntactical and Word Formation strategies were no more effective in facilitating word recognition learning than the Repetition and Control conditions. The results of the criterion task indicate that the Syntactical subjects learned the criterion words at a slightly faster rate than did subjects from the other conditions. The retention data show that the subjects in the Repetition condition elicited the most correct responses during the retention task. However, these differences during the learning and retention tasks were not statistically significant.

The results obtained in this study have implications regarding the nature of the supplied strategies administered to EMR subjects. It seems that the structure of the syntactical strategies, such as "Room for the mushroom to grow," or "Be on your best behavior," may have actually confused the subjects during the learning trials. Also, the Syntactical subjects were presented two types of learning strategies; the syntactical phrases mentioned above and the embedded cue word strategies. The learning and retention data indicate that both methods were facilitative since the Syntactical and Word Formation subjects performed equally well during the different tasks. However, simultaneous presentations of the two strategies, as during syntactical training, appear to have impaired rather than aided criterion word learning.

The Syntactical subjects also had difficulty in understanding the instructions to associate the syntactical phrase with the cue/criterion combination. Thus, the subjects in this condition failed to search for the embedded cue words during the retention task.

TABLE 2.5

Means and Standard Deviations of the Total Number of Correct Responses on the Criterion Learning Task

	Syntactical	Word Formation	Repetition	Control
Mean	20.92	20.20	19.50	15.26
S.D.	13.73	8.23	8.86	9.78

TABLE 2.6

Means and Standard Deviations of the Number of Correct Responses on the Retention Trial and on the Two Relearning Trials

	Syntactical	Word Formation	Repetition	Control
Retention				
Mean	3.30	3.00	3.62	2.46
S.D.	3.09	2.17	2.55	2.44
Relearning				
Mean	10.15	10.20	10.56	8.86
S.D.	5.96	3.78	4.39	5.51

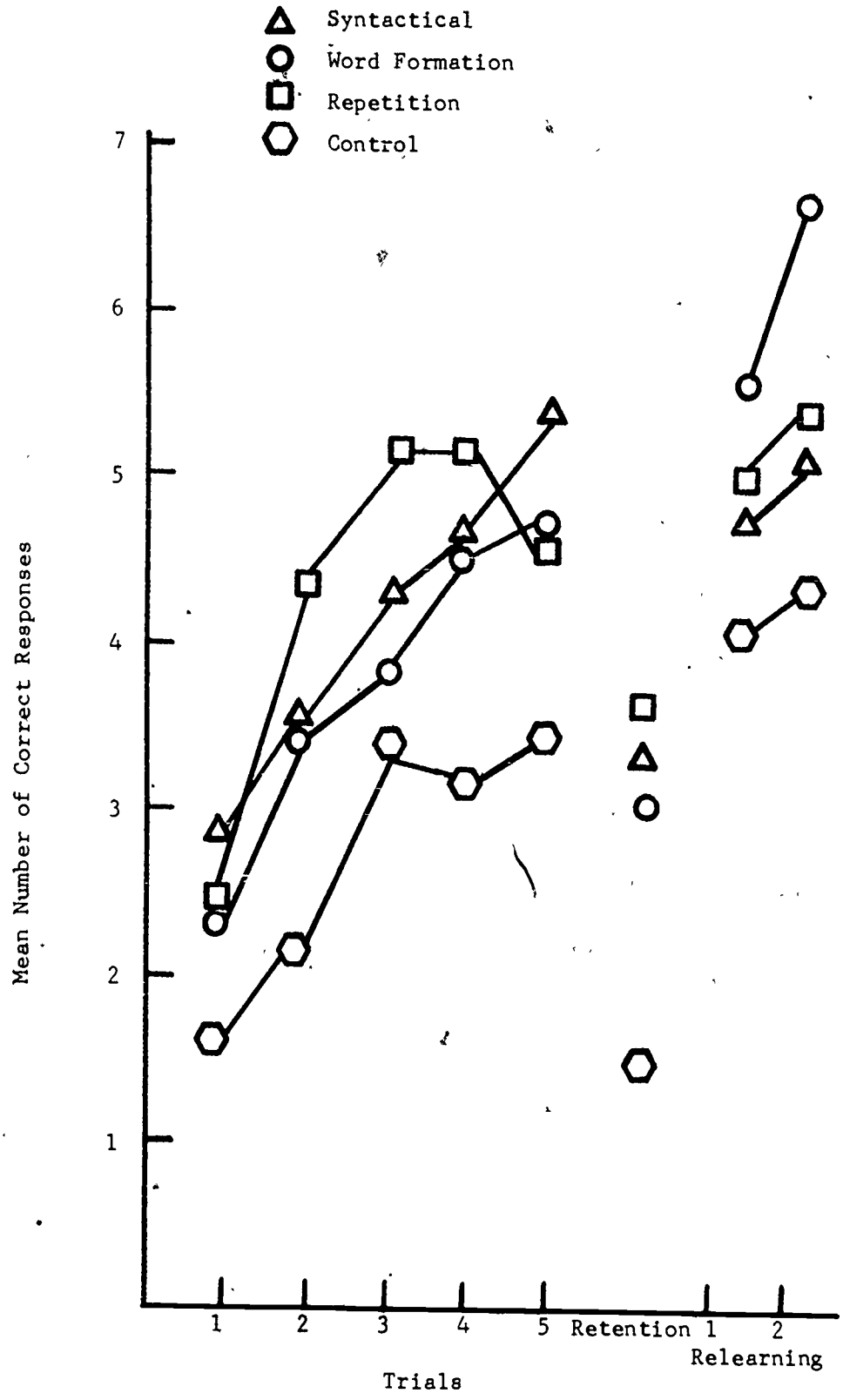


Figure 2.1. Mean number of correct responses for each group on acquisition, retention, and relearning.

Recognition of the cue words was necessary during the test trials in order for the subjects to recall the syntactical strategy and elicit the correct criterion word. This sequence was necessary since the cue words were not underlined during the test trials.

Although such factors as the length of the verbal phrases and the subject's inability to comprehend the use of associative strategies contributed to generally negative results, additional factors have since been investigated. One such factor is the experimental procedure employed during the learning and retention tasks. During the strategy presentation for the Syntactical subjects, the experimenter first presented the criterion word on an index card and then pointed out the underlined cue word. The experimenter then pronounced the cue word and orally presented the syntactical strategy to the subjects. It is possible that this method of presentation may have impaired learning. It is suggested that subjects would profit more by a visual presentation of the cue/criterion word list. This procedure should not only optimize the utility of the various strategies but also increase the comprehension of the mediational instructions.

Another factor undoubtedly affecting the performance of all subjects during the experiment was a lack of motivation. This motivational factor appears to be a function of both the time factor involved and the nature of the population being tested. Most of the experimental subjects appeared to become distracted early in the experiment. This problem may possibly be eliminated or reduced by allowing more time between training sessions or by introducing some form of reinforcement.

In conclusion, there was only slight evidence concerning the greater effectiveness of the Syntactical condition. The three strategy groups performed better than the Control group during each experimental task but the effect was not significant. The hypothesis stating that the Syntactical and Word Formation conditions would perform better than the Repetition and Control conditions was not supported. These results suggest that special caution should be used when administering experimenter-supplied strategies to EMR students. The present study indicates that future research should be concerned with the construction of easily learned strategies, procedures for presenting strategies to subjects, and types of reinforcement. This study failed to produce the facilitative effects which were expected on the basis of research in paired associate learning.

CHAPTER III

EXPERIMENT II -- EFFECT OF REINFORCEMENT ON WORD KNOWLEDGE AMONG EDUCABLE MENTALLY RETARDED CHILDREN

Introduction

The efficacy of presenting experimenter-supplied learning strategies via slide projection with synchronized tape recorded instructions was evaluated in a pilot study. In Experiment I of this report, the visual stimuli were displayed on index cards and the instructions were given by the experimenter. Procedural changes were made to maximize the attention level among the EMR subjects and to provide a more precise control of exposure time during the learning trials. The learning strategies developed for Experiment I were used in this study.

A sample of 64 EMR subjects, 38 males and 26 females, were selected to determine the feasibility of the testing procedure. All subjects were enrolled at the Texas State School for the Mentally Retarded in Mexia, Texas. The mean IQ (WISC and WAIS) of the subjects tested was 53.22. The mean chronological age (CA) of the sample population was 11.29. The testing began immediately after the subjects were randomly assigned to one of the following treatment conditions: Syntactical (N = 16), Word Formation (N = 16), Repetition (N = 16), and Control (N = 18).

The instructions for the treatment conditions were recorded on a cassette tape player and carefully synchronized with the slide display so as to limit the amount of manual operation required in previous research. Appendix G presents the procedures used in the four conditions.

All other methodologies were identical to that reviewed in Experiment I with the exception of the newly adopted audio-visual presentation. An additional measure included in this experiment was a test of transfer. It was hypothesized that the stimulus word learned during the criterion task (Appendix G) would be recognized among other similar words. The similar stimuli were also selected on the basis of grade level as well as to the degree of resemblance to the criterion item. The transfer task was administered to all subjects immediately following the retention test trials. The multiple choice transfer paradigm is presented in Table 3.1.

After testing eight subjects, it was obvious that the procedure employed was too mechanical and impersonal for the EMR population. The recorded tapes were too lengthy, the instructions were monotonous, and a lack of interaction between the experimenter and the subjects caused many subjects to become bored early during the learning trials. Most subjects became distracted, looking around the room and many times initiating conversation with the experimenter. Hence, a quantitative analysis of the few subjects tested was considered inappropriate.

TABLE 3.1

Multiple Choice Transfer Design

1)	allowance	a)	potato	c)	alligator
		b)	allowance	d)	score
2)	attic	a)	attend	c)	vote
		b)	attic	d)	guard
3)	bandit	a)	benefit	c)	bandit
		b)	vessel	d)	straight
4)	cargo	a)	juice	c)	carpet
		b)	cargo	d)	warm
5)	cattle	a)	goose	c)	cattle
		b)	tonight	d)	catch
6)	forever	a)	calendar	c)	forehead
		b)	forever	d)	human
7)	iceberg	a)	iceberg	c)	ranch
		b)	volcano	d)	ice-cream
8)	mosquito	a)	motto	c)	lake
		b)	mosquito	d)	brother
9)	raisin	a)	ravine	c)	obtain
		b)	junior	d)	raisin
10)	rotten	a)	narrow	c)	written
		b)	rotten	d)	daughter
11)	soldier	a)	continent	c)	soldier
		b)	solid	d)	kettle
12)	theory	a)	theory	c)	therefore
		b)	June	d)	banjo

However, experimenters continued to test the remaining subjects hoping to identify other procedural difficulties. Subjects were tested in an interview-type setting and were questioned primarily about the manner in which the stimuli were presented. Otherwise, the methodology reported previously in this study remained the same.

A group of 40 subjects were interviewed with each session lasting approximately 20 minutes. A significant number (75%) of these subjects reported problems pertaining to the following areas of methodology:

1) List of Criterion Words. All subjects included in past experiments (where mnemonic strategies were examined) have been presented lists of 12 cue/criterion word combinations. Subjects in the present study were asked if they thought 12 words were too many words for them to learn. Most subjects agreed that the list of 12 criterion words and corresponding strategies were very confusing. In future experiments, EMR subjects should not be presented with a list of more than six or eight words.

2) Nature of Presentation.
(a) Recorded tapes--all subjects commented on how boring and distracting the tapes were. Most subjects stated that they would rather have the experimenter give instructions orally than to listen to a tape recording.
(b) Slide projection--subjects reported that they preferred viewing the stimulus presentations on slides rather than on printed index cards. A high percentage of subjects requested pictures of the cue/criterion word combinations. Such representation. they thought, would help them to remember the unfamiliar words.

3) Reinforcement Schedule. Subjects in the initial pilot study were not presented any form of external reinforcement. It was assumed that the audio-visual stimulation would provide the necessary reinforcement. However, as the results indicated, the EMR population required a more discrete form of reinforcement. During the interview sessions, the experimenters examined the efficacy of verbally reinforcing subjects for each correct response. Subjects demonstrated a significant increase of alertness when reinforced for each correct response. These results suggest further experimentation with various schedules of reinforcement when testing the mentally handicapped population.

In summary, the above findings have prompted a need for further investigation in the following two areas: (1) application of effective reinforcers during learning-test trial sequences; and (2) more efficient means of presenting stimulus items (i.e., instructions, visual display, strategy constructions, etc.).

The former of these two designated areas (application of reinforcement) was examined at the Texas School for the Mentally Retarded at Mexia, Texas. A study was designed to test the hypothesis that cue word recognition could be facilitated by administering a reinforcer, in this case one M&M candy, following each correct response. Verbal

reinforcement was also given as the small piece of candy was presented.

Greenspoon (1955) has demonstrated that the nature of the response is a determinant of the reinforcing character of the stimulus. The immediacy of reinforcement has been shown to affect the nature of the response. The longer the reinforcement is delayed after the response occurs, the less likely is one to obtain the desired response. Another factor is the frequency of reinforcement. When reinforcement is consistently delivered, the desired response is more likely to be emitted. All of the aforementioned aspects of reinforcement were employed in the following study.

Method

Subjects

A sample of 40 EMR subjects, 20 males and 20 females, were randomly assigned to one of two experimental conditions. One group of subjects received reinforcement while the second group did not receive any reinforcement for giving a correct response.

Procedure

Both groups were presented 80 cue words printed on 5 x 8 inch index cards. Presentation time for each word was 6 seconds. Subjects were instructed to say the word if it was recognized. Approximate time of testing for each subject was 10 minutes.

Results and Discussion

A 1 x 2 ANOVA was performed on the total number of correctly identified words. The means and standard deviations for the total number of correct responses for Reinforced and Nonreinforced groups are presented in Table 3.2. The analysis of these data indicate that the Reinforced group yielded a significantly greater number of correct responses (F (1,48) = 6.12, $p < .05$) than the Nonreinforced group.

The most important aspect of this study is the failure of the highly controlled aspects of the pilot study to induce any learning among the EMR subjects. Review of the approach used in this study (Appendix G) reveals a well controlled but very mechanical procedure. It soon became obvious that the impersonal nature and the complication involved in the methodology was not suitable for these children. These factors appeared to be responsible for the relatively low motivational level of the participating subjects.

While there does not appear to be any intrinsic difficulty in using mechanical apparatus to present the materials, it is necessary

to maintain close rapport while the experiment is in progress. The children were very sensitive to the lack of personal concern and excitement about learning when the mode was highly mechanized and little personal feedback was given. It appears that the success of mechanical learning devices for these children will depend upon the use of highly interesting materials and the interaction of a concerned experimenter. The film study reported in Experiment VI of this research report is relevant to the results obtained in this pilot experiment.

TABLE 3.2

Means and Standard Deviations for the Total Number of Correct Responses

	Reinforced	Nonreinforced
Mean	14.54	12.69
S.D.	11.80	11.29

CHAPTER IV

EXPERIMENT III -- EFFECT OF PICTORIAL STIMULI ON WORD RECOGNITION LEARNING AMONG RETARDED CHILDREN

Introduction

The purpose of Experiment III was to test the effectiveness of supplying visual mediators to EMR subjects in a word recognition learning task. Previous experiments in this research have attempted to identify various approaches to assist subjects in learning unfamiliar words. In these experiments, strategies were verbally presented to each subject. Although such methods have not produced statistical significance, the results have been in the expected direction.

In regard to language acquisition, Osgood (1961) has long argued in favor of nonverbal mediating processes and Staats (1961) has suggested that visual mediators can be incorporated into the learning model. The present study was designed to evaluate simultaneous presentations of verbal and visual associative strategies.

Two treatment conditions, Imagery and Nonimagery, were formed. In the Imagery condition, subjects received the cue-criterion word combinations, corresponding pictures, and were instructed in the use of syntactical strategies. In the Nonimagery condition, subjects received the cue-criterion word combinations and were instructed in the use of syntactical strategies. However, this group was not presented the pictures of the cue and criterion words.

Method

Two groups of associative strategies were evaluated. Therefore, the following methodology was divided into Phases I and II.

Subjects

Phase I. Prior to the learning trials, a total of 28 subjects from the Texas State School for the Mentally Retarded in Mexia, Texas, were pre-tested on eight cue words and corresponding criterion words. Subjects were eliminated if they correctly responded to any criterion word that was subsequently used during the testing sessions. This criterion resulted in an elimination of 16 subjects. The remaining sample of 12 subjects consisted of six males and six females ranging in ages from 11 years to 16 years. All subjects were from Levels III and IV of the EMR population. The mean IQ (WISC and WAIS) for each treatment group was: Imagery, 58 (range 56 to 61, N = 6); Nonimagery, 57 (range 53 to 60, N = 6).

Phase II. A total of 15 subjects from the aforementioned state residential institution were pre-tested on eight cue and criterion words. There were five subjects eliminated for either correctly recognizing one of the criterion words or for behavioral reasons. The remaining subjects were from Level IV of the EMR population. The sample consisted of five males and five females ranging in ages from 10 years to 17 years. The mean IQ (WISC and WAIS) for each treatment group was Imagery, 62 (range 58 to 65, N = 5); Nonimagery, 64 (range 59 to 67, N = 5).

Procedure

The following procedure was administered to subjects in both phases of the experiment. However, as previously mentioned, two groups of mediators were evaluated. The eight cue-criterion word combinations and syntactical strategies presented during Phase I are listed in Table 4.1. The eight cue and criterion words and syntactical strategies presented during Phase II are listed in Table 4.2.

A Treatment x Subject design was employed. Each subject was tested on a total of eight words, four words and their corresponding images and four words without their associative images. Following the pre-test session, all the subjects received training on both sets of words. The four words employed in the Imagery condition were presented in a three-page folder. The cue word and its picture appeared on the first page; the second page presented the criterion word and its picture; and the third page showed the cue-criterion word combination with the interacting picture. For example, the cue word was ICE for the criterion word ICEBERG. On the first page, the word ICE was presented with a picture of an ice cube. On the second page, the criterion word ICEBERG was printed along with a picture of an iceberg. On the third page, a picture and the word ICE was presented beside the picture of an iceberg and the word ICEBERG. When the third page was presented to the subject, the experimenter said, "Ice makes an iceberg." The four words in the Nonimagery condition were presented in the same sequence without the visual mediators. However, the Nonimagery groups received a syntactical strategy while viewing the cue-criterion word combination.

During the learning trials of the criterion task, all subjects were presented the stimulus items as previously described. The method of adjusted learning was employed. When a subject gave a correct response for both the cue word and the criterion word, these words were removed from the list. Verbal reinforcement was administered whenever attempts were made to pronounce the word. An M&M candy was given whenever a subject emitted a correct response during the test trials.

A retention task was administered to all subjects four days following the learning session. If a subject did not respond correctly on the first trial, he was given two more learning and test trials. Prior to the retention task a transfer task was administered

TABLE 4.1

Cue and Criterion Words Used for the Training Tasks and the Criterion Task (Phase I)

Criterion and Cue Word	Syntactical Strategy
allowance	All of my allowance.
attic	At home in the attic.
bandit	It was taken by the bandit.
cargo	Go pick up the cargo.
cattle	Cat scared the cattle.
forever	For now and forever.
iceberg	Ice makes an iceberg.
mosquito	To hit the mosquito.
raisin	In the box is a raisin.
rotten	Ten apples were rotten.
soldier	So you are a soldier.
theory	The man has a theory.

TABLE 4.2

Cue and Criterion Words Used for the Training Tasks and the Criterion Task (Phase II)

Criterion and Cue Word	Syntactical Strategy
tennis	Ten balls to play tennis.
panther	The pan hit the panther.
candy	The can is full of candy.
mantle	The man is on the mantle.
peacock	The pea hit the peacock.
party	Part of the case for the party.
carpet	The car is on the carpet.
caterpillar	The cat saw the caterpillar.

to all subjects. The transfer task contained four words: the criterion word, a word in which the cue word was contained, a word with the same number of letters as the criterion word, and a dissimilar word in terms of letter similarity and letter length. The transfer words for ICEBERG were: ICEBERG, ICE CREAM, VOLCANO, RANCH. It was expected that the order of generalization of incorrect responses would be in the above order. The greatest number of incorrect responses would be made to the word which contained the cue word and the least error generalization to the word with dissimilar letters and different length. The lists of words used during the transfer task for Phases I and II are presented in Tables 4.3 and 4.4, respectively.

Results

Phase I

A Wilcoxon Matched Pair Test was used to analyze the following dependent variables: total number of correct responses on the criterion task and total number of correct responses on the retention task.

The analysis performed on the criterion task was nonsignificant at the .05 level. Among all subjects, a total of 97 test trials was required to learn the imagery words while a total of 115 trials was required to learn the nonimagery words. A total of 21 correct responses was scored on the retention task for the Imagery group and 18 correct responses for the Nonimagery group. An analysis of these data indicated nonsignificance at the .05 level (Wilcoxon T = 16, N = 12). However, these data approached significance at the .05 level. A T-value equal to 14 was required to reject the null hypothesis. Figure 4.1 presents the learning curve for both groups of words on the criterion and retention tasks as well as for the two relearning trials. Figure 4.2 presents the generalization gradient for the transfer task.

Phase II

A Wilcoxon Matched Pair Test was used to analyze the following dependent variables: total number of correct responses on the criterion task and total number of correct responses on the retention task.

A greater number of learning trials was required to learn the criterion words which were presented without pictures. During the criterion task, a total of 156 learning trials was recorded for subjects in the Nonimagery condition, whereas a total of 123 learning trials was required of the Imagery condition. However, an analysis of these data indicated nonsignificance at the .05 level (Wilcoxon T = 35.99, N = 10).

TABLE 4.3

Multiple Choice Transfer Design
(Phase I)

1) allowance	a) potato	c) alligator
	b) allowance	d) score
2) attic	a) attend	c) vote
	b) attic	d) guard
3) bandit	a) benefit	c) bandit
	b) vessel	d) straight
4) cargo	a) juice	c) carpet
	b) cargo	d) warm
5) cattle	a) goose	c) cattle
	b) tonight	d) catch
6) forever	a) calendar	c) forehead
	b) forever	d) human
7) iceberg	a) iceberg	c) ranch
	b) volcano	d) ice cream
8) mosquito	a) motto	c) lake
	b) mosquito	d) brother
9) raisin	a) ravine	c) obtain
	d) junior	d) raisin
10) rotten	a) narrow	c) written
	b) rotten	d) daughter
11) soldier	a) continent	c) soldier
	b) solid	d) kettle
12) theory	a) theory	c) therefore
	b) June	d) banjo

TABLE 4.4

Multiple Choice Transfer Design
(Phase II)

1)	tennis	a) tennis	c) stomach
		b) insect	d) tender
2)	panther	a) panther	c) certificate
		b) bonfire	d) pantry
3)	candy	a) candle	c) candy
		b) husky	d) buffalo
4)	mantle	a) manual	c) spider
		b) mantle	d) lodge
5)	peacock	a) warden	c) peaceful
		b) peacock	d) violet
6)	party	a) husband	c) party
		b) partner	d) service
7)	carpet	a) carriage	c) carpet
		b) entrance	d) postage
8)	caterpillar	a) fruit	c) caterpillar
		b) catsup	d) organ

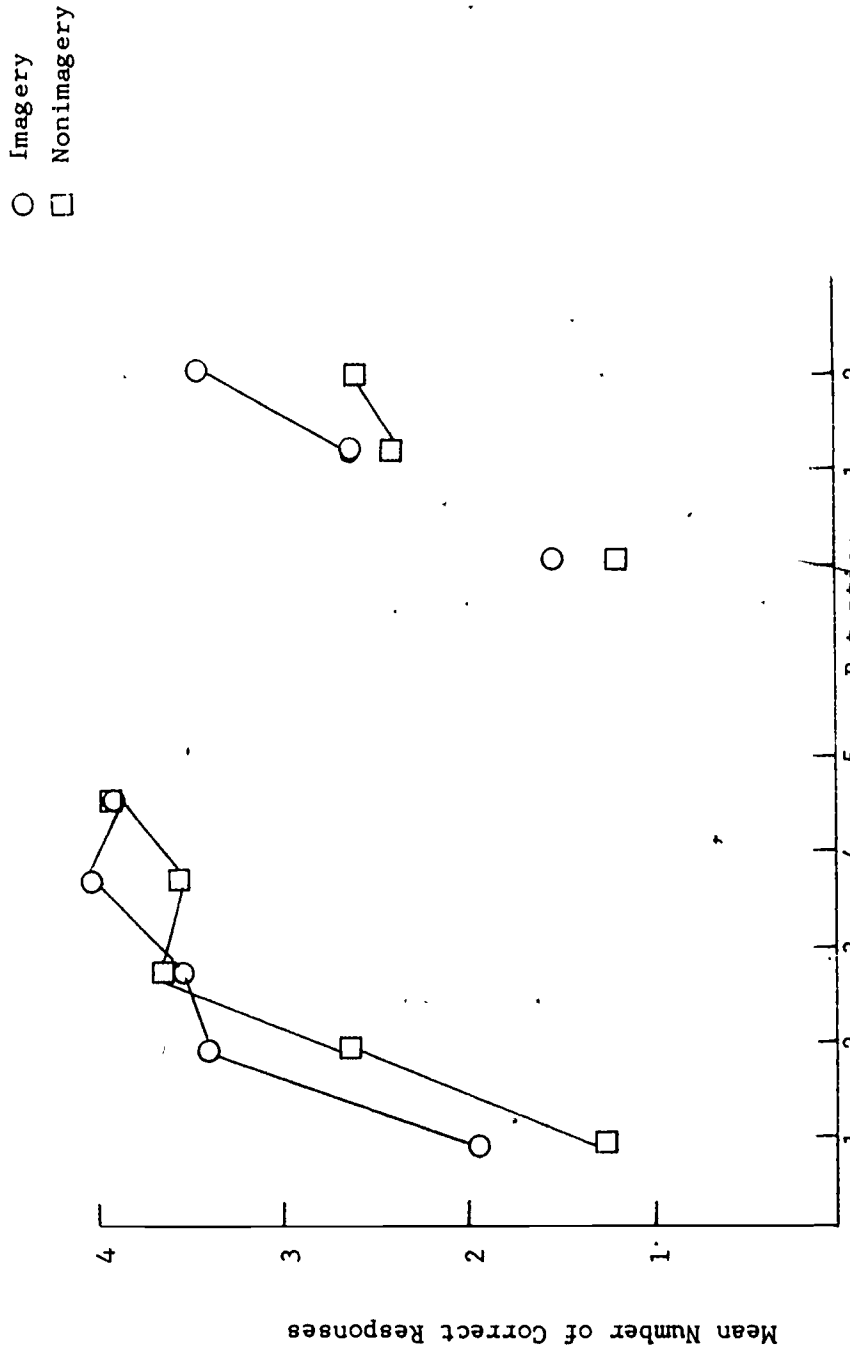


Figure 4.1. Learning curve for Imagery and Nonimagery word groups (Phase I).

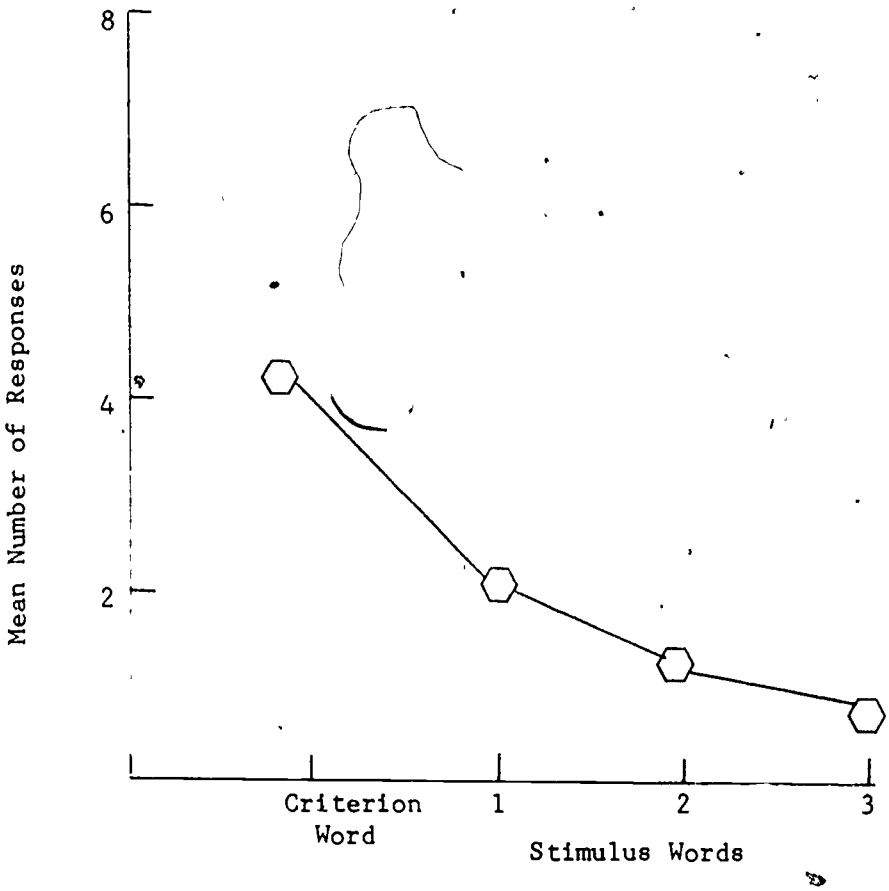


Figure 4.2. Generalization gradient for the criterion word and the three distractor words (Phase I).

During the retention task a greater number of correct responses was recorded for the subjects in the Imagery condition. A total of 56 correct responses was emitted by the Imagery subjects. Subjects in the Nonimagery condition scored a total of 43 correct responses. Although approaching the critical value, the difference between these two conditions was nonsignificant (Wilcoxon T = 11, N = 10). A T-value equal to 14 was required to reject the null hypothesis. Figure 4.3 presents the learning curves for the criterion and retention tasks. The generalization gradient for the transfer task is shown in Figure 4.4.

Conclusions

The results of this study revealed no facilitative effect due to the presentation of a visual mediator. Visual representation of the associative strategy produced little effect either during acquisition of the criterion word or during retention. The overall trend was in favor of the Imagery condition but no significant effects were obtained in the statistical analyses. Inspection of Figures 4.2 and 4.4 reveals a generalization effect. These figures present the mean number of responses to each of the four words when the subject was instructed to identify the criterion word in the transfer task. Since the criterion list contained eight words, slightly over half of the responses were correct. The distribution of the incorrect responses was in the predicted order. Most of the incorrect responses were to the distractor word containing the same cue word as the criterion word (Stimulus Word 1). The word attracting the next largest number of correct responses was the word with the same number of letters as the criterion word (Stimulus Word 2). The word which had the least degree of letter similarity attracted the least number of incorrect responses (Stimulus Word 3).

In conclusion, the results failed to show the expected facilitative effects of presenting pictorial stimuli of the cue and criterion words. Acquisition of the imagery and nonimagery words was similar. Likewise, retention and the relearning data failed to produce any differences among the two groups of words. As expected, the transfer task did show a gradient of generalization of incorrect responses based upon the degree of similarity between the criterion word and the distractor word.

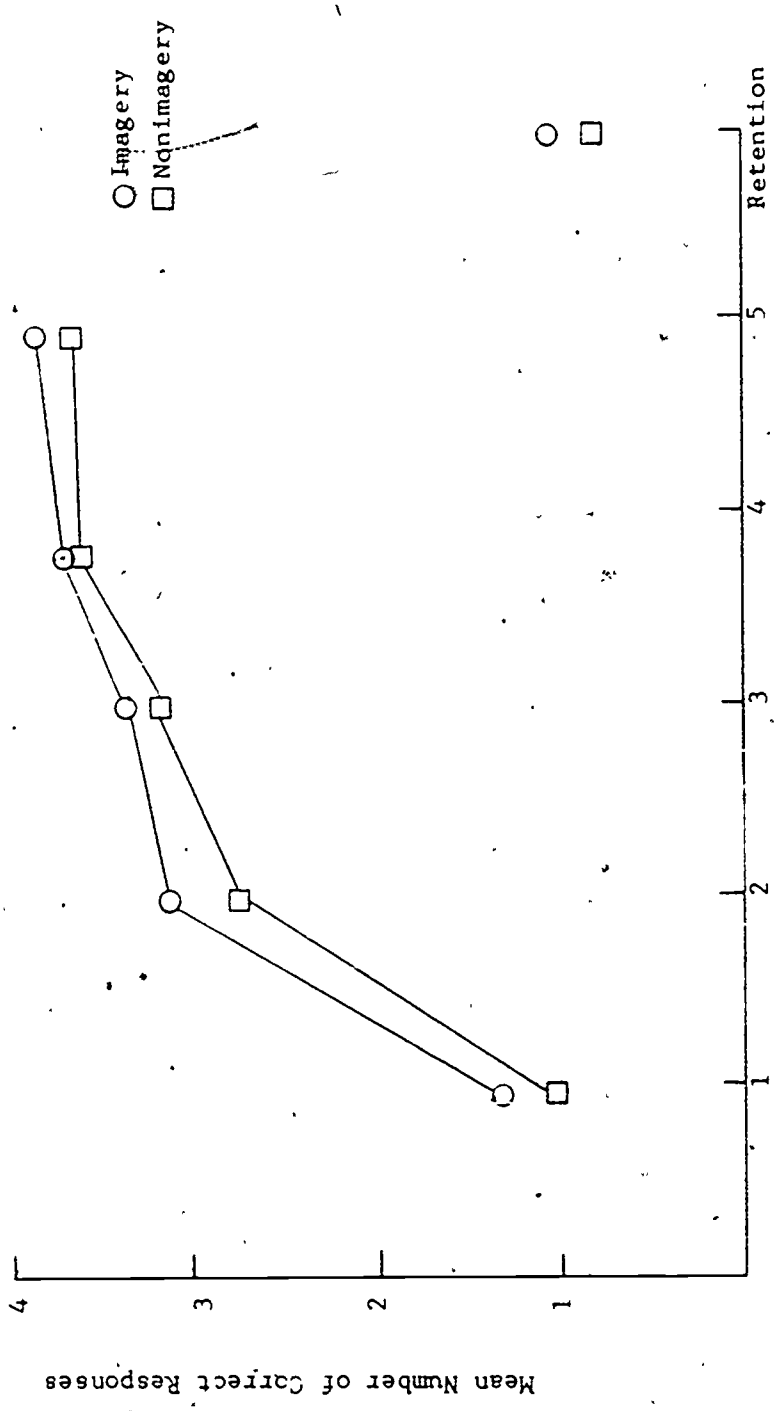


Figure 4.3. Learning curve for Imagery and Nonimagery word groups (Phase II).

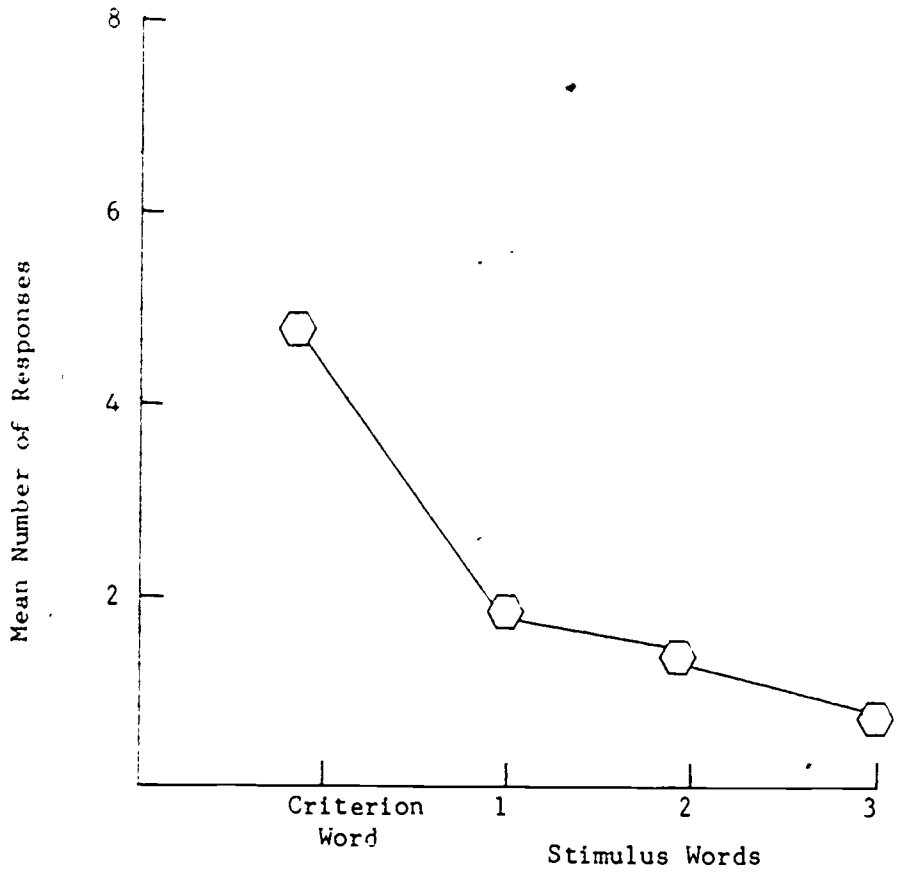


Figure 4.4. Generalization gradient for the criterion word and the three distractor words (Phase II).

CHAPTER V

EXPERIMENT IV -- COMPARISON OF EXPERIMENTER- AND SUBJECT-SUPPLIED ASSOCIATIVE STRATEGIES AMONG RETARDED CHILDREN

Introduction

The purpose of the present study was to determine whether associative learning can be facilitated best by using mediators which are supplied by the experimenter or by other mentally retarded subjects. There is a great deal of literature which shows that memory of stimulus-response (S-R) associations can be facilitated if the supplied mediators possess certain characteristics. For example, it has been demonstrated that instructions to form sentences containing the noun pairs to be learned are facilitative for children of a variety of ages (Jensen & Rohwer, 1965; Martin, 1967; Rohwer, 1967, Exp. XIII). That the context must be meaningful is also demonstrated by Rohwer's finding that meaningful sentences, such as "Roses drink rain" and "Roses like rain," produced facilitation, but meaningless sentences like "Roses drink hats" and "Roses like hats" produced no facilitation (Reese, 1970). Additional experiments reported by Reese (1965) and Milgram (1967) have likewise demonstrated the facilitating effect on meaningful sentences in paired-associate (PA) learning.

Even though a more meaningful association will enhance the storage of the to-be-remembered items, there is still evidence suggesting that mediation is less efficient in young children than in older children. Two alternative hypotheses are given for the often-reported deficiency in verbally mediated performance during early childhood. The first, offered by Reese (1962), is the "mediational-deficiency hypothesis." Reese suggests that there is a stage in ontogenesis during which the child tends not to mediate or regulate his overt behavior verbally, despite the fact that he is able to understand and correctly use the words in question. Subsequently, this discrepancy between linguistic and mediational capacities are reduced, that is, mediational deficiency tends to disappear with age. Maccoby (1964) has called attention to an apparent ambiguity in the meaning of this hypothesis: "The question is, then, whether they (i.e., these young children) simply fail to use the verbal lables which are presumably available to them, or whether they do use them, but for some reason the words do not serve to mediate the response." According to Maccoby there are two distinct and separate developmental hypotheses which ought to be entertained here. One of these hypotheses asserts that the younger child does indeed spontaneously produce the potential verbal mediators at the appropriate point in the task situation, just as the older child does, but that these verbalizations for one reason or another fail to have their expected mediational effects on his overt behavior; in brief, they occur when they ought but do not mediate when they ought (Maccoby, 1964). The second hypothesis

This experiment was based in part upon a M.S. thesis by Dennis Seal submitted to the Graduate College of Texas A&M University.

predicts that the younger child tends not to produce the relevant words in the first place, and this suffices to explain the apparent nonmediated character of his overt task behavior. It is stipulated that the child "knows" the relevant words and that he can and does produce them in some situations; his deficiency here consists solely on the fact that this particular task (or perhaps, task-like situations in general) fails to elicit them.

In reference to the second hypothesis concerning verbal mediation during childhood, Flavell, Beach, and Chinsky (1966) have proposed the term "production deficiency." Flavell, et al. (1966) suggest that the child's difficulty may not lie in an inability to use the words which he produces in a mediational fashion, but rather in a lack of ability or disposition to produce or emit them on appropriate occasions.

Paivio and Yuille (1968) present evidence that subjects will often ignore instructions to use a particular kind of mediator if it is inefficient, and will spontaneously select a more efficient kind. Furthermore, subjects have a tendency to disregard instructional sets if the supplied strategy is inappropriate for the particular PA referents (Paivio and Yuille, 1969). If a subject disregards inappropriate mediators, he will encode the response materials as if he were in the control condition.

In view of these results, it seems tenable to suggest that a more appropriate mediator could be supplied by the subject himself. Studies have recently been reported in which subjects were instructed to elaborate noun pairs by either verbal or visual means. In experiments with adult subjects, Bower (1968) reported notably large effects of both kinds of instructions. The procedure was a relatively straightforward one: Subjects were told to imagine a visual interaction between the two objects named by the nouns in each pair, or they were told to create a sentence containing the two nouns in each pair. Using the same method, Paivio and Yuille (1967) reported that both imagery and sentence instructions were facilitative in adults for the learning of either concrete noun pairs or abstract noun pairs. Bugelski, Kidd, and Segmen (1968) also reported significant facilitation of PA learning in adults as a function of training in the use of imagery to link pair members. Further confirmation of the hypothesis that instructing subjects to formulate their own mediators will facilitate learning have been cited in experiments by Milgram (1967), Reese (1965), Rohwer, Lynch, Levin and Suziki (1967), and Spiller (1960). However, it has not as yet been determined whether this same elaboration-inducing variable is operative in children for simultaneous presentations of visual and verbal types (Rohwer, 1970).

It has been shown that there is a preference for and a capacity among young children to make verbal storage of an image representation. It would, therefore, seem most beneficial to simultaneously present the child with verbal and imaginal strategies that have been constructed by children of the same age and educational level.

The present study was an attempt to induce more efficient mediational sets among trainable and educable mental retardates

(TMRs, EMRs). Of main interest was the linguistical and imaginal characteristics of the mediators constructed by the child in relation to performance during the retention task. The following hypotheses were tested:

1) Subjects presented with the verbal and visual mediators, previously constructed by EMRs of the same developmental level (subject-generated mediators) will perform significantly better than those subjects who are presented with mediators supplied by the experimenter (experimenter-supplied mediators).

2) Syntactical subjects instructed to associate a sentence to the combined image of the S-R items will do better on the retention task than the Word Formation subjects presented with only word-image associations. The Word Formation group will have the S-item embedded within the R-item and it will be accentuated for all learning trials.

3) Syntactical and Word Formation subjects in both the subject-generated (S-G) and experimenter-supplied (E-S) conditions will perform better than the Control subjects on the retention task. The Control subjects receiving E-S strategies will be instructed to repeat the target word three times while viewing the corresponding image. The S-G Control group will not receive any instructions while viewing the word and matching image.

4) The difference between the S-G and E-S conditions will be greater for the Syntactical group and diminish as a function of performance on the retention task for both the Word Formation and Control groups.

5) A negative correlation between the number of trials required to meet criterion (for the criterion word learning trials) and performance during the retention task will be obtained for all six conditions.

Method

Subjects

The subjects in this study were 96 EMRs. 67 males and 29 females, tested at Lufkin, Travis, and Richmond State Schools, Texas. Six experimental conditions were formed containing 16 subjects each. Table 5.1 presents the means and standard deviations of the IQ values (Peabody Picture Vocabulary Test, Stanford Binet, and Weschler Intelligence Scale for Children), for each treatment group, as a result of a matching assignment.

TABLE 5.1

Means and Standard Deviations of IQ Values
for Each of the Six Treatment Groups

Mediator	Strategy					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Subject-Generated	53.84	10.27	54.13	10.68	52.84	8.98
Experimenter-Supplied	53.57	10.44	54.53	8.79	51.50	7.62

Material

Phase I. A list of 18 pairs of words was constructed in which the stimulus item (cue word) was embedded in the response item (criterion word). All cue-criterion word combinations were selected such that the embedded cue word appeared at the beginning of the criterion word (e.g., PEN-PENNY); thus, serving as a mnemonic strategy during the learning and retention phases of the experiment. The compiled list of 36 words was chosen from a source of 6,991 elementary level words found in the Educational Development Laboratories (EDL) Bulletin (Taylor, Frackenpohl, & White, 1969).

Phase II. For the pre-test, 18 words, from which the three criterion words were chosen, and 18 embedded cue words were formed from black, upper case 48-point Futura Demi prestype on 4 x 6 inch index cards. For cue word training, criterion learning, and retention tasks, all cue and criterion word presentations, as well as associative images, were presented via 35mm color slides on a Kodak Carousel model 800 projector. All instructions and verbal mediational sets were presented orally by the experimenter. The three cue-criterion word combinations and corresponding verbal strategies for the Syntactical/E-S and Syntactical/S-G conditions are presented in Tables 5.2 and 5.3, respectively. The cue-criterion word associations for the Word Formation/E-S and Word Formation/S-G conditions are presented in Tables 5.4 and 5.5, respectively. Neither of the Control conditions received instruction concerning the utility of the embedded cue word; consequently, they were not provided with cue-criterion associations. The Control groups received simultaneous presentation of the criterion words and either the experimenter- or subject-supplied mediators.

TABLE 5.2

Three Cue-Criterion Word Combinations and
Experimenter-Supplied Syntactical Strategies

Cue Word	Criterion Word	E-S Syntactical Strategy
pen	penny	The pen cost a penny.
can	candy	The can is full of candy.
cap	captain	The cap is on the captain.

TABLE 5.3

Three Cue-Criterion Word Combinations and
Subject-Generated Syntactical Strategies

Cue Word	Criterion Word	S-G Syntactical Strategy
pen	penny	I bought a pen with a penny.
can	candy	I bought a can of candy.
cap	captain	he captain is wearing a cap.

TABLE 5.4

Three Cue-Criterion Word Combinations for the Word Formation/ Experimenter-Supplied Condition

Cue Word	Criterion Word
pen	penny
can	candy
cap	captain

TABLE 5.5.

Three Cue-Criterion Word Combinations for the Word Formation/ Subject-Generated Condition

Cue Word	Criterion Word
pen	penny
peppermint stick	candy
ship	captain

Procedure

Phase I. This phase involved the construction of the verbal and imaginal mediators for both the E-S and S-G strategy conditions.

Experimenter-supplied mediators (E-S). Experimenters from the Human Learning Research Laboratory at Texas A&M University structured meaningful sentences from the aforementioned list of 18 noun pairs. These cue-criterion word sets and corresponding sentences were presented to faculty members of EMRs at the Texas State School for the Mentally Retarded, Mexia, Texas. The teachers were instructed to rate the sentences on a seven-point scale as to the "ease of difficulty with which any sentence might arouse a mental image and therefore help your students to learn the criterion word more quickly and easily." Listed in Table 5.6 are the mean scale values for six of the syntactical strategies that were judged to be highest in image-arousing capacity.

TABLE 5.6

Mean Scale Values of Six Syntactical Strategies Rated Highest in Image-Arousing Capacity

Cue Word	Criterion Word	Strategy	Mean
bed	bedroom	The bed is in the bedroom.	7.00
pen	penny	The pen cost a penny.	6.28
cup	cupboard	The cup is in the cupboard	6.00
can	candy	The can is filled with candy.	6.00
cap	captain	The cap is on the captain.	6.00
bee	beehive	The bee lives on the beehive.	5.42

Subject-generated mediators (S-G). The same group of cue-criterion words was used to construct the S-G mediators. A total of 20 upper level EMRs, 10 males and 10 females, from Mexia State School, were randomly assigned to the Syntactical and the Word Formation strategy conditions. Those subjects assigned to the Syntactical conditions were individually presented the cue-criterion word sets listed in Table 5.3. The subject's task in this condition was to form a meaningful sentence from the word combination and then to sketch a pictorial representation of the same sentence. Upon presentation of each noun pair, the Syntactical subjects were administered the following instructions:

> On the paper in front of you there are two words. I want you to make a sentence which has both of these words in it.... Now I want you to close your eyes and think of a picture describing your sentence. Would you please draw that picture for me.

Subjects assigned to construct the Word Formation strategies were presented the criterion word only (e.g., PENNY, CANDY, CAPTAIN). Upon viewing the single word presentations, subjects in this condition were told to think of a word which would help them to remember the criterion item. Subjects were requested to imagine a picture involving both verbal items. Instructions were administered in the following manner:

> On the paper in front of you there is a big word. Would you read that word for me.... Think of another word that will help you remember the big word. Now I want you to close your eyes and think of a picture which has both of these words in it. Would you please draw that picture for me.

Subjects had no difficulty in complying to either of the above sets of instructions. All subject-generated strategies were scored in ascending order, according to frequency of response and a hierarchial schema was established. The most frequently evoked verbal associates and corresponding images were employed as the S-G mediators during Phase II. The verbal and imaginal hierarchies for the Syntactical/S-G and Word Formation/S-G conditions are presented in Table 5.7.

Phase II. An outline of the experimental procedure is presented in Table 5.8.

Six experimental conditions were formed for this phase of the study.

1) Syntactical/Subject-generated Condition (Syntactical/S-G): Embedded cue word plus subject-generated syntactical strategy and associative images. -- The subjects in this condition were instructed in the use of the embedded cue word as a strategy for learning the criterion word. The subjects were then presented the cue-criterion word combination and the associative images, as well as the S-G syntactical strategy.

2) Word Formation/Subject-generated Condition (Word Formation/S-G): Subject-generated cue word and associative images. -- The subjects in this condition were presented the S-G cue word and given instruction on how it could aid in learning the criterion word. The subjects were then presented both the cue and criterion words and S-G images while receiving further instruction concerning the importance of the cue word. This condition did not receive the aid of a syntactical strategy.

TABLE 5.7

Verbal and Image Hierarchies for
Syntactical and Word Formation Strategies

VERBAL HIERARCHIES	
Syntactical Strategy	Word Formation Strategy
PEN - PENNY	PENNY
Penny used to 'purchase' a pen If I had one more penny I could buy a pen. I bought a blue pen with one penny. I had a penny and bought a pen with it. I can buy a pen with a penny. Can a penny buy a pen?	Symbol cent cent ¢ cents one cent ¢ one cent
Possession of a pen and penny I had a pen and a penny. I had a pen and a penny. I have a pen and I have a penny.	Type coin - nickel nickel
Drawing I used a pen to draw a penny.	Class money - 1 dollar money
Location A pen is on the penny.	Embedded Word pen - penny
CAN - CANDY	CANDY
'Purchase' - a can of candy I bought a can of candy. I bought a can of candy. I bought a can of candy. I can buy some candy. I can buy candy. Can I buy a piece of candy?	Type peppermint sticks peppermint sticks peppermint stick peanut candy peanut candy peanut patty candy bar--chocolate bar candy bar--almond bar sweets, candy bars (Baby Ruth), cupcakes
Location I put my candy in a can. I threw my candy in a can.	
Possession I have a can of candy.	Embedded word can (full of candy)
Give away Can you give me some candy?	

TABLE 5.7

(continued)

VERBAL HIERARCHIES	
Syntactical Strategy	Word Formation Strategy
CAP - CAPTAIN	CAPTAIN
Possession (captain)	Military 'rank'
The captain wore a cap.	leader
The captain wears a cap.	colonel
A captain wears a cap.	general
A captain wears a cap.	Goerge Washington
The captain has a cap on.	soldier
The captain had a cap.	
Captain, will you put your cap on.	Military 'branch'
I saw a cap and a captain.	sea
	sea
Possession (subject)	ship
I have a captain's cap.	army
I have a captain's cap.	army

IMAGE HIERARCHIES	
Syntactical Strategy	Word Formation Strategy
PEN - PENNY	PENNY
Purchase	Symbol
penny - pen (R)	cent - peppermint stick, bought with a penny
I - pen - penny	cent - cent sign ¢
penny - pen (R) - I	cents - penny, quarter, nickel, dime, dollar
pen (R) - penny - I	one cent - 1¢
pen (R) - penny (R)--pen is red	one cent - 3 pennies
CAN - CANDY	CANDY
Purchase	Type
can - candy (Pay Day)	peppermint stick
can - candy - I (at store)	peppermint stick
can - candy - I (Suckers)	peppermint stick
can - candy - I (at store)	peanut candy
can - candy - I (at store) (peppermint)	peanut candy
can - candy (peppermint)	peanut patty

TABLE 5.7

(continued)

IMAGE HIERARCHIES	
Syntactical Strategy	Word Formation Strategy
CAP - CAPTAIN	CAPTAIN
Possession (captain)	Military 'rank'
cap on captain - standing by ship	leader - captain at the front of a march
cap on captain - holding glass of milk	colonel - captain plus cap
cap on captain - large cap	general - with cap and medals
cap on captain	George Washington - flag
cap on captain - large cap	soldier - in his tank
captain is picking up his cap	sea - captain at sea (ship) plus flag
can on captain	sea - captain's cap
cap on captain	ship - captain at sea plus flag

TABLE 5.8

Outline of Experimental Procedure for the Six Treatment Conditions

Experimental Conditions	Pre-Test	Cue Word Training[1]	Criterion Word Learning Task[2]	Retention Task[3]	Post-Retention Task[4]
EXPERIMENTER SUPPLIED	a)Cue-criterion word recognition task (e.g., pen, penny)	a)Learning Trial cue word plus E-S associative image (e.g., pen + image of pen) b)Test Trial cue word (e.g., pen)	a)Learning Trial cue word plus E-S associative image (e.g., pen + image of pen) b)Criterion word plus E-S associative image (e.g., penny + image of penny) c)Cue-criterion word combination plus E-S associative image and syntactical strategy (e.g., pen, penny; The pen cost a penny;	a)Test Trial present criterion word (e.g., penny)	a)Two Learning Test Trials
Syntactical					

TABLE 5.8

(continued)

Experimental Conditions	Pre-Test	Cue Word Training	Criterion Word Learning Task	Retention Task	Post-Retention Task
EXPERIMENTER SUPPLIED (cont'd) Syntactical (cont'd)			image of hand exchanging pen for a penny). d)Test Trial criterion word (e.g., penny)		
Word Formation	a)Cue-criterion word recognition task (e.g., pen, penny)	a)Learning Trial cue word plus E-S associative image (e.g., pen + image of pen) b)Test Trial cue word (e.g., pen)	a)Learning Trial cue word plus E-S associative image (e.g., pen + image of pen) b)Criterion word plus E-S associative image (e.g., penny + image of penny) c)Cue-criterion word combination	a)Test Trial present criterion word (e.g., penny)	a)Two Learning-Test Trials

TABLE 5.8

(continued)

Experimental Conditions	Pre-Test	Cue Word Training	Criterion Word Learning Task	Retention Task	Post-Retention Task
EXPERIMENTER SUPPLIED (cont'd) Word Formation (cont'd)			plus E-S associative images (e.g. pen, penny; image of pen; image of penny) d)Test Trial criterion word (e.g., penny)		
Control	a)Cue-criterion word recognition task (e.g., pen, penny)	No cue word training	a)Learning Trial repetitious presentations of the criterion word plus E-S associative image (e.g., penny + image of penny, penny + image of penny, penny +	a)Test Trial present criterion word (e.g., penny)	a)Two Learning-Test Trials

TABLE 5.8

(continued)

Experimental Conditions	Pre-Test	Cue Word Training	Criterion Word Learning Task	Retention Task	Post-Retention Task
EXPERIMENTER SUPPLIED (cont'd) Control (cont'd)			image of penny) d)Test Trial criterion word (e.g., penny)		

[1]Repeat Cue Word Training (Learning-Test Trials) until subject correctly responds to all three cue words.

[2]Repeat Criterion Learning Task (Learning-Test Trials) until subject elicits two successively correct responses.

[3]Administered approximately two days following Criterion Learning Task.

[4]For all subjects eliciting incorrect responses.

3) Control/Subject-generated Condition (Control/S-G): Subject-generated associative images. -- The subjects in this condition were presented the criterion word and S-G image. These subjects did not receive any strategy instruction.

4) Syntactical/Experimenter-supplied Condition (Syntactical/E-S): Embedded cue word plus experimenter-supplied syntactical strategy and associative images. -- The subjects in this condition were instructed in the use of the embedded cue word as a strategy for learning the criterion word. The subjects were then presented the cue-criterion word combination and the associative images, as well as the E-S syntactical strategy.

5) Word Formation/Experimenter-supplied Condition (Word Formation/E-S): Embedded cue word and experimenter-supplied associative images. -- The subjects in this condition were instructed in the use of the embedded cue word as a strategy for learning the criterion word. The subjects were then presented both the cue and criterion words and E-S images while receiving further instruction concerning the importance of the cue word. This condition did not receive the aid of a syntactical strategy.

6) Control/Experimenter-supplied Condition (Control/E-S): Experimenter-supplied associative images. -- The subjects in this condition received three presentations of each criterion word and E-S image. During each presentation, the experimenter pronounced the criterion word. The subject was asked to repeat each criterion word. No further instructions were given to this group.

All subjects were tested on an individual basis throughout the experiment.

Cue word training. Prior to cue word training, all subjects were administered a pre-test. The pre-test involved a word recognition task comprised of the 18 cue-criterion words listed in Phase I. All subjects were allowed 30 seconds for responding to each of the 36 single word presentations. Any subject correctly identifying more than one of the three criterion words, which was subsequently employed during the criterion learning task, was eliminated from the experiment. Whenever possible, subjects were matched to the six treatment groups on the basis of their IQ level (Peabody Picture Vocabulary Test, Stanford Binet, and Weschler Intelligence Scale for Children). When IQ values were not available, subjects were matched according to the number of cue and criterion words known on the pre-test. Table 5.9 presents the means and standard deviations of the number of correct responses on the pre-test for the 18 cue words and 18 criterion words.

Following the pre-test, all subjects in the Syntactical/S-G, Syntactical/E-S, Word Formation/S-G, and Word Formation/E-S groups received cue word training. During the learning trials, the experimenter presented the cue word and corresponding image to each

TABLE 5.9

Means and Standard Deviations of the Number of Correct Responses on the Pre-test for the 18 Cue Words and 18 Criterion Words

Mediator	Strategy		
	Syntactical	Word Formation	Control
Subject-Generated			
Cue Words			
Mean	8.00	8.18	5.37
S.D.	5.05	5.44	3.32
Criterion Words			
Mean	1.18	1.62	0.81
S.D.	1.79	2.09	1.10
Experimenter-Supplied			
Cue Words			
Mean	4.93	5.18	6.00
S.D.	5.13	5.80	3.88
Criterion Words			
Mean	0.93	0.62	0.93
S.D.	1.73	1.74	1.94

subject for an 8-second interval. Each subject was requested to read the cue word. If the subject was unable to say the word, the experimenter pronounced it. The subject was asked to repeat the word until familiarization with the cue word was achieved. During the test trial, each subject was asked to read the cue word. All subjects received alternate learning and test trials until a correct response for each cue word was elicited. No time limit was imposed on the test trial.

Criterion learning task. The criterion learning task began as soon as each subject completed cue word training. All subjects, including the Control groups, received alternate learning and test trials until two successively correct responses were given for each criterion word. All learning and test trials were automatically presented on the slide projector for an 8-second rate. Subjects in both Syntactical conditions, during learning trials, were presented the underlined cue word and either the E-S or S-G image. The criterion word and corresponding image appeared as the experimenter was instructing the subject on the utility of the embedded cue word for learning the criterion item. Subjects were then presented the cue-criterion word combination and matching image while the experimenter supplied the appropriate verbal strategy. All Syntactical subjects were told how the sentence could help them remember the criterion word and were asked to repeat the strategy. Syntactical subjects were again shown the criterion word and image while the experimenter pronounced the to-be-remembered word. The cue word was underlined during all learning trials for the Syntactical groups only.

The Word Formation subjects were presented the same number of learning trials as the Syntactical subjects. However, the Word Formation subjects were not supplied with a syntactic strategy. These subjects were instructed to associate the familiar cue word to the criterion word with the aid of the E-S or S-G images. Although the subjects in the E-S condition could have used the embedded cue word as a word formation strategy, the possibility was not mentioned during instructions. For the Control subjects receiving the E-S images, the experimenter pronounced the criterion word three times; and each subject repeated the word after the experimenter said it. The subjects in the Control/S-G condition viewed the criterion word and the S-G images while the experimenter pronounced the word. They received one presentation with no instructions on how to remember the criterion word.

On the test trials, all subjects were instructed to read the criterion word. The cue word was not underlined and there were no imaginal strategies available during test trials. Throughout the experiment, subjects received verbal reinforcement and M&M candies for each correct response.

Retention task. The retention task was administered approximately two days following the criterion learning task. All subjects were given a test trial in which they were instructed to read the

criterion word. If a correct response was elicited, the word was removed from the list. Subjects unable to pronounce the word received two more learning trials (L) and two test trials (T) alternately (LTLT). This procedure was the same as during the criterion learning task.

Design and Analysis

The basic design for this study will be a 2 x 3 factorial analysis of variance (ANOVA) to determine if any differences exist between the six treatment conditions in relation to the following dependent variables:

1. Total number of learning trials required to achieve criterion during cue word training.
2. Total number of trials required to achieve criterion during the criterion word learning task.
3. Total number of correct responses during the retention task.

The matrix for each of the 2 x 3 ANOVAs is shown in Table 5.10.

TABLE 5.10

2 x 3 Factorial Analysis of Variance Design

Mediators	Strategies: Syntactical	Strategies: Word Formation	Strategies: Control
Subject-Generated		N = 16/cell	
Experimenter-Supplied			

A Lindquist Type III ANOVA design (Lindquist, 1953) will be used to determine if any differences exist between the treatment groups in relation to the acquisition trials. The dependent variable in this particular analysis will be the total number of correct responses during the criterion learning task.

Further exploratory analyses will involve the computation of certain correlation coefficients in order to measure the amount of interrelationship existing among the following variables:

1. Both age and IQ of the subject population will be correlated with:

   a. total number of learning trials during cue word training
   b. total number of learning trials during the criterion word learning task
   c. total number of correct responses during the retention task.

2. Total number of cue words known on the pre-test will be correlated with the total number of learning trials during cue word training.

3. Total number of criterion words known on the pre-test will be correlated with the total number of learning trials during the criterion word learning task.

4. Total number of learning trials required to achieve criterion during the criterion word learning task will be correlated with the total number of correct responses during the first trial of the retention task.

Results and Discussion

The following results are organized into two sections. In Section I the main analyses of the dependent variables are reported. Additional analyses concerning the relationships between the dependent variables, for both the ungrouped and grouped data, are reported in Section II. For all analyses, the .05 level of significance was used as the basis for rejecting the null hypothesis.

Section I

The subjects in this experiment were drawn from three locations; therefore, a measure of homogeneity was needed to justify the pooling of subjects from the different locations. A total of 12 Chi-square analyses were computed in order to assess the degree of homogeneity existing among the three populations. A Chi-square analysis was applied to both the criterion word learning trials and the number of correct responses during the retention task for each treatment condition. Each analysis indicated no significant differences existing among the three populations for any of the six treatment conditions. Thus, the assumption of homogeneity was confirmed. Table 5.11 presents the two Chi-square values for each treatment condition.

In order to further assess the comparability of the six groups, performance during the pre-test was examined. Two 2 x 3 ANOVAs were performed on the total number of cue words and the total number of criterion words known during the pre-test. Table 5.12 presents the means and standard deviations of the number of correct responses on the pre-test for the 18 cue words. Analysis of the data in Table 5.12 revealed no significant differences between the Mediator main effect

TABLE 5.11

Chi-square Values for the Measure of Homogeneity Among the Three Populations for the Criterion and Retention Tasks

Treatment Condition		Chi-square Value	Observed Percentile
Syntactical/S-G	Criterion Learning	5.64	.68 NS
	Retention	1.30	.52 NS
Word Formation/S-G	Criterion Learning	8.83	.54 NS
	Retention	5.77	.45 NS
Control/S-G	Criterion Learning	9.22	.32 NS
	Retention	5.87	.20 NS
Syntactical/E-S	Criterion Learning	5.95	.91 NS
	Retention	11.60	.37 NS
Word Formation/E-S	Criterion Learning	17.77	.21 NS
	Retention	8.35	.60 NS
Control/E-S	Criterion Learning	3.24	.82 NS
	Retention	10.79	.31 NS

TABLE 5.12

Means and Standard Deviations of the Number of Correct Responses on the Pre-test for the 18 Cue Words

Mediator	Condition					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Subject-Supplied	8.00	5.05	8.18	5.44	5.37	3.32
Experimenter-Supplied	4.93	5.13	5.18	5.82	6.00	3.88

(F (1,90) = 3.34, $p > .05$), or the Strategy main effect (F (1,90) = .37, $p > .05$). The Mediator x Strategy interaction term was also nonsignificant. Table 5.13 presents the means and standard deviations of the number of correct responses on the pre-test for the 18 criterion words. A 2 x 3 ANOVA design indicated no significant differences for the Mediator main effect (F (1,90) = 1.03, $p > .05$) or for the Strategy main effect (F (1,90) = .17, $p < .05$). The interaction term for these two main effects was also nonsignificant.

TABLE 5.13

Means and Standard Deviations of the Number of Correct Responses on the Pre-test for the 18 Criterion Words

Mediator	Condition					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Subject-Supplied	1.18	1.79	1.62	2.09	0.81	1.10
Experimenter-Supplied	0.93	1.73	0.62	1.74	0.93	1.94

The analyses of the pre-test data, for both the cue and criterion words, indicated that the subjects assigned to the mediator and strategy groups were similar in learning capacities prior to the introduction of the mnemonic aids.

The means and standard deviations for the total number of trials required to achieve criterion during the cue word training task are presented in Table 5.14. A 2 x 2 ANOVA design was used to analyze these data. The two Control groups did not receive cue word training; therefore, they were not included in the analysis. The Mediator main effect was not significant, indicating that the two mediator conditions (S-G and E-S) required approximately the same number of learning trials to achieve criterion during the cue word learning task. However, there was a significant difference (F (1,60) = 4.34, $p < .05$) obtained for the Strategy main effect which indicates that the subjects in the Word Formation condition required more trials to learn the cue words than subjects in the Syntactical condition. The subject-generated cue words (e.g., pen, peppermint stick, ship), presented to the subjects in the Word Formation/S-G condition, contained more letters than the experimenter-supplied cue words (e.g., pen, can, cap); therefore, the Word Formation/S-G condition required additional learning trials. The Mediator x Strategy interaction term was not significant.

The total number of trials required to achieve criterion during the criterion word learning task was analyzed by a 2 x 3 ANOVA. The means and standard deviations are presented in Table 5.15. A significant difference (F (1,90) = 10.21, $p < .01$) was found for the

TABLE 5.14

Means and Standard Deviations of the Total Number of Trials Required to Achieve Criterion During the Cue Word Training Task

Mediator	Condition			
	Syntactical		Word Formation	
	Mean	S.D.	Mean	S.D.
Subject-Supplied	3.37	0.61	4.18	1.22
Experimenter-Supplied	3.56	1.03	3.87	1.31

TABLE 5.15

Means and Standard Deviations of the Total Number of Trials Required to Achieve Criterion During the Criterion Word Learning Task

Mediator	Condition					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Subject-Supplied	7.31	2.05	7.31	1.74	7.18	1.64
Experimenter-Supplied	7.81	1.68	9.18	2.37	9.00	3.01

Mediator main effect, indicating that subjects presented with the S-G mediators required fewer learning trials to achieve criterion than subjects receiving the E-S mediators. The mean response for the E-S group was 1.38 trials greater than the mean response for the S-G group. Both mediator groups were similar in learning performance prior to the criterion and learning task. It appears as if mentally retarded subjects learn at a faster rate when presented with mediators that have been constructed by children having similar learning deficits. The Strategy main effect was not significant, showing that the Syntactical, Word Formation, and Control groups learned the criterion words at approximately the same rate. The Mediator x Strategy interaction term also was nonsignificant.

The learning curves for all groups on the criterion word learning task are presented in Figure 5.1. Individual learning curves for the two mediator conditions (S-G and E-S) and the three strategy conditions (Syntactical, Word Formation, and Control) are presented in Figures 5.2, 5.3, 5.4, 5.5, and 5.6, respectively. The mean number of correct responses was plotted as a function of the total number of learning trials administered during the criterion task. A ceiling effect appeared during trials four and five as a result of the two successive correct responses required by each subject in order to achieve criterion.

The total number of correct responses during the criterion task was subjected to a Lindquist Type III analysis of variance (Lindquist, 1953). The means and standard deviations are presented in Table 5.16. The Mediator main effect was significant (F (1,90) = 7.25, $p < .01$) indicating that the S-G group elicited a significantly greater number of correct responses during the criterion task than the E-S group. This result was expected since the S-G group achieved the learning criterion at a significantly faster rate. Inspection of the learning curves for the six groups (Figure 5.1) reveals that during the acquisition trials the three S-G conditions performed at a higher rate than the three E-S conditions. The Strategy main effect was not significant indicating that each of the three strategy conditions were similar in performance during the criterion task. Figures 5.4, 5.5, and 5.6 present the learning curves for the Syntactical, Word Formation, and Control conditions, respectively. A comparison of these three curves reveals that the two Syntactical conditions produced a greater number of correct responses during the first trial. However, trials one through three indicate the rate of acquisition to be remarkably similar for all groups. There was also a significant difference (F (4,360) = 65.31, $p < .0001$) found for the Trials main effect, indicating that all groups improved through the criterion task. Although successive learning trials increased the response performance in each group, the significant Trials x Mediator interaction term (F (4,360) = 6.05, $p < .001$) shows that the S-G and E-S groups learned at different rates. Figures 5.2 and 5.3 present the learning curves for the S-G and E-S groups, respectively. The three strategy conditions receiving the S-G mediators (Figure 5.1) performed similarly throughout the five learning trials. However, inspection of the learning curve in

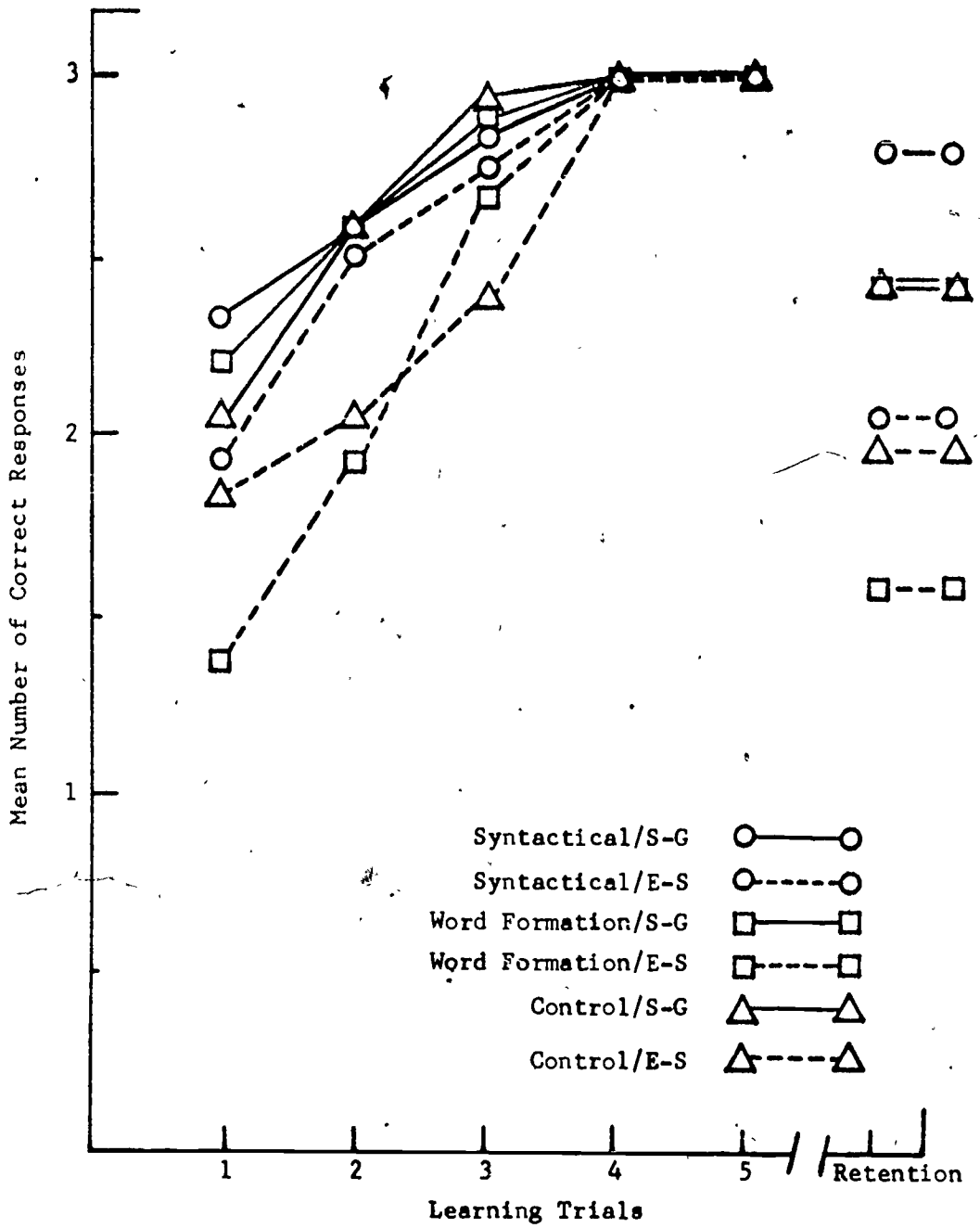


Figure 5.1. Mean number of correct responses for each group on acquisition and retention.

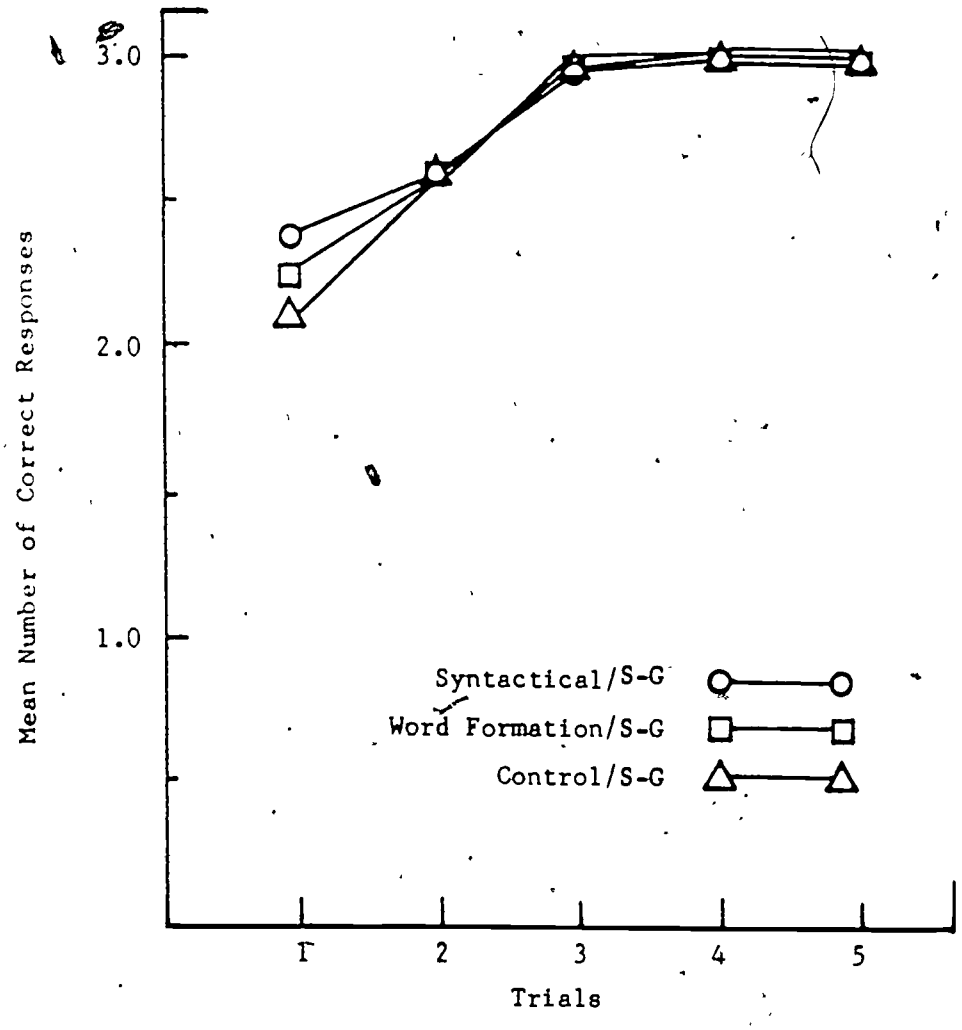


Figure 5.2. Mean number of correct responses on acquisition for the three subject-generated conditions.

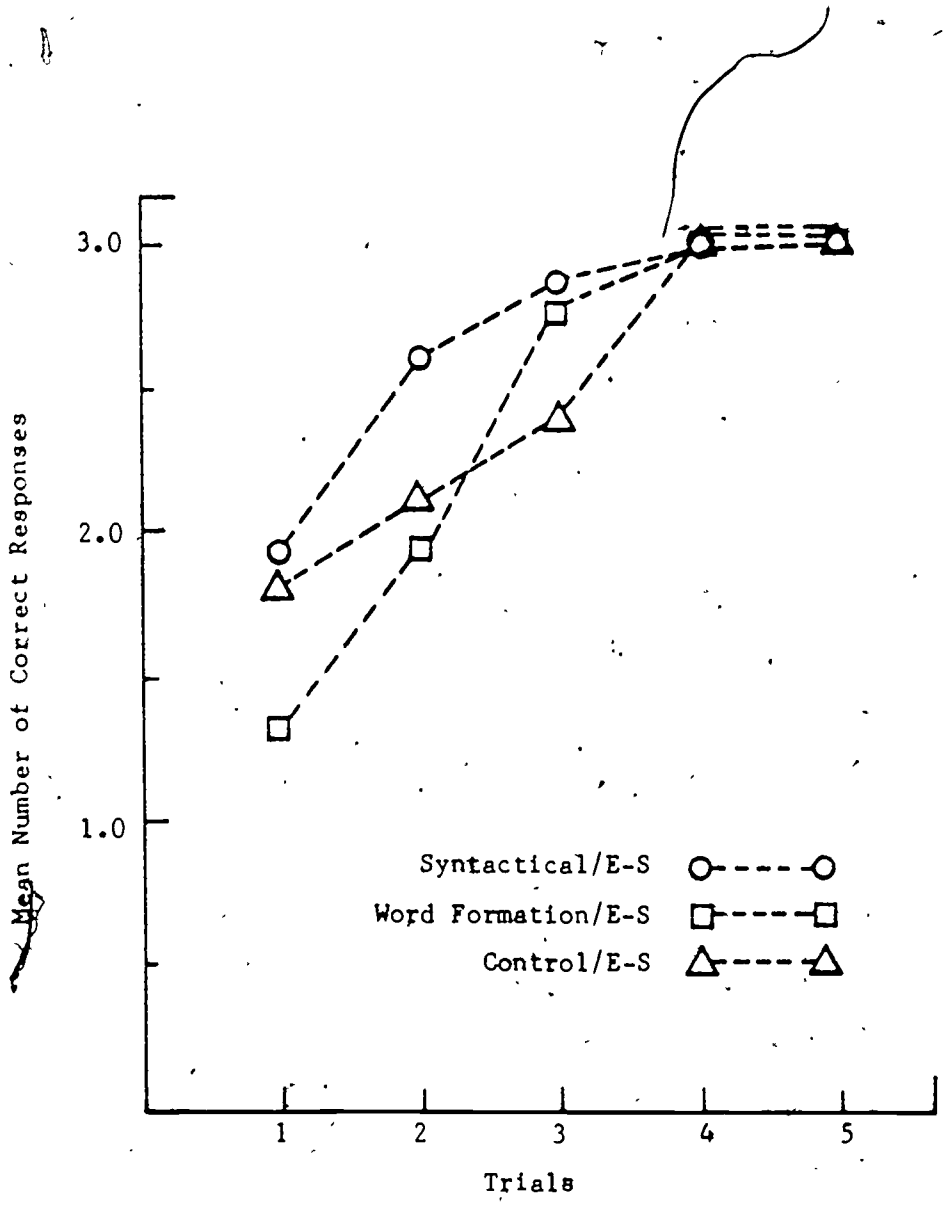


Figure 5.3. Mean number of correct responses on acquisition for the three experimenter-supplied conditions.

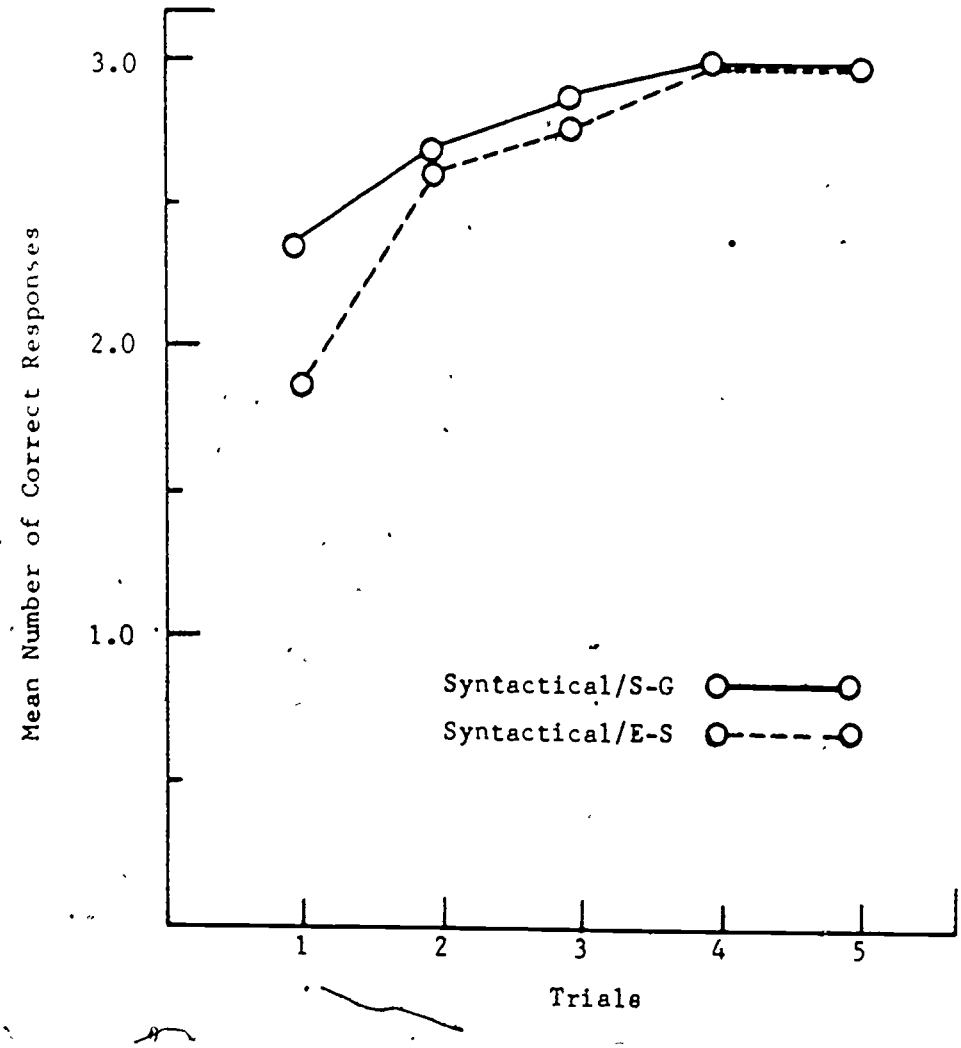


Figure 5.4. Mean number of correct responses on acquisition for the Syntactical/S-G and Syntactical/E-S conditions.

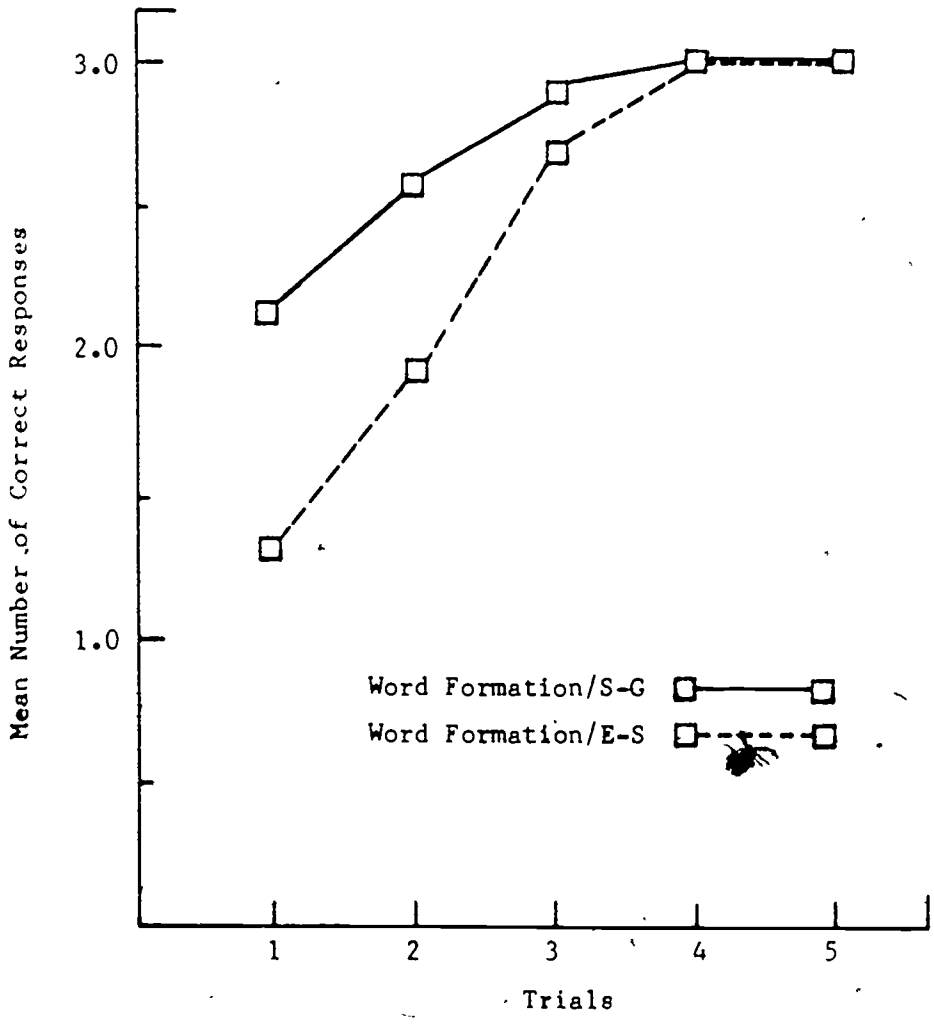


Figure 5.5. Mean number of correct responses on acquisition for the Word Formation/S-G and Word Formation/E-S conditions.

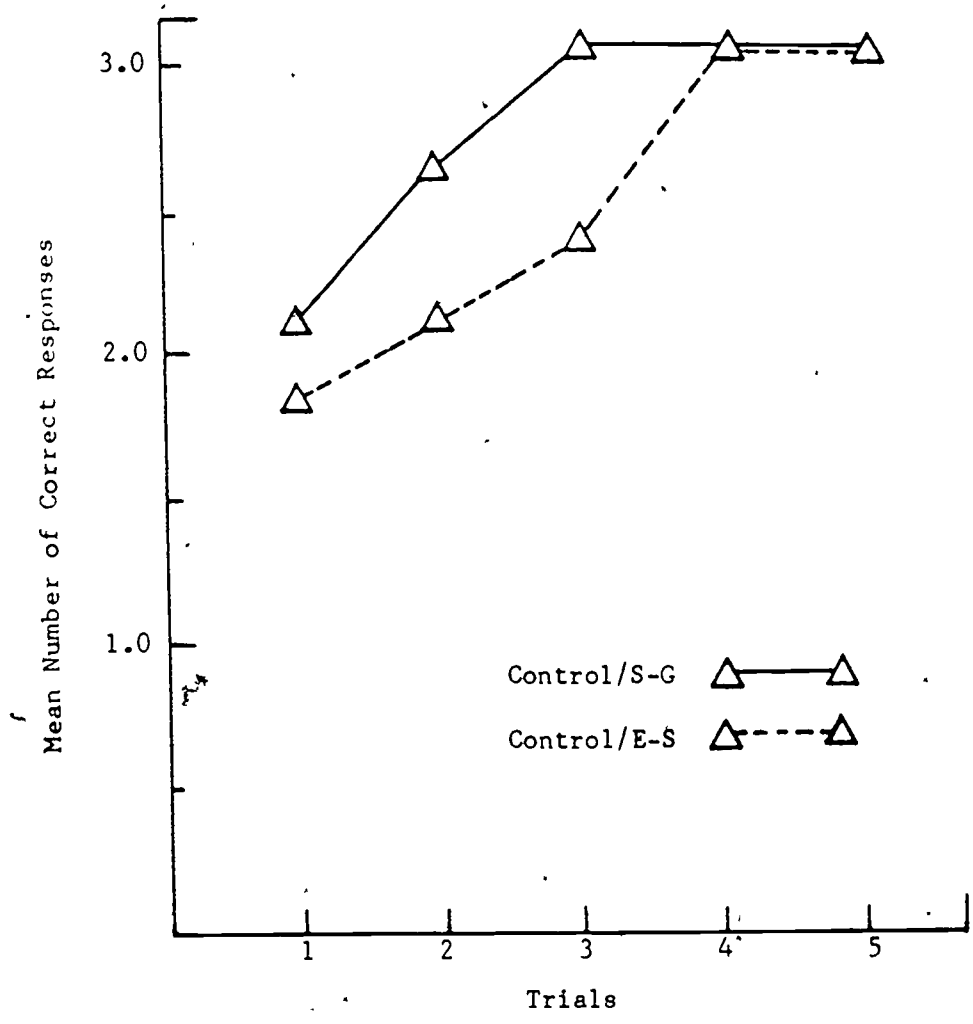


Figure 5.6. Mean number of correct responses on acquisition for the Control/S-G and Control/E-S conditions.

Figure 5.2 reveals that the performance of the Word Formation/E-S condition is inferior to the performance of the other two E-S conditions.

TABLE 5.16

Means and Standard Deviations of the Total Number of Correct Responses During the Criterion Word Learning Task

Mediator	Condition					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Subject-Supplied	44.40	2.31	44.60	2.53	44.20	3.04
Experimenter-Supplied	42.80	3.52	38.00	6.03	39.60	4.22

The performance of the three E-S groups (Figure 5.2) was subjected to a Lindquist Type I analysis of variance (Lindquist, 1953). The means and standard deviations for the number of correct responses during the criterion task are presented in Table 5.17. Although the Strategy main effect was not significant (F (2,93) = 2.24, $p > .05$) there was a significant difference (F (4,372) = 91.24, $p < .0001$) obtained for the Trials main effect. The interaction term Trials x Strategy was also found to be significant (F (8,372) = 5.15, $p < .0001$). These results indicate that the three E-S groups did learn the criterion words at significantly different rates. No other terms were found to be significant.

TABLE 5.17

Means and Standard Deviations of the Number of Correct Responses for the Three Experimenter-Supplied Groups on the Criterion Word Learning Trials

Learning Trials	Condition					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Trial 1	1.93	2.07	1.43	2.60	1.81	3.07
Trial 2	2.68	1.34	1.93	2.81	2.18	2.39
Trial 3	2.81	0.90	2.75	1.00	2.43	1.41
Trial 4	3.00	0	3.00	0	3.00	0
Trial 5	3.00	0	3.00	0	3.00	0

The retention task was administered approximately two days following the criterion word learning task. Table 5.18 presents the means and standard deviations for the total number of correct responses during the test trials. A comparison of the means presented in Table 5.18 was made by using a 2 x 3 ANOVA design. A highly significant mediator effect was obtained (F (1,90) = 16.98, $p < .001$) indicating that the S-G group retained more criterion words than the E-S group. On the average, the subjects in the three S-G conditions remembered 1.46 more criterion words than those subjects in the three E-S conditions. The Strategy main effect was not significant, showing that each of the Syntactical, Word Formation, and Control conditions elicited a similar number of correct responses during the retention task. The Mediator x Strategy interaction term was also nonsignificant.

TABLE 5.18

Means and Standard Deviations of the Number of Correct Responses During the Retention Task

Mediator	Condition					
	Syntactical		Word Formation		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Subject-Supplied	2.75	0.39	2.44	0.70	2.44	0.70
Experimenter-Supplied	2.13	0.90	1.56	0.93	2.00	1.06

The data from the 2 x 3 ANOVAs clearly demonstrate that the S-G mediators were much more beneficial in learning as well as in retention of the criterion words than the E-S mediators. The results concerning the strategy applications showed the performance of the Syntactical condition to be significantly greater than the Word Formation condition during the cue word learning task. However, the data from the criterion word learning task, as well as from the retention task, demonstrate that the Syntactical, Word Formation, and Control conditions did not differ during the acquisition trials or during the retention task. Further analysis of these data was conducted in an effort to identify those variables most responsible for the results obtained during the acquisition and retention tasks.

Section II

The Pearson product-moment correlation coefficient (r) was used to measure the degree of linear relationship existing between the age and IQ of the subjects and the following dependent variables: 1) total number of criterion words known on the pre-test; 2) total number of trials required to achieve criterion during the

cue word learning task; 3) total number of trials required to achieve criterion during the criterion word learning task; and 4) total number of correct responses during the retention task. The number of trials required to achieve criterion during the criterion task was also correlated with each of the other three dependent variables. Correlation coefficients were computed for both the grouped and ungrouped data.

Table 5.19 presents the correlations for the ungrouped data. The age of the subjects ($N = 96$) was found to correlate significantly ($r = .36$, $p < .001$) with the number of criterion words known on the pre-test. The subjects in this experiment ranged in age from 10 years to 66 years. A positive correlation was expected between chronological age and the number of cue and criterion words recognized on the pre-test. A significant negative correlation ($r = -.26$, $p < .05$) existed between the subjects' IQ and the number of trials required to achieve criterion during the criterion word learning task. The mean IQ of the subject population was 53.40, with IQs ranging from 35 to 74. As expected, subjects with higher IQs reached criterion more rapidly during the learning trials than subjects having lower IQs. However, the correlation coefficient was quite low ($r = -.26$), but significant at the .05 level.

The number of trials required to achieve criterion during the criterion task was negatively ($r = -.22$, $p < .05$) related to the number of criterion words known on the pre-test. A high negative correlation ($r = -.67$, $p < .0001$) was obtained between the rate of acquisition during the criterion task and the number of correct responses during the retention task. The correlation coefficient obtained between the performance on the criterion task and the number of criterion words known on the pre-test was quite low ($r = -.22$), indicating that the fewer criterion words known on the pre-test, the greater the number of learning trials that were required to achieve criterion. However, the coefficient found between the performance on the criterion task and the number of correct responses during the retention task was much higher ($r = -.66$), indicating that the fewer the number of learning trials needed to achieve criterion, the greater the number of correct responses during the retention task. The results for the ungrouped data highly suggest that the linguistical and imaginal associations employed during the criterion task significantly aided the retarded subjects in overcoming their initial learning deficit. All other correlations for the ungrouped data were found to be nonsignificant.

The same variables for the subject-assigned (grouped) data were also analyzed using the Pearson product-moment correlation coefficient. The correlation coefficients for the Syntactical/S-G condition are presented in Table 5.20. A significant ($r = -.51$, $p < .05$) negative correlation was found between the age of the subjects and the number of learning trials required to achieve criterion during the cue word training task. The subjects in this group ranged in age from 12 years to 64 years, with a mean age of 31.37 years. Although all Syntactical/S-G subjects reached criterion by the second test trial, it appears as if the older subjects met criterion

TABLE 5.19

Correlation Coefficients (r) Among the Dependent Variables for the Ungrouped Data

N = 96	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.36***	-.07 NS	-.05 NS	-.06 NS
IQ	.007 NS	.05 NS	-.26*	-.19 NS
Learning Trials Criterion Word (to criterion)	-.22*	.06 NS	--	-.67****

* $p < .05$

*** $p < .001$

**** $p < .0001$

TABLE 5.20

Correlation Coefficients (r) Among the Dependent Variables in the Syntactical/S-G Condition

N = 16	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.41 NS	-.51*	-.21 NS	-.11 NS
IQ	.61*	-.16 NS	.08	-.12 NS
Learning Trials Criterion Word (to criterion)	-.39 NS	.37 NS	--	-.85****

* $p < .05$

**** $p < .0001$

by the first test trial. There was not a significant relationship between the age of the subjects and the learning trials during the criterion task nor between the age of the subjects and the number of correct responses on the retention task. The IQ of the subjects in this group was significantly (r = .61, p < .05) related to the number of criterion words known on the pre-test. However, IQ measures did not correlate with any of the other dependent variables. The number of learning trials required to achieve criterion during the criterion task negatively correlated (r = -.85, p < .0001) with the number of correct responses on the retention task. The negative relationship between the performance on the criterion and retention tasks was extremely high (r = -.85), indicating that the Syntactical subjects receiving the S-G mediators required a minimum number of learning trials and still retained a high percentage of the criterion words.

Table 5.21 presents the correlation coefficients for the Syntactical/E-S condition. None of the dependent variables in this group were significantly related to the age of the subjects. However, a significant (r = -.54, p < .05) negative correlation was found between the IQ of the subjects and the number of learning trials needed to achieve criterion. The IQ scores were also found to be significantly (r = .61, p < .05) related to the number of correct responses on the retention task. Performance during the criterion task was negatively correlated (r = -.60, p < .01) with the number of correct responses during the retention task.

The correlation coefficients for the Word Formation/S-G condition are presented in Table 5.22. A significant (r = -.59, p < .05) negative correlation was obtained between the age of the subjects and the number of learning trials required to achieve criterion during the cue word training task. It appears that the older subjects in this group learned the cue words at a faster rate than the younger subjects. The chronological age of these subjects ranged from 11 years to 66 years with a mean age of 26.18 years. The IQ of the subjects was found to be unrelated to all of the dependent variables. The only other significant (r = .53, p < .05) relationship obtained for the Word Formation/S-G condition was between the number of learning trials required to achieve criterion during both the cue word training task and the criterion task.

Only one significant correlation was obtained for the Word Formation/E-S condition. Table 5.23 presents the correlation coefficients for this group. The age of the subjects was significantly (r = .54, p < .05) related to the number of criterion words known on the pre-test, indicating that the older subjects recognized more criterion words. The IQ of the subjects was unrelated to each of the dependent variables. The relationship between the rate of acquisition and the performance during the retention task was not significant.

The correlation coefficients for the Control/S-G group are presented in Table 5.24. Neither of the Control conditions received cue word training; therefore, no correlations were computed

TABLE 5.21

Correlation Coefficients (r) Among the Dependent Variables in the Syntactical/E-S Condition

N = 16	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.06 NS	-.23 NS	.19 NS	.28 NS
IQ	-.11 NS	-.16 NS	-.54*	+.61*
Learning Trials Criterion Word (to criterion)	-.34 NS	-.12 NS	--	-.60*

* $p < .05$

TABLE 5.22

Correlation Coefficients (r) Among the Dependent Variables in the Word Formation/S-G Condition

N = 16	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.16 NS	-.59*	-.25 NS	.19 NS
IQ	-.37	-.19 NS	.04 NS	.06 NS
Learning Trials Criterion Word (to criterion)	-.36	.53*	--	-.44 NS

* $p < .05$

TABLE 5.23

Correlation Coefficients (r) Among the Dependent Variables in the Word Formation/E-S Condition

N = 16	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.54*	-.39 NS	-.07 NS	-.35 NS
IQ	.11 NS	.30 NS	-.44 NS	.07 NS
Learning Trials Criterion Word (to criterion)	-.19 NS	.43 NS	--	-.43

* $p < .05$

TABLE 5.24

Correlation Coefficients (r) Among the Dependent Variables in the Control/S-G Condition

N = 16	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.65**	--	.02 NS	-.35 NS
IQ	.01 NS	--	-.25 NS	-.35 NS
Learning Trials Criterion word (to criterion)	-.27	--	--	-.74**

** $p < .01$

for this dependent variable. The age of the subjects in this group was significantly (r = .65, p < .01) related to the number of criterion words known on the pre-test. Also significantly (r = -.74, p < .01) correlated were the number of learning trials required to achieve criterion during the criterion task and the number of correct responses on the retention task.

Table 5.25 presents the correlation coefficients for the Control/E-S condition. Once again, the age of the subjects was significantly (r = .50, p < .05) correlated with the number of criterion words known on the pre-test. As expected, the older subjects recognized more criterion words during the pre-test than the younger subjects. The IQ of the Control/E-S subjects was found to be unrelated to each of the dependent variables. The rate of acquisition during the criterion task was negatively (r = -.68, p < .001) related to the number of correct responses on the retention task.

In summary, the subjects in this study were administered various linguistical and imaginal associative aids and then told how each mnemonic would help in remembering the list of unfamiliar words. Half of the subjects received mediators that had been generated by a group of retarded students, while the remaining subjects received mediators that had been constructed by the experimenter. The results of the foregoing analyses demonstrate that retarded subjects can learn at a significantly faster rate and retain a greater amount of information when instructed in the application of subject-generated associations.

While the retarded students were constructing the associations, that were subsequently presented to the S-G condition, some major differences were noticed between the two mediator groups. The retarded students produced syntactical strategies that were more active, in a grammatical sense, than were the E-S mediators. The associative images in each of the S-G groups were found to be graphically more complex than those used in the E-S groups. It was anticipated that the retarded students would produce images of a somewhat simpler content. Such a difference strongly suggests that the retarded individual, and possibly the beginning reader, relies more heavily upon visual aids in a learning situation than upon verbal means of association.

The data from the strategy conditions show that the Syntactical, Word Formation, and Control applications did have an affect upon the rate of acquisition during the criterion word learning task. Inspection of the learning curves for the S-G strategies (Figure 5.2) and for the E-S strategies (Figure 5.3) reveals that all conditions improved throughout the criterion task. However, the data also indicate that these same strategies did not have an affect upon performance during the retention task.

The results indicate that the three conditions receiving the S-G mediators had little difficulty understanding the value of

TABLE 5.25

Correlation Coefficients (r) Among the Dependent Variables in the Control/E-S Condition

N = 16	Pre-test Criterion Words	Learning Trials Cue Words (to criterion)	Learning Trials Criterion Words (to criterion)	Retention Task
Age	.50*	--	.24 NS	.04 NS
IQ	.03 NS	--	.47 NS	-.24 NS
Learning Trials Criterion Word (to criterion)	.07 NS	--	--	-.68**

* $p < .05$

** $p < .01$

associating the verbal and visual cues to the list of unfamiliar words. The performance for these strategy conditions was similar throughout the criterion and retention tasks, indicating that the three strategy formations were equally effective when constructed with subject-generated mediators. However, when less facilitative mediators were introduced, as were those employed within the E-S conditions, then subjects relied upon the strategy formations as a means of acquiring and retaining the unfamiliar words. Hence, a significant Trial x Strategy interaction was obtained during the learning trials for the E-S conditions indicating that the performance of these three groups increased at different rates. Inspection of the learning curves for the E-S conditions (Figure 5.3) shows that the performance of the Word Formation subjects was remarkably inferior to that of the Syntactical and Control subjects. The relationships between the performance on the criterion task and the number of correct responses during the retention task, for both the Syntactical/E-S and Control/E-S conditions, were significantly negatively correlated (-.60 and -.68, respectively), demonstrating the facilitative effects of both groups. However, the correlation coefficient found between the same dependent variables for the Word Formation/E-S condition was not significant.

The negative results obtained for the Word Formation/E-S condition highly suggest that these subjects experienced the most difficulty in understanding the concept of the verbal associations. It was this group's task to associate the embedded cue word to the unfamiliar criterion word (i.e., pen-penny). Have to associate two completely unrelated words was conceptually too abstract for these subjects. However, when Syntactical subjects were instructed to repeat a phrase which includes both the cue and criterion words, such as, "The pen cost a penny," then the functional value of the strategy became more obvious. The data for the Control/E-S condition also suggested that subjects profit more by repeating the unfamiliar words than by using the embedded cue word strategy.

Conclusions

The first hypothesis proposed in this study, concerning the facilitative effects of the subject-generated mediators during both acquisition and retention, was supported. Subjects instructed to link the PA items by the use of S-G mediators performed significantly better throughout the experiment than those instructed in the use of E-S mediators. The rate of acquisition correlated negatively with the number of correct responses during recall. This relationship suggests that the S-G subjects reached criterion faster than the E-S subjects during the initial learning trials and produced a higher level of performance during the retention task.

Most of the PA research involving the manipulation of mediators have shown facilitative effects when instructing subjects to formulate their own verbal and/or visual aids during the testing situation.

The main objective of the present study was to demonstrate the occurrence of similar affects when administering mediators which had been constructed prior to the testing situation. In particular, sets of mediators which had been selected from hierarchies of actual images and linguistical strategies, having been produced by a retarded population with the same limitations as the experimental subjects.

Bower (1968) has repeatedly demonstrated significant facilitation of PA learning when instructing subjects to elaborate noun pairs by both verbal and visual means. However, there is a limited amount of research available that has concerned itself with the categorization of learning strategies which the retarded person might use in remembering words. The results of this experiment provide convincing evidence that further identification of the associative strategies, employed during various stages of learning, is necessary.

Although there is evidence indicating that during recall both Syntactical conditions performed better than the Word Formation and Control conditions, the hypotheses concerning the desired effectiveness of the strategy applications were not supported. The subjects instructed in the use of S-G mediators and who received the Syntactical strategy, performed better than each of the other conditions during acquisition as well as retention. However, the Word Formation/S-G and Control/S-G conditions performed remarkably similar during acquisition. The retention results show that these same two conditions gave an identical number of correct responses during recall. These data indicate that when S-G verbal mediators, specifically sentence constructions, are accompanied by S-G visual aids, associative learning is enhanced.

A separate analysis of the E-S conditions revealed a significant amount of variance existing within these three strategy conditions during acquisition. The performance of the Syntactical/E-S and Control/E-S conditions significantly differed from that of the Word Formation/E-S condition during the criterion task. The analysis shows that subjects profited by the Syntactical associations and by rote repetition more so than by the embedded cue word strategy. The retention data also show that the Syntactical/E-S and Control/E-S subjects elicited more correct responses during the retention task than did the Word Formation/E-S subjects. Since all of the E-S conditions received the same visual mediators, it appears as if the Word Formation condition experienced difficulty in understanding the utility of the cue word strategy. Instructing retarded subjects to repeat a meaningful sentence, or to repeat a word three times is much simpler to comprehend than instructing them to associate two words. During the construction of the S-G mediators it was obvious that subjects did not notice the embedded cue word within each criterion word. When these subjects were asked to supply a word that would help them remember the criterion word they consistently reported an association that was more related in a meaningful context. For example, when given the word "candy" most subjects,

having overlooked the embedded word "can," responded with a particular type of candy such as peppermint stick, candy cane, chocolate bar, etc.

The developmental literature, concerning mediational studies in PA learning, provide a similar explanation for the negative results obtained with the strategy conditions. Milgram (1967) has stated that with younger children, the facilitation of PA learning in a visual compound depends upon covert encoding of the pictured interaction in verbal form. However, as the present study indicates, this learning sequence is severely hampered by the introduction of inappropriate verbal forms, as were the embedded cue word strategies.

Rohwer (1970) presents convincing evidence that pictures evoke images at all age levels. However, Rohwer further states that the ability to profit from stored images, is contingent upon the subject's ability to store an "appropriate" verbal representation of the object along with its image. Once again, the analysis of the strategy conditions shows that during the Word Formation/E-S presentation the visual interactions of the objects displayed (e.g., pen-penny) were not properly presented in verbal form.

In general, the hypotheses concerning the relationship between the criterion word learning trials and performance during the retention task were supported. The most significant negative correlation was obtained for the Syntactical/S-G group ($r = -.85$). As was predicted for these subjects, a minimum number of learning trials was required to achieve criterion while yielding a maximum number of correct responses on the retention task. The correlation coefficient for the Syntactical/E-S group was somewhat smaller ($r = -.60$), indicating less facilitative effects with the E-S mediators.

It was interesting to find that neither of the Word Formation conditions had significant relationships between the criterion and retention tasks. The correlation coefficient was larger for the Word Formation/S-G condition, suggesting that the S-G cue words were more facilitative than were the embedded cue word strategies. It is also possible that the imaginal presentations in these conditions hindered the subjects. However, this explanation is most unlikely when considering that the same visual strategies were presented to the two Control conditions and that the relationships between the same dependent variables for both of these conditions were also negative.

The results of the above correlations provide further evidence that S-G mediators are more facilitative during an associative learning task than are E-S mediators. The analysis of the strategy applications also demonstrate that retarded subjects learn faster and retain more words when they are constructed into meaningful sentences. Consequently, the hypothesis concerning the syntactical strategy formation, based upon the studies of Jensen and Rohwer (1965) and Martin (1967), were supported in this study.

In summary, the results of this experiment clearly demonstrated that S-G mediators are more effective than E-S mediators during simultaneous presentations of visual and verbal strategies. The acquisition and retention analyses revealed that the retarded subjects learned the associations much faster and retained more information when presented with S-G mediators, and especially so when the words were formed into a meaningful sentence.

In essence, this study has shown the structural and functional differences which exist between two sets of mediators that have been constructed by a retarded and a normal population. Such results suggest that further identification of associative strategies is necessary, especially with respect to developmental differences. It is also suggested that all strategies, for each developmental stage should be ranked along a continuum of increasing complexity. The present results indicate that retarded subjects can profit from the more complex strategies when they have been constructed by other retardates. However, further research is needed to identify, in a hierarchial fashion the limitations of associative learning at each developmental level.

CHAPTER VI

EXPERIMENT V -- DRAWING STYLE PREFERENCES OF EDUCABLE MENTALLY RETARDED CHILDREN

Introduction

This experiment was concerned with determining drawing style preferences of educable mentally retarded (EMR) children. Assuming animation is a viable approach for facilitating learning among the retarded, then an important consideration in animated films is the drawing style and character preferences of retarded viewers. It is assumed that animated learning materials will elicit higher motivational and attentional levels than more conventional manual or slide presentations. Animated film offers the opportunity to present learning strategies in a more efficient and effective manner. That is, by using animated materials it may be possible to induce learning strategies in the mentally retarded which otherwise would not be available to them.

The use of animated film strips by Rohwer (1970) demonstrated that action imagery is more effective than static imagery on learning in paired-associate lists. However, little research information is available concerning the type or style of characters which most effectively mediate the imagery or strategy information.

Several variables were examined in the present experiment so that a determination of the optimal style and content of drawings to be used in future experiments could be made. Four ordered variables were examined:

1) Age of the subject depicted in the drawing (infancy through old age;
2) Media richness (pencil drawings through color);
3) Realism of the object depicted in the drawing (stick figure through realistic); and
4) Background detail included in the drawing.

In addition, three variables which were not ordered were examined:

1) Mood of the object depicted in the drawing (happy, sad, angry, afraid);
2) Personality of the object depicted in the drawing (cute, dumb, cocky, cultured); and
3) Type of animal depicted in the drawing (lion, elephant, bull, wolf).

Method

Subjects

A total of 11 subjects (six males and five females) from the Texas State School for the Mentally Retarded in Mexia, Texas, were used for each picture set, with the exception of two sets, for ~~which 12 subjects (seven males and five females) were used.~~ Subjects participating in the study were taken from educational levels two, three, and four at the school (age range from 7 to 15).

Procedure

Four drawings for each of nine picture sets (one set for each of the seven independent variables with an additional set for the age and media richness variables) were prepared for the study. Figure 6.1 shows the pictures used. Each drawing was done with pencil on white paper, with the exception of the two sets concerned with media richness, in which one picture per set was done with black ink and one picture was done with ink and colored pencils.

Each set of drawings was randomly arranged and the subject was asked to select the drawing he would most like to read a story about. The chosen drawing was removed and the subject was asked to do the same with the three remaining drawings and so on until all drawings were removed. After each of the drawings in the nine sets had been placed in order of popularity within the set, the first choice from each set (excluding the two media richness sets) was placed on the table and the subject was again asked to select his favorite drawing. The two media richness sets were not included in the latter exercise because these sets had been previously rank-ordered by a different group of subjects.

Results and Conclusions

Because the data were based on rank orderings, Friedman's analog of the 1 x k ANOVA (Kraft & Eeden, 1968) was performed for each of the nine picture sets. The Tukey test was performed on all significant overall effects found in the Friedman test so that post hoc comparisons of mean ranks could be made (Hartley, 1955; Wilcoxon & Wilcox, 1964). In addition, a preference test (Snedecor & Cochran, 1967) was performed to determine whether there was a preference for human or animal drawings among the seven most popular drawings chosen by the subjects.

The mean ranks for the four drawings in each of the nine picture sets are presented in Table 6.1. The results of the Friedman test performed on the two age sets indicated a significant difference ($X^2 = 13.25$, df = 3, $p < .01$) in one of the age sets (Set 1,

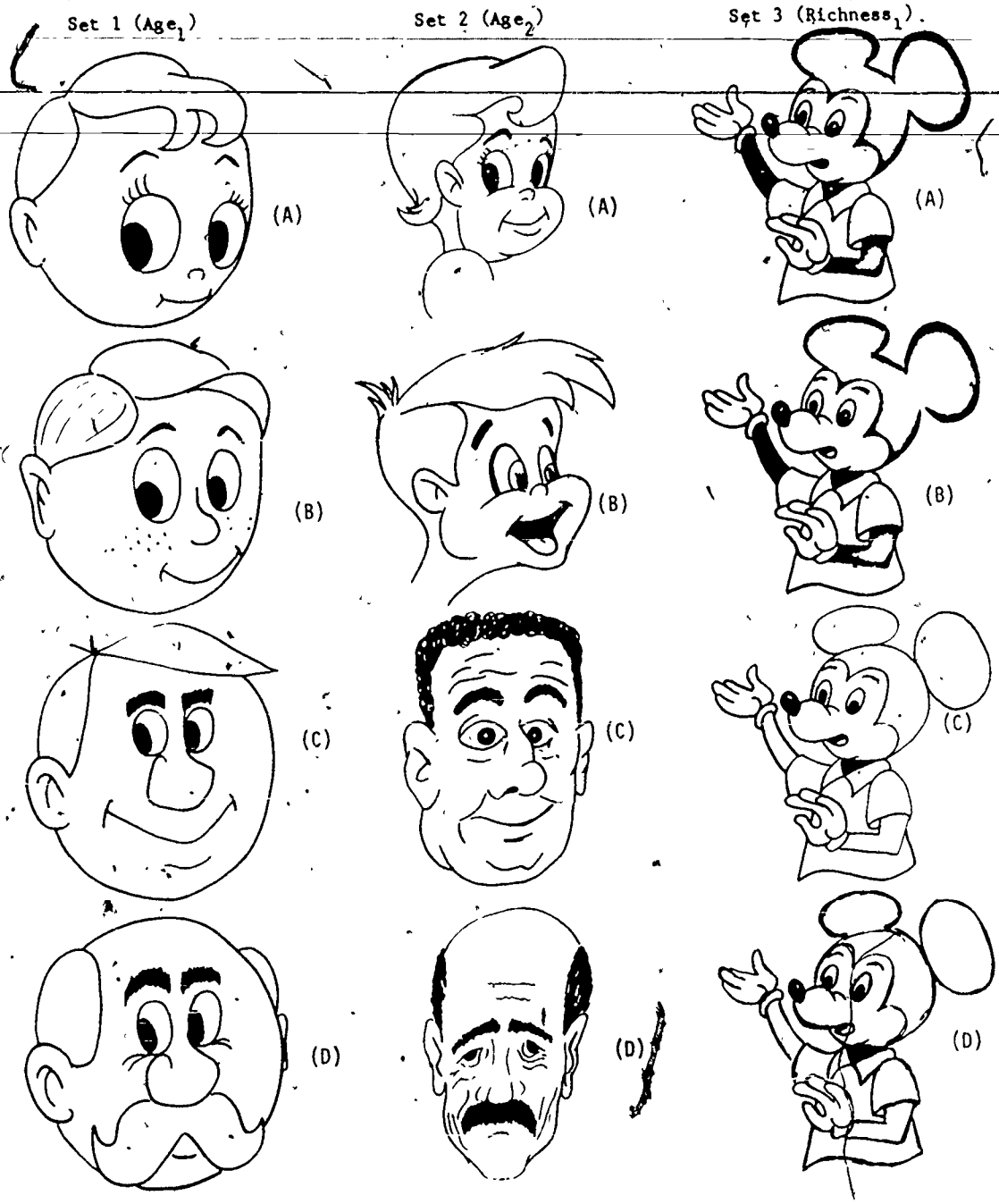
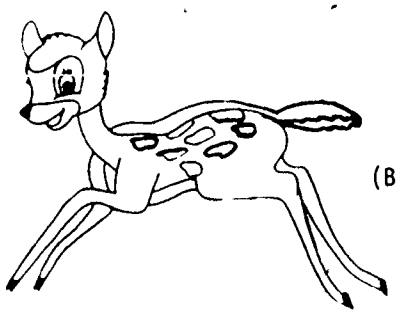


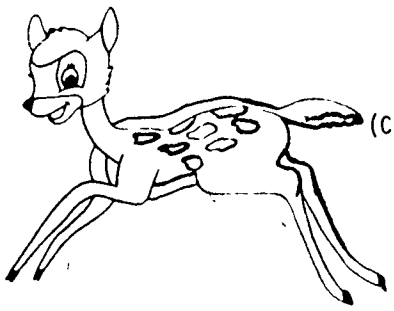
Figure 6.1. The nine picture sets rated by the educable retarded sample.

Set 4 (Richness$_2$)

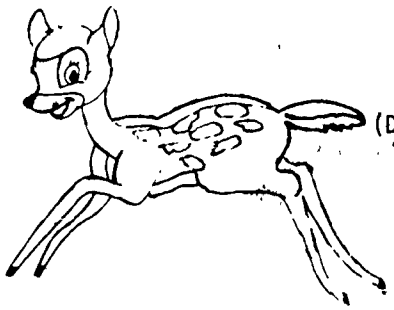
(A)



(B)

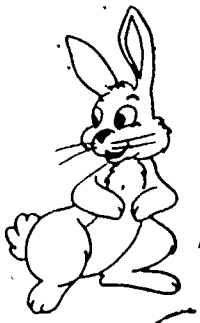


(C)



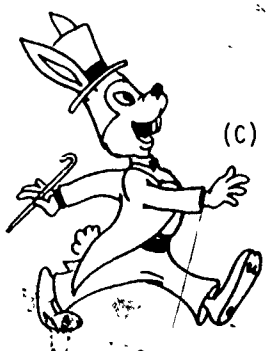
(D)

Set 5 (Personality)



(A)

(B)



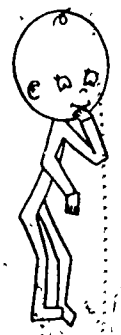
(C)

(D)

Set 6 (Realism)

(A)

(B)

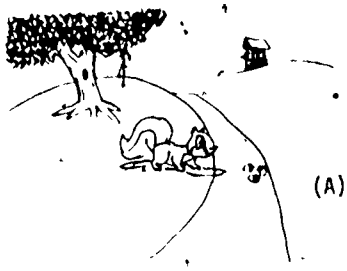


(C)

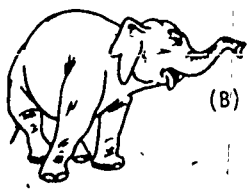
(D)

Set 7 (Mood)

Set 8 (Detail)



Set 9 (Animal Type)



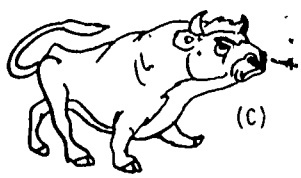


TABLE 6.1

Total Mean Preferences for all Nine Sets

Sets	Illustrations			
	A	B	C	D
1 (Age_1)	1.81	2.00	3.63	2.50
2 (Age_2)	2.54	2.54	3.00	2.00
3 ($Richness_1$)	1.91	2.00	2.91	3.16
4 ($Richness_2$)	1.16	2.25	3.16	3.41
5 (Personality)	2.00	2.63	1.72	3.63
6 (Realism)	1.63	2.36	2.36	3.63
7 (Mood)	2.09	3.00	2.27	2.60
8 (Detail)	2.27	2.36	2.90	2.45
9 (Animal type)	1.90	2.18	2.90	2.90

Figure 6.2), but no significant differences were found in the second age set (Set 2, Figure 6.3). The Tukey test performed on the mean ranks of Set 1 revealed significant differences between pictures A and C ($p < .01$) and between pictures B and C ($p < .01$). Picture C was significantly less popular than pictures A and B in Set 1.

Significant differences were found in both of the media richness sets (Set 3, $X^2 = 8.70$, df = 3, $p < .05$; Set 4, $X^2 = 22.50$, df = 3, $p < .01$). The results of the Tukey test did not indicate the exact location of the differences for Set 3, although the largest difference was between the color drawing and the pencil sketch. The Tukey test performed on the results of Set 4 indicated that both picture B (ink drawing) and picture A (color drawing) were significantly more popular than picture D (pencil sketch) (Set 3, Figure 6.4; Set 4, Figure 6.5).

A significant difference was found in the Friedman test performed on Set 5 (Figure 6.6), the personality set ($X^2 = 14.24$, df = 3, $p < .01$), and on Set 6 (Figure 6.7), the realism set ($X^2 = 13.61$, df = 3, $p < .01$). The Tukey test indicated that picture D in the personality set was less popular than picture C ($p < .01$) and picture A ($p < .05$). Picture D in the realism set was shown to be significantly less popular than picture A ($p < .01$).

No significant differences were found in the Friedman test performed on the sets developed to compare the drawings for mood (Set 7, Figure 6.8), setting detail (Set 8, Figure 6.9), and animal preference (Set 9, Figure 6.10).

The first choice of each set (excluding the two richness sets) was randomly arranged in front of the subject and he was asked to select the most preferred one. The results indicated that no single category was preferred over all others ($X^2 = 1.09$, df = 1, $p < .05$).

The results from this study indicate that those pictures which depict happy and younger characters are more preferred than those which depict characters who are older and illustrate more serious moods. Not surprising is the fact that these retarded children preferred characters whose personalities illustrated aspects which were cute and cocky as opposed to dumb and dumpy. Preference was also expressed for those scenes which depicted realistic body portrayals rather than stick figures. These results do demonstrate that retarded children have reliable preferences with respect to cartoon illustrations. Whether the type of cartoon illustration influences the extent to which learning strategies are effective is a researchable question and is worthy of study. In a scientific analysis of educational media and materials development, it certainly seems that this type of concern could profitably be researched. The results of such investigations would then have important implications for the development of educational materials.

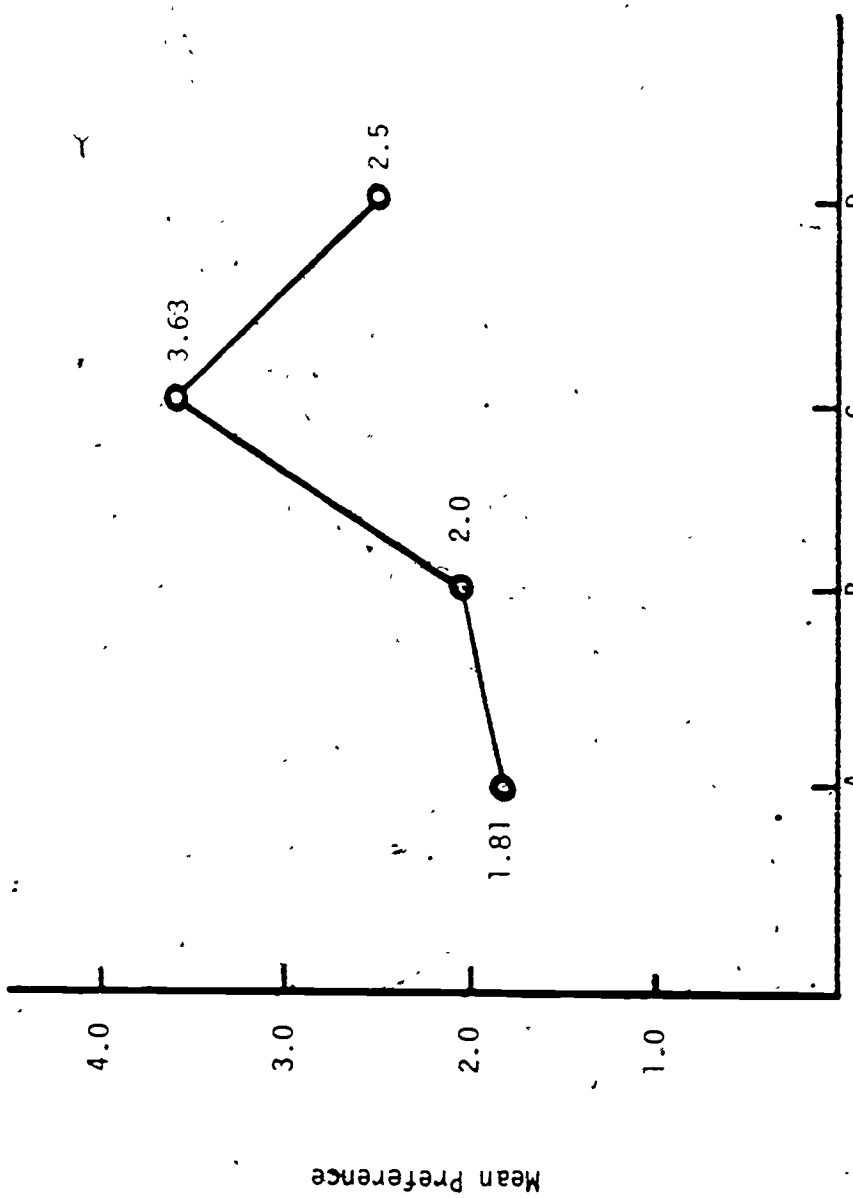


Figure 6.2. Mean rank preference scores for Set 1 (Age_1).

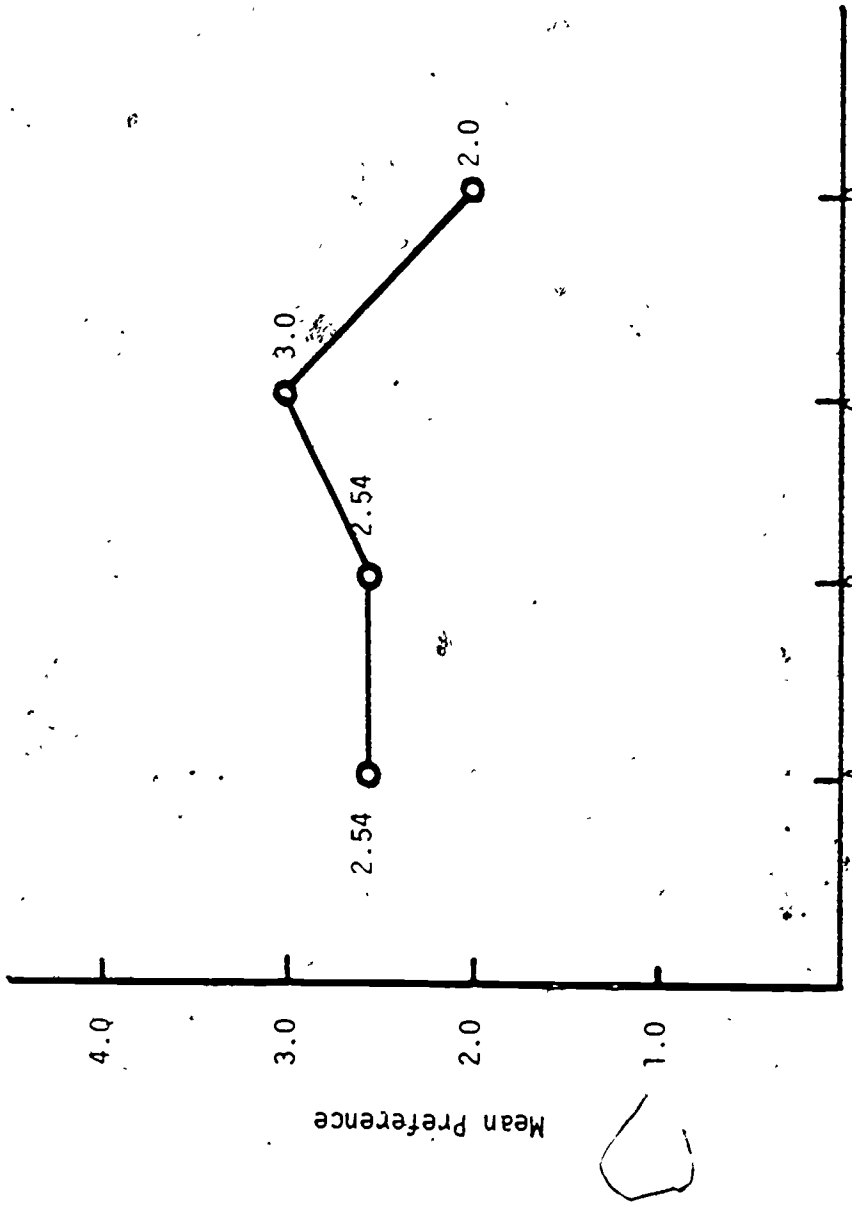


Figure 6.3. Mean rank preference score for Set 2 (Age_2).

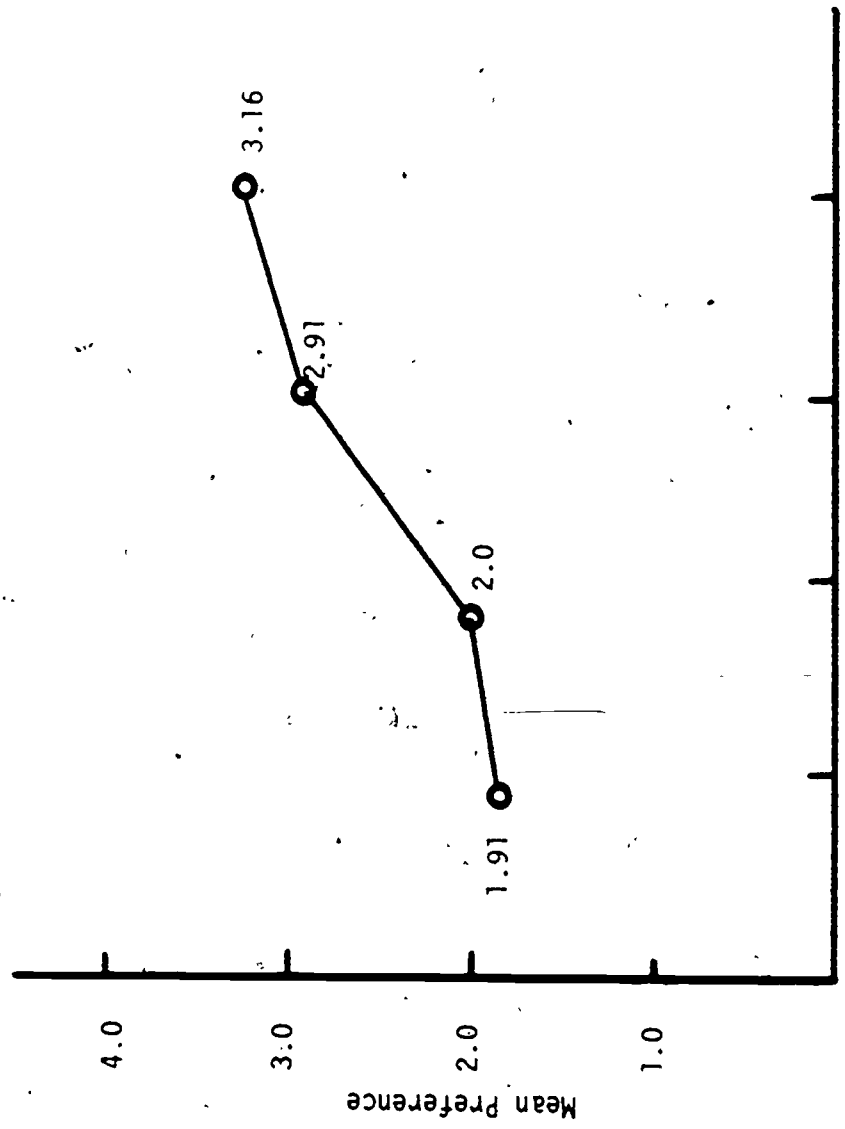


Figure 6.4. Mean rank preference score for Set 3 ($Richness_1$).

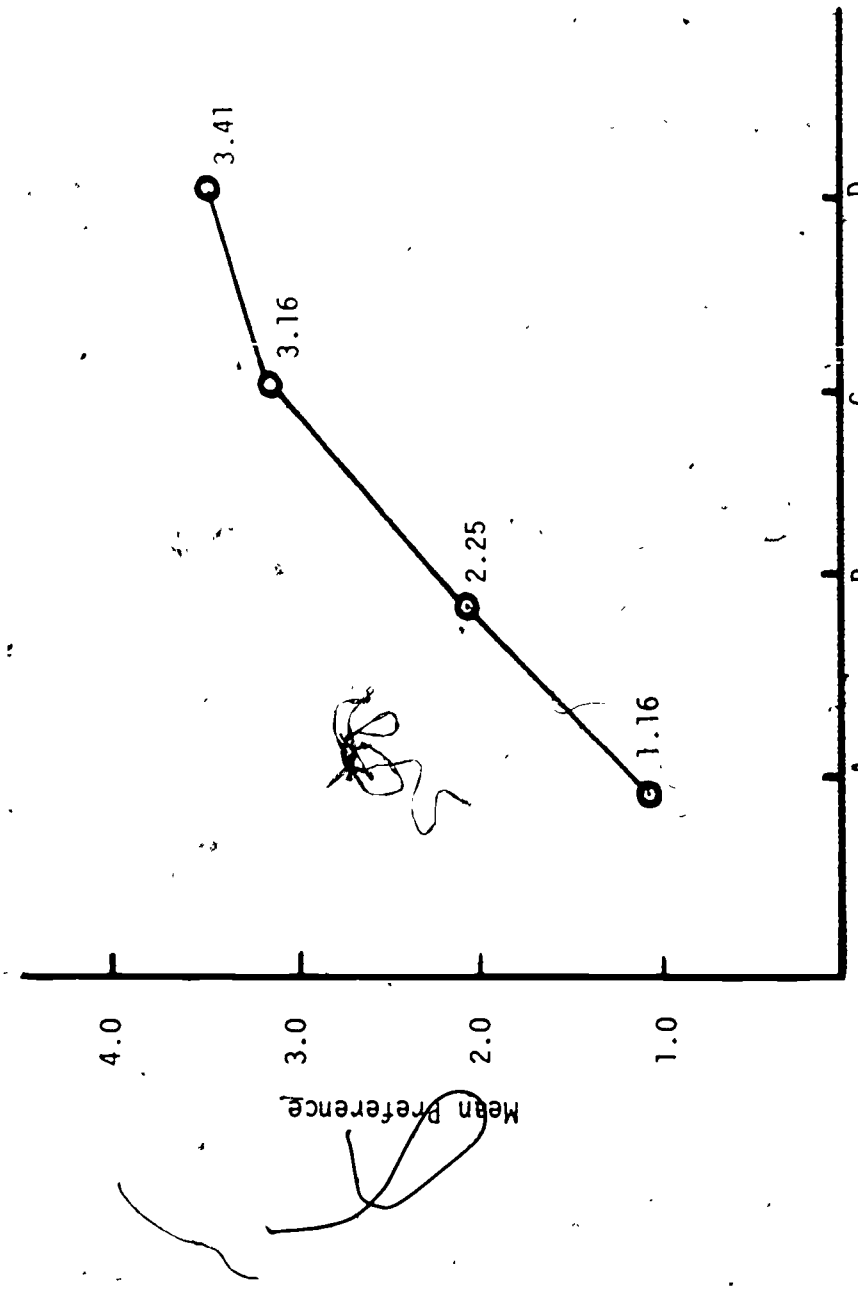


Figure 6.5. Mean rank preference score for Set 4 ($Richness_2$).

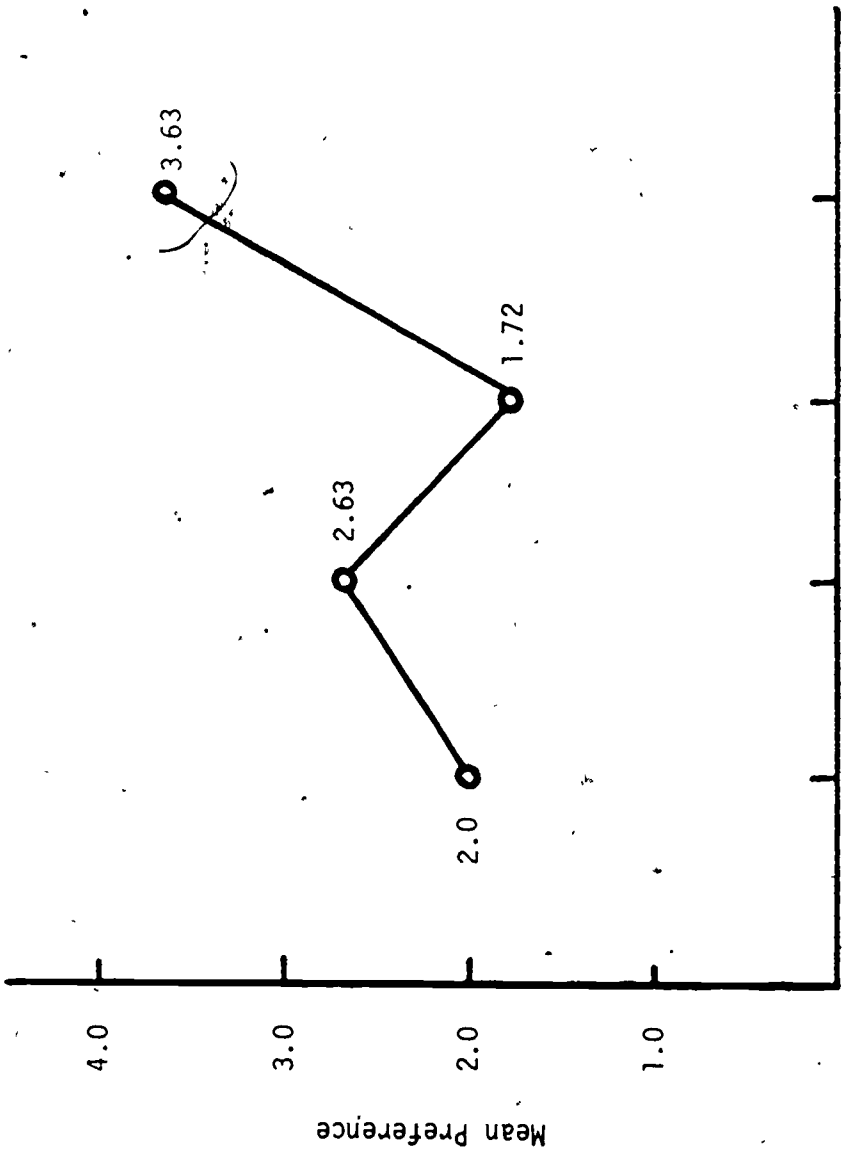


Figure 6.6. Mean rank preference score for Set 5 (Personality).

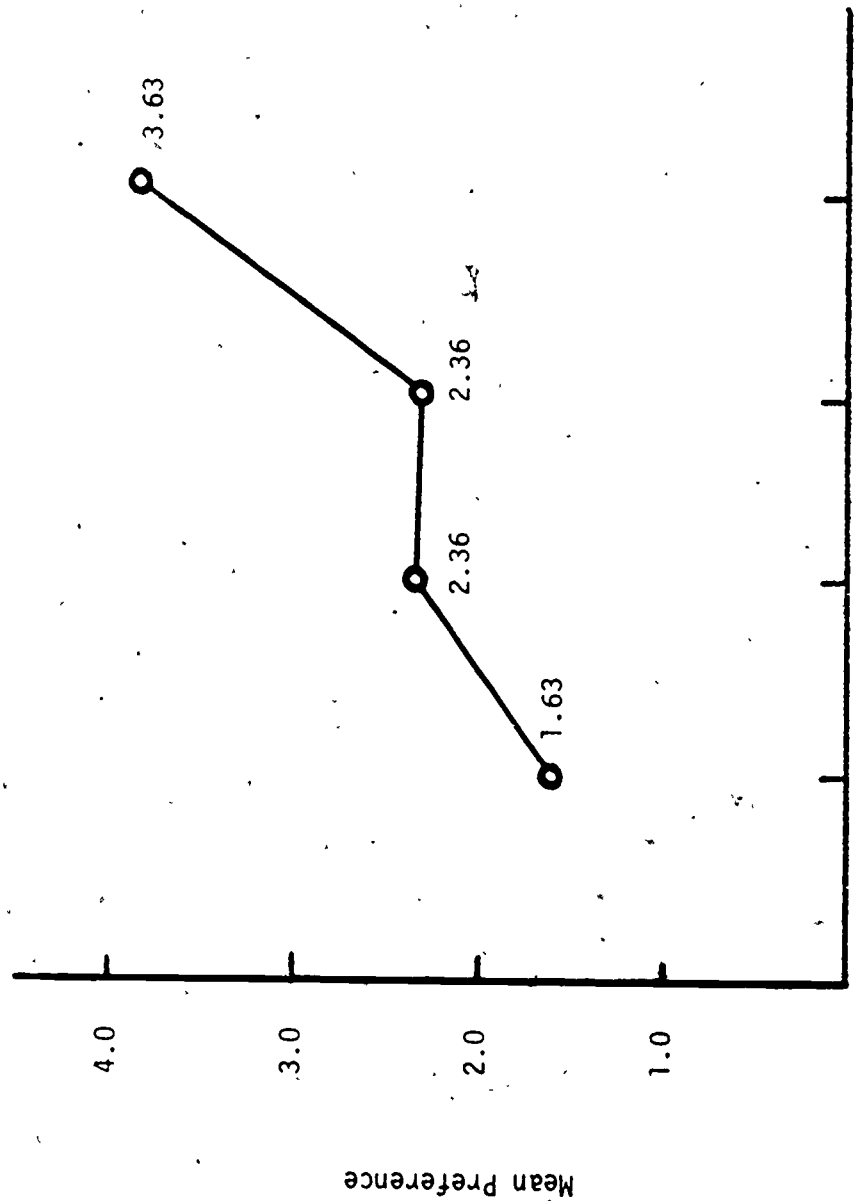


Figure 6.7. Mean rank preference score for Set 6 (Realism).

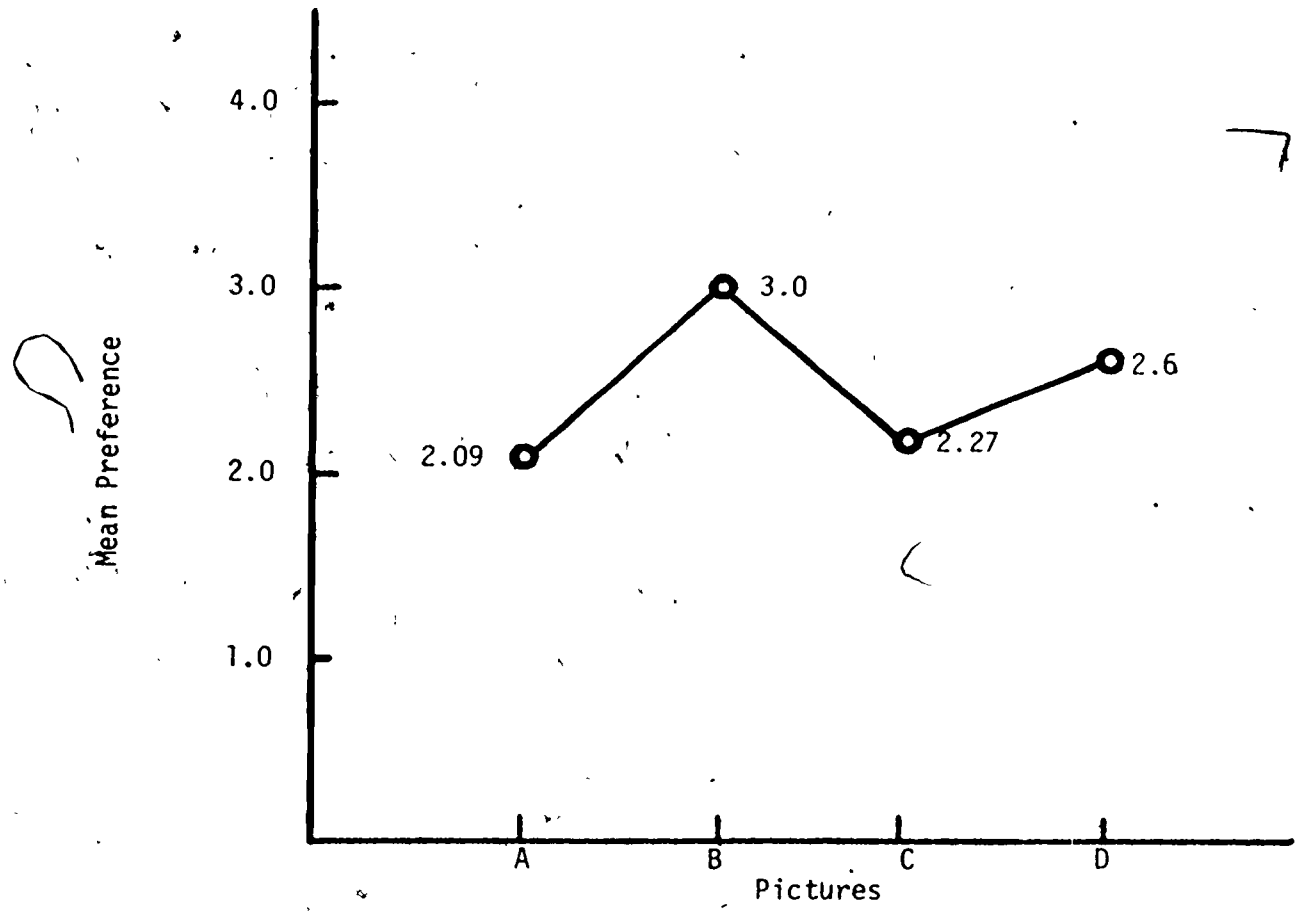


Figure 6.8. Mean rank preference score for Set 7 (Mood).

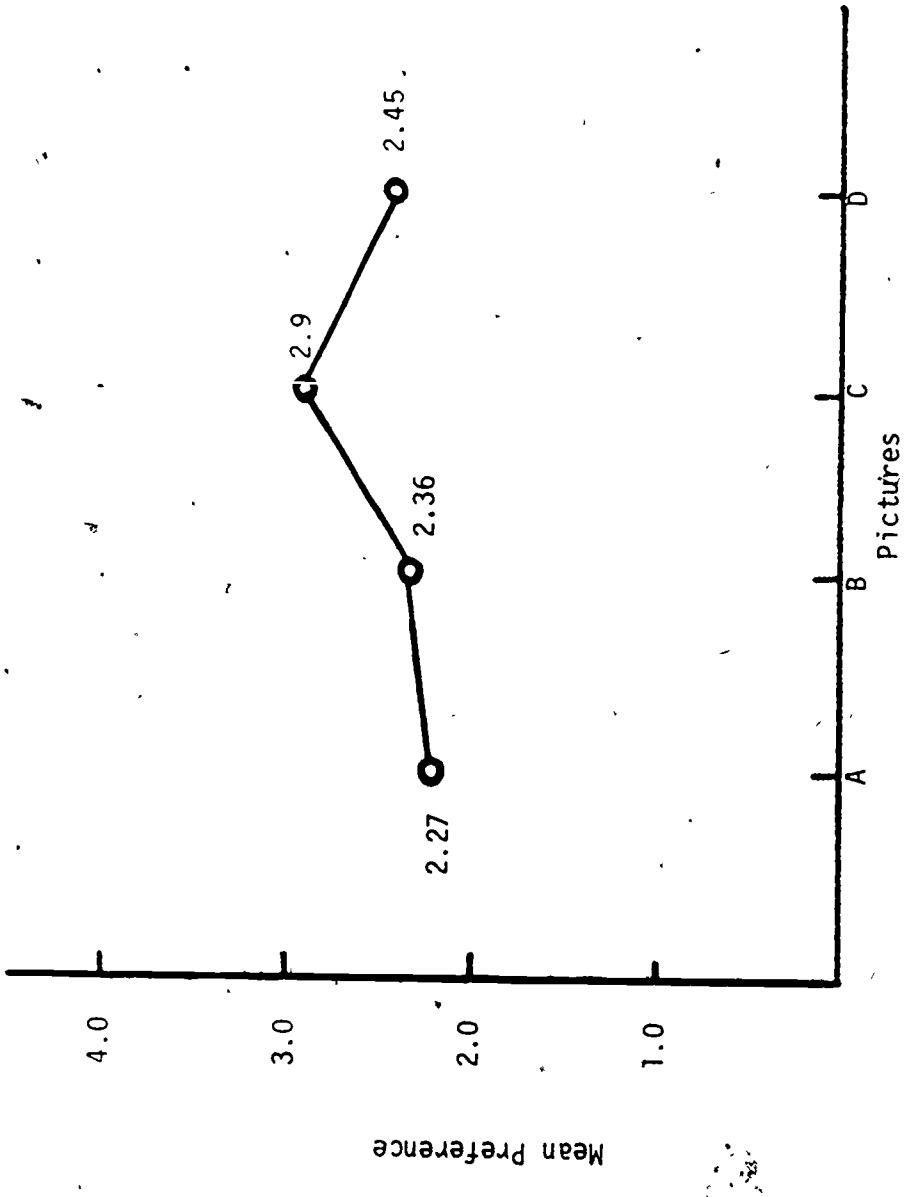


Figure 6.9. Mean rank preference score for Set 8 (Setting Detail).

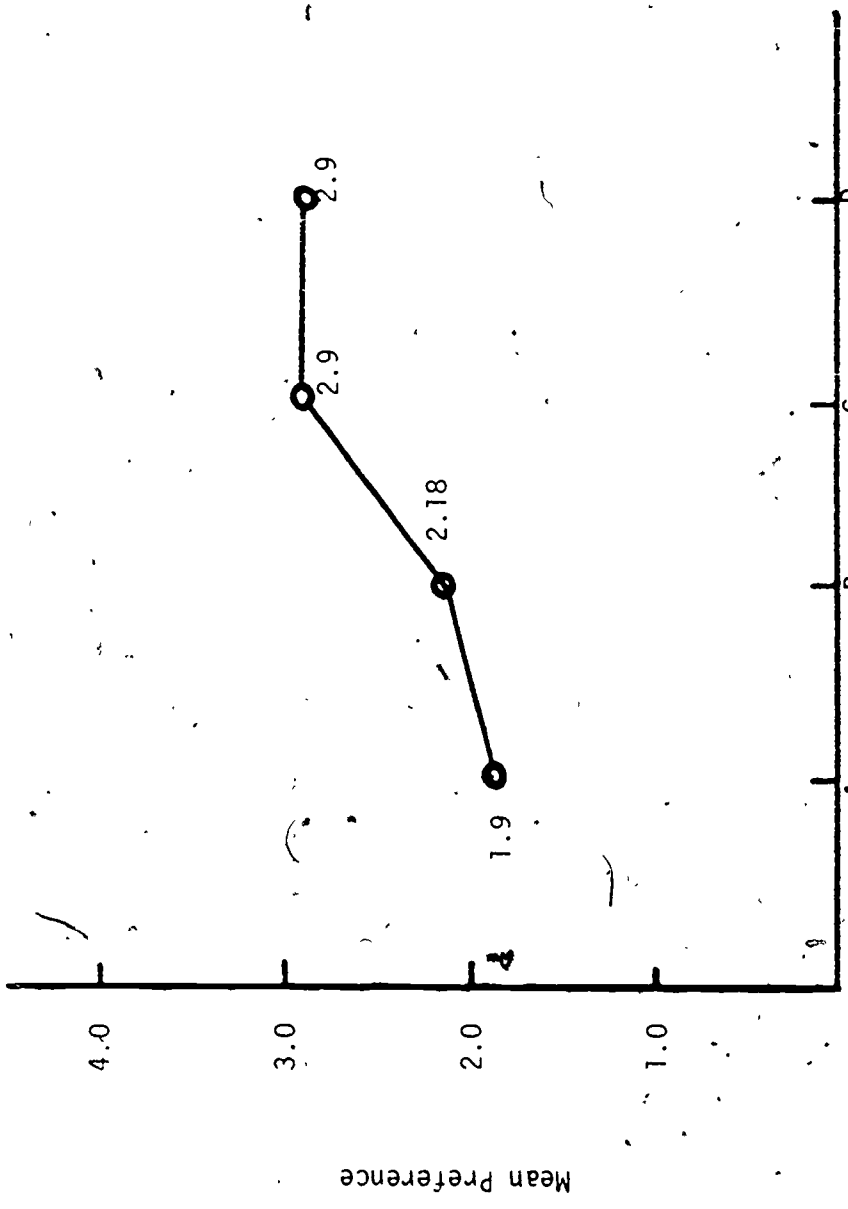


Figure 6.10. Mean rank preference score for Set 9 (Animal Preference).

CHAPTER VII

EXPERIMENT VI -- FACILITATIVE EFFECTS OF ANIMATION ON WORD MEMORY AMONG INSTITUTIONALIZED RETARDED CHILDREN AND ADULTS

Introduction

One of the problems which has been encountered in the conduct of the associative strategy research is related to the concept of an associative strategy. Many of the retarded subjects who have been assigned to the more complex treatment conditions such as the syntactical condition have experienced difficulty in understanding the concept of an associative strategy. At times it appeared as though they failed to search for the cue word and once they found it would fail to comprehend the relationship between the cue word and the syntactical mediator. Throughout the conduct of this research it has been assumed that the basic memory processes involved in word recognition learning are the same or similar to those involved in paired-associate (PA) learning. For example, in the initial stage of learning to read, children are often presented words one at a time and are expected to memorize them so that when the words are encountered again they will be recognized and recalled. This look-and-say learning of whole words has been likened to PA memorization by Coleman (1970). However, the association which is learned in the word recognition task is between a printed stimulus (S) term and an oral (pronunciation of the word) response (R) term. Although little experimental evidence is available concerning the learning strategies which children employ in learning such associations, the fact that various types of cues are employed is undeniable.

Martin (1967) reported on a three-year U.S. Office of Education research project which had as its goal the facilitation of verbal associative learning among educable retarded children. One of the first objectives of the project was the development of a classification scheme which would permit the categorization of subjects' reported associative learning strategies and the determination of the relationship between the types of strategies reported and the rate at which the material was learned and retained. The most important objective concerned the degree to which learning and retention could be facilitated by providing educable retarded children with effective associative strategies.

The results of the Martin (1967) project indicated that the inferior performance of the EMR was due to the preponderant use of the least efficient associative learning strategies. The fact that experimenter-supplied strategies significantly facilitated learning of verbal associations for the EMR subjects suggested that such subjects do not normally employ these strategies which accounts for their inferior performance. In addition, experimenter-supplied strategies facilitated long term retention. When the degree of original learning was the same for normal and EMR subjects, there was no difference in the amount of forgetting. The implication of

this finding is that the retarded subject does not possess a memory deficit per se. Rather, he appears to possess a strategy deficit for when the educable retarded child was provided an associative strategy, no difference in learning or retention was observed between the EMR subjects and the CA matched normal subjects.

The final experiment reported in the Martin (1967) project was concerned with the administration of associative strategies to educable retarded children in a word recognition task. It was assumed that in order to make a correct response in the word recognition task, the visual presentation of the printed word must elicit the correct oral response (saying the word). One of the beneficial effects of experiment-supplied strategies in the paired-associate task was the fact that the associative strategy incorporated an element of the stimulus term and also incorporated the response term. For example, if the subject is presented the pair, ZUMAP - VILLAGE, and is provided the strategy, "map of the village," then, upon presentation of the stimulus term the embedded word, MAP, serves to elicit the strategy and hence the correct response.

A comparable situation was devised in the word recognition task for the EMR children. Criterion words which the subjects could not read were selected. On the learning trials, the criterion words were presented visually while the experimenter pronounced each word. The test trial consisted of presenting the same words, but on this trial, the experimenter did not pronounce them and the subject was required to say the word if he remembered it. For the strategy group, it was first necessary to establish a cue in the criterion word upon which the experimenter-supplied strategy could be based. This was achieved by selecting criterion words that contained small embedded words which the subject already could read or be easily trained to read.

The above conditions made it possible to supply subjects with associative strategies. For example, in learning to recognize the word, BRACELET, pre-training on a cue word such as LET permitted the possibility of supplying the subject with a strategy. During the learning trials, subjects receiving strategy training were instructed that they could use the little word LET to learn the larger word BRACELET by remembering, "Let me have the bracelet." It was assumed that, on the test trials, the cue words and the experimenter-supplied strategies would facilitate learning and retention of the criterion words.

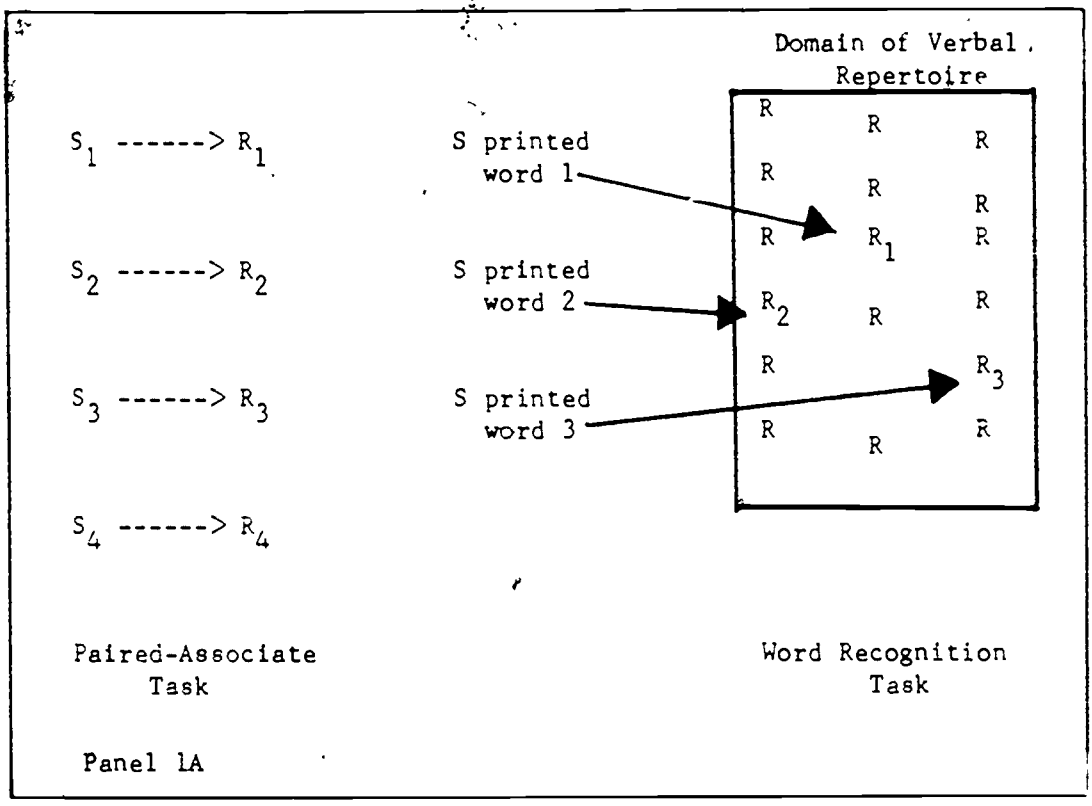
While the results showed no significant differences among the groups on the criterion task, there was some evidence from the retention data demonstrating a significant difference in favor of the strategy group. However, in general, the results during the learning phase were in sharp contrast to the previous experiments in which learning was greatly enhanced.

The PA and word recognition tasks are depicted in Figure 7.1A. In the PA task, the subject is required to associate the arbitrarily

paired verbal S and R terms. In the word recognition task, the subject is required to learn to "say" the R-term when the S-term (printed word) is presented. Although there are some similarities between PA learning and word recognition at the methodological level, there are some important differences. The elements which comprise a PA list might be letters, nonsense syllables, words, or pictures. In the word recognition task, the components are meaningful words. Furthermore, the S-R elements in a PA list are paired arbitrarily. Any verbal or pictorial unit may be used in either the stimulus or response position. But, in the word recognition task the written or printed symbol dictates the nature of the elicited response. As depicted in Figure 7.1A, the response system in the word recognition task potentially consists of all responses in the verbal repertoire of the learner. In learning to recognize the word, the printed S-term must elicit its oral response. If the child has learned the grapheme-phoneme correspondences of the language and can partition the word into these elements visually, then he has broken the code and can thus read. However, many children are not able or do not learn the basic linguistic "facts" of the language and are thus not able to use this approach in learning to develop a basic sight vocabulary.

The review of the literature related to this phase of the project revealed the existence of several potent variables responsible for facilitating PA learning. One such variable involves the administration of an associative strategy which assists the formation of the association between the stimulus and the response. Martin (1967) has demonstrated the powerful effect this variable has upon the learning rate of retarded children. The approach which has been used is depicted in Figure 7.1B. The nominal stimulus refers to the actual printed S-term. The effective stimulus is that component in the S-term which the subject actually uses as a cue to associate the R-term with the S-term. The subject is told that he can use NEG in NEGLAN to refer to NEGRO and then told to think of the phrase "Negro leader." It is assumed that the syntactical phrase "Negro leader" has some already existing association in memory and can be used in the formation of the new arbitrarily paired units, NEGLAN - LEADER. The same approach is applied to other verbal units such as, ZUMAP - VILLAGE. The test trial is depicted in Figure 7.1C. On this trial the S-term is presented and the subject's task is to recall the appropriate R-term. It is assumed that the subject will notice NEG in NEGLAN, transform NEG into NEGRO, and use NEGRO to elicit LEADER.

The assumption being tested in this phase of the research is that the above process involved in facilitating PA learning can also be used to facilitate word recognition among retarded subjects. Figure 7.1D shows the application of the associative strategy concept to the word recognition task. Here the subject is presented the nominal stimulus BRACELET. His task in learning involves associating the visual S-term with the oral R-term. On the learning trial he is shown the cue word LET in BRACELET and told to use the phrase "Let me have the bracelet" in remembering the word BRACELET. It is assumed that on the test trial as shown in Figure 7.1E the



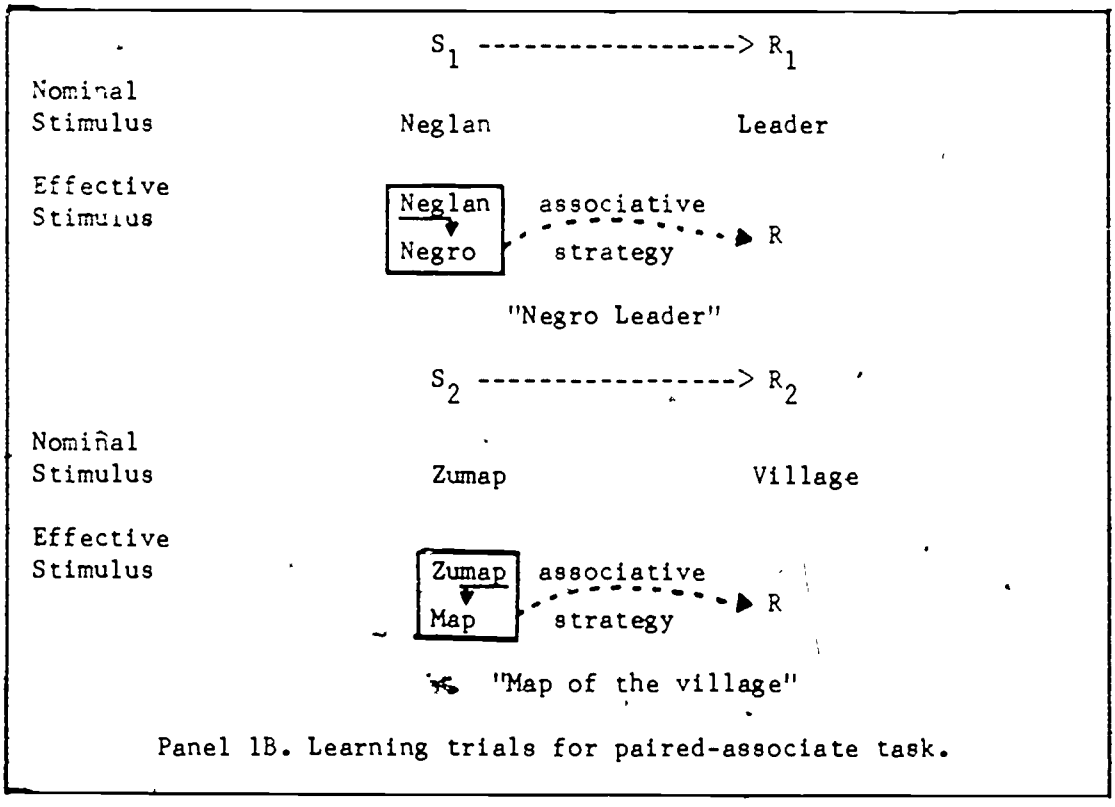
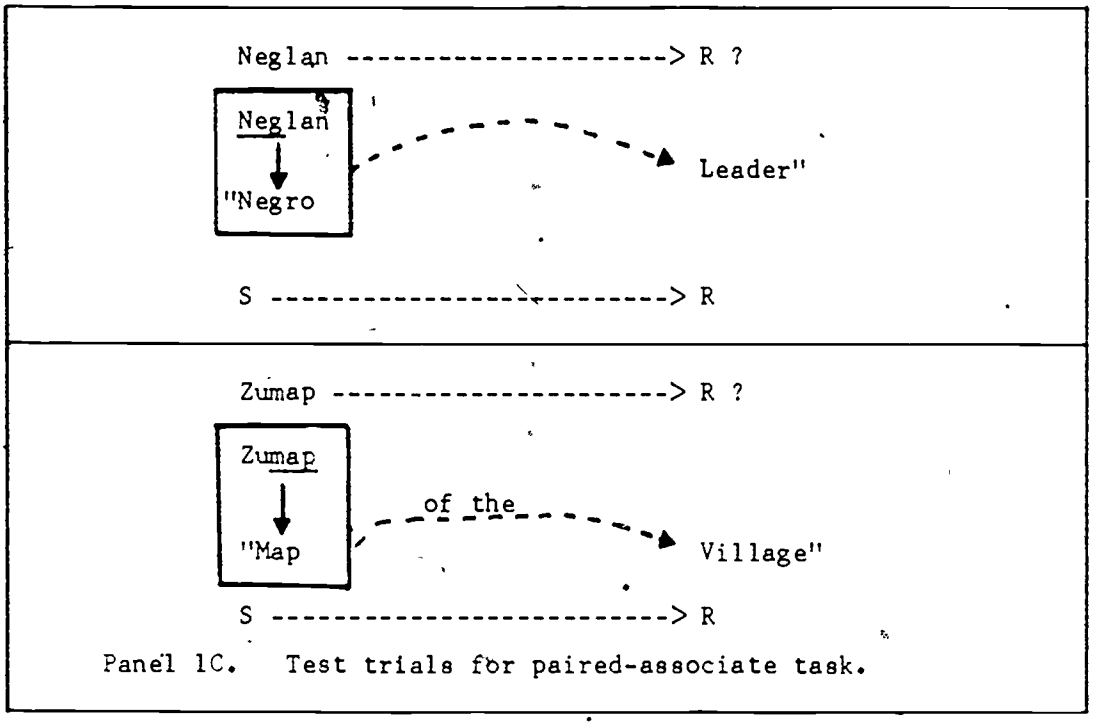
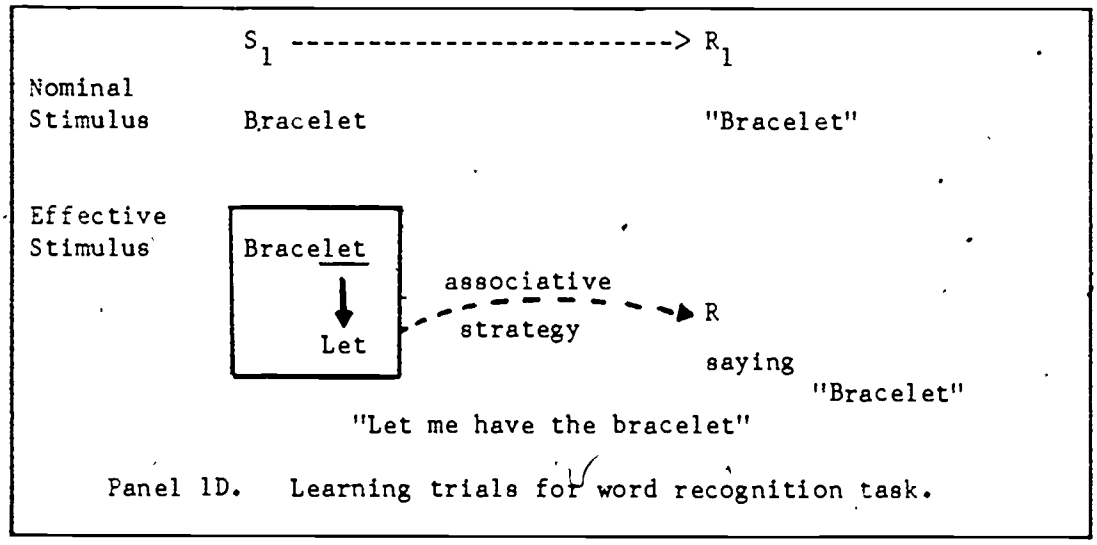


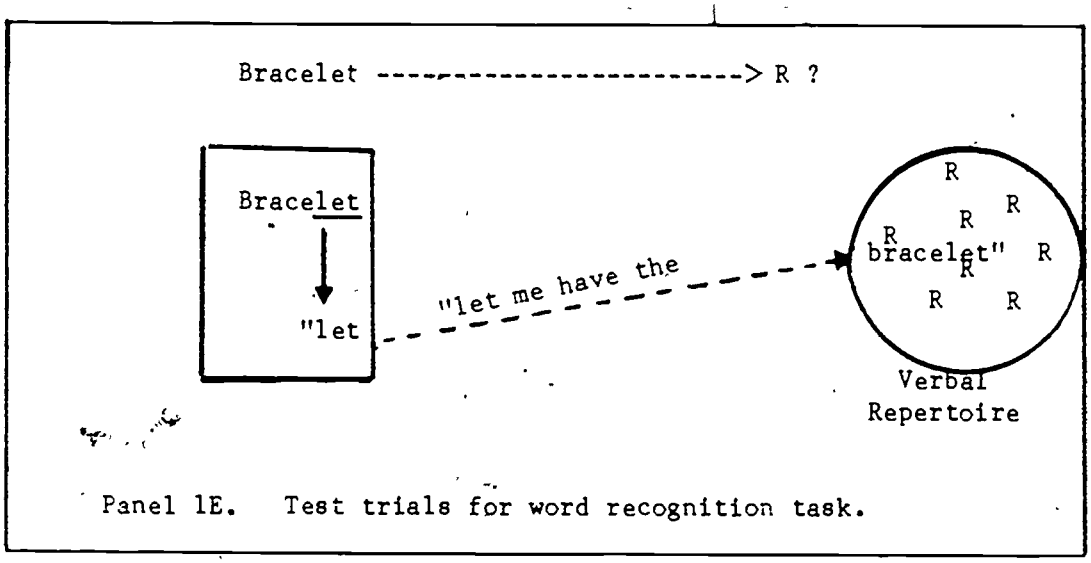
Figure 7.1. Comparison of mediational effects in paired-associate and word recognition learning.



Panel 1C. Test trials for paired-associate task.



Panel 1D. Learning trials for word recognition task.



Panel 1E. Test trials for word recognition task.

subject will recognize the cue word LET and then think of the phrase, "Let me have the bracelet" and thus recall the correct R-term from the domain of possible responses (Rs) in his verbal repertoire.

The basic question being asked in this film study is whether or not the concept of an associative strategy can be effectively communicated to the retarded child by using a semi-animated task. By using animation, it is possible to focus attention upon the cue word and to visually depict the associative strategy. The three most basic strategy conditions have been selected for this study: Repetition, Word Formation, and Mediation. The Repetition condition involves only the presentation of the S-term several times. Nothing is done to focus attention upon the cue element in the criterion word. The Word Formation condition involves drawing attention to the cue word but no strategy or mediating phrase or visual representation is provided. The Mediation condition consists of the process depicted in Figure 7.1D in addition to providing the subject with a visual representation of the mediating phrase. The hypotheses are simply:

1) Subjects receiving the Word Formation condition will exhibit more learning than those receiving the Repetition condition, and
2) Subjects receiving the Mediation condition will exhibit more learning than those receiving the Word Formation condition.

Method

Subjects

A total of 54 retarded persons (from two state residential institutions) participated in this experiment. Thirty-nine were males and 15 were females. Subjects were randomly assigned to one of three treatment groups: Repetition, Word Formation, and Mediation; thus, each condition contained 18 subjects. Thirty-one subjects were selected from Travis State School and 23 from Richmond State School. Subjects met the following criteria: (1) did not correctly identify the words PANTHER, PANTRY, PARTY, CLOSET, during pre-test; and (2) did not manifest any physical or behavioral abnormality (e.g., speech impediment, motor dysfunction, hyperactivity, etc.).

Table 7.1 presents the means and standard deviations for chronological age (CA), IQ, and number of years institutionalized (YI). IQ scores were available for 51 subjects. Thirty-six subjects had either WISC or WAIS scores, 14 had Stanford-Binet scores, and one subject's score was based on the Peabody Picture Vocabulary Test. The number of years institutionalized was available on only those subjects from Richmond State School.

TABLE 7.1

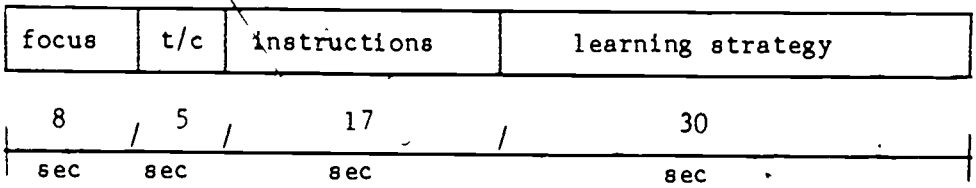
Means and Standard Deviations for
Chronological Age (CA), IQ, and
Number of Years Institutionalized (YI)

Meaure	Total	Treatment Group: Repetition	Word Formation	Mediation
CA				
Mean	29.17	23.04	31.58	32.89
S.D.	12.34	9.25	13.08	12.54
IQ				
Mean	49.63	50.17	45.69	52.76
S.D.	11.22	11.32	11.14	10.71
YI				
Mean	8.48	5.06	10.83	8.60
S.D.	9.67	6.37	10.15	11.02

Materials and Procedure

Three 60-second film sequences were prepared, each filmed in 16mm Kodak Ektachrome Commercial (7252 ECO) film with a Bolex H-16 camera activated by a NCE single frame sequencing motor mounted on a FAX animation stand. The soundtrack master was recorded on Ampex 261 magnetic tape with a Sony TC 110-A two-channel recorder. Film editing and conformation, soundtrack transfer and synchronization, and post-production development were completed in cooperation with A-V Corporation, Houston, Texas.

To provide uniformity in composition and graphic design, all sequences had a constant density pastel yellow background and all words were formed in black upper case 48-point Futura Demi type. Field dimensions were adjusted during filming to standardize word and/or image configuration. Corresponding audio and video elements were synchronized to provide a consistent 0.25 second audio initiation lag. The order and time intervals provided for focus grid, title/credit (t/c), instructions, and learning strategy presentations were equivalent for each sequence as illustrated in the following diagram.



Three different types of learning strategies, each of 30 seconds duration were designed for teaching the subject to recognize the word PANTHER. All strategies involved both audio and video elements and in order of increasing complexity, were designated Repetition, Word Formation, and Mediation.

Repetition film. This was the simplest condition. It consisted of presenting the criterion word PANTHER six times during the 30-second learning strategy period. Table 7.2 presents the timeline for the video and audio stimuli for this film.

Word Formation film. This condition involved the presentation of the cue word PAN in addition to the criterion word PANTHER. The word PAN was moved across the screen and dissolved into the word PANTHER. Table 7.3 presents the timeline for the video and audio segments.

Mediation film. This condition was the most complex. It involved the presentation of both the cue and criterion words and their corresponding pictures. In addition, the subject was given a verbal mediator, "The pan hits the panther." As the sentence was presented on the audio track, the action described in the sentence was portrayed on the video portion of the film. Table 7.4 presents the sequencing of the audio and visual components.

TABLE 7.2

Video and Audio Timeline for the Repetition Film

Timeline (seconds)	Video	Audio
17	background	You will see and hear a word several times. Try to remember the word.
4	panther	Panther.
1	background	-------
4	panther	Panther.
1	background	-------
4	panther	Panther.
1	background	-------
4	panther	Panther.
1	background	-------
4	panther	Panther.
1	background	-------
4	panther	Panther.
1	background	-------

TABLE 7.3

Video and Audio Timeline for the Word Formation Film

Timeline (seconds)	Video	Audio
17	background	You will see and hear a little word and a big word. Repeat each word out loud every time you hear it. Try to remember the big word.
4	pan	Pan.
1	background	-------
1	pan	Pan.
1	background	-------
4	panther	Panther.
1	background	-------
1	panther	Panther.
1	background	-------
4	pan (left) moves across screen and dissolves into panther (right)	-------
2	panther (right)	-------
1	pan (right)	-------
1	panther (right)	-------
1	background	-------
4	panther	Panther.
1	background	-------
1	panther	Panther.
1	background	-------

TABLE 7.4

Video and Audio Timeline for the Mediation Film

Timeline (seconds)	Video	Audio
17	background	You will see some words and pictures, and you will hear the words and a sentence. Repeat the word or sentence out loud every time you hear it. Try to remember the big word.
4	pan & pan (image)	Pan.
1	pan (image)	-------
1	pan & pan (image)	Pan.
1	pan (image)	-------
4	panther & panther (image)	Panther.
1	panther (image)	-------
1	panther & panther (image)	Panther.
1	panther (image)	-------
4	pan (image) moves down screen until just above panther (image)	The pan hits the panther.
1	pan (image) hits panther (image)	bong
1	pan (image) bounces just above panther (image)	-------
2	pan (image) hits panther (image)	bong
1	background	-------
4	panther & panther (image)	Panther.
1	panther (image)	-------
1	panther & panther (image)	Panther.
1	panther (image)	-------

Five discrimination tasks were developed. All words were printed on white 8-1/2 x 11 inch 70-pound vellum bond paper in black upper case 48-point Futura Demi type. The pictures were also presented on the same size paper.

Cue word discrimination. The words PAN, TAN, CAN, BIG were presented together on a single page.

Criterion word discrimination. The words PANTHER, PANTRY, PARTY, CLOSET were presented together on a single page.

Criterion word picture identification. Sketches of a panther, lion, cat, and dog were presented together on a single page.

Criterion word discrimination - Sentence 1. The word PANTHER was presented in the sentence, "Give the panther a party." The subject was instructed to circle the word PANTHER.

Criterion word discrimination - Sentence 2. The subject was presented the sentence, "Is the panther in a closet?" and asked to circle the word PANTHER. This sentence was considered to be a low similarity with respect to other words which might interfere with recognition of the criterion word. Copies of these discrimination tasks are presented in Appendix F, Volume II.

To avoid position effects, four different word and picture orders were used in the cue word, criterion word, and picture discrimination tasks. Answer booklets for the Repetition subjects contained the criterion word discrimination materials and the two sentence discrimination tasks. The answer booklets for the Word Formation subjects contained all discrimination tasks except the picture identification task. All five discrimination tasks were administered to the Mediation subjects.

Learning and test trials were alternated for a maximum of five learning and five test trials or until correct responses were made on all discrimination tasks for two consecutive trials. Retention was assessed 48 hours after original learning on those discrimination tasks used during learning.

Results and Conclusions

The analyses involved simple 1 x 3 ANOVAs in which the independent variable was the type of film treatment: Repetition, Word Formation, or Mediation. The dependent variables were the trials on which two consecutive correct responses were made on the criterion and the two sentence discrimination tasks. The cue word and picture discrimination tasks were not analyzed because, of course, they were not appropriate to all three film conditions.

To determine whether any differences existed between the subjects from the two institutions, ANOVAs were performed on each of the dependent variables. The location main effect did not approach significance at the .05 level for any of the analyses, thus, the data were combined. In order to check on the effects of randomization across the three film conditions on the IQ and CA variables, two 1 x 3 ANOVAs were performed. No significant differences were obtained for the IQ variable among the three conditions, but there was a significant difference on the CA variable ($F = 3.73$, df = 2/51, $p = .03$). However, none of the correlations between CA and performance on the discrimination tasks approached significance at the .05 level.

The means and standard deviations of the number of trials required to reach criterion on each of the discrimination tasks are presented in Table 7.5. Three 1 x 3 ANOVAs were performed on the criterion word, criterion word sentence 1, and criterion word sentence 2 discrimination tasks. The results of the criterion word discrimination task revealed an $F = 7.18$, df = 2/51, $p < .002$. Inspection of Table 7.5 indicates little difference between the Word Formation and Mediation conditions. However, the Repetition condition required more trials to correctly identify the criterion word than the other two conditions.

The criterion word sentence 1 discrimination task required the subject to correctly identify the word PANTHER in the sentence, "Give the panther a party." The 1 x 3 ANOVA yielded an $F = 6.64$, df = 2/51, $p < .003$. Inspection of Table 7.5 reveals that again the Repetition condition was associated with poorer performance than either the Word Formation or Mediation film conditions. However, there was no difference between the latter two conditions.

Criterion word sentence 2 discrimination task contained no words beginning with the same initial letter as the criterion word. In this task the subject had to identify the criterion word in the sentence, "Is the panther in a closet?" The 1 x 3 ANOVA yielded an $F = 7.02$, df = 2/51, $p < .002$. The Repetition condition was again inferior to either of the other two conditions. Again, there was no difference between the Word Formation and the Mediation conditions.

Results of the retention data showed no differences among any of the three conditions. In fact, all subjects responded correctly to the criterion word on the criterion word test as well as the two sentence discrimination tasks. Considering the results of the learning task, the retention data are not entirely unexpected. A total of five learning and test trials were given during acquisition. The maximum number of trials required to reach two consecutive errorless trials was 2.89 for the Repetition group on the criterion word task. Thus, all subjects were able to reach the same level of learning within the five trial sessions. Research in the paired associate area indicates that there is no difference in retention when treatment conditions are brought to the same degree of original learning. Likewise, there is no difference in retention among subjects who learn at different rates provided the degree of original learning is

TABLE 7.5

Mean Number of Trials Required to Reach Two Consecutive Errorless Trials on Each of the Discrimination Tasks

Discrimination Task	Film Conditions		
	Repetition	Word Formation	Mediation
Cue Word	--	Mean = 2.39 S.D. = .70	Mean - 2.27 S.D. = .57
Criterion Word $F=7.18, df=2/51, p<.002$	Mean = 2.89 S.D. = 1.02	Mean = 2.17 S.D. = .38	Mean = 2.11 S.D. = .47
Criterion Word Pictured	--	--	Mean = 2.11 S.D. = .47
Criterion Word Sentence 1 (High Similar Sentence) $F=6.64, df=2/51, p<.003$	Mean = 2.83 S.D. = 1.10	Mean = 2.11 S.D. = .32	Mean = 2.11 S.D. = .32
Criterion Word Sentence 2 (Low Similar Sentence) $F=7.02, df=2/51, p<.002$	Mean = 2.61 S.D. = .98	Mean = 2.00 S.D. = 0.00	Mean = 2.00 S.D. = 0.00

the same. This aspect of the results tends to support the assumption concerning the underlying similarity between paired associate and word recognition learning.

Since IQ and CA were used as matching variables, these data were intercorrelated with number of years institutionalized (YI) and the number of learning trials (LT) required to reach criterion on the criterion learning task. The product-moment correlations among these variables are presented in Table 7.6.

TABLE 7.6

Intercorrelation Matrix Among IQ, CA, YI, and LT

	IQ	CA*	LT*	YI*
IQ		.20 N=51	-.19 N=51	-.18 N=51
CA			-.09 N=54	.16 N=54
LT				.20 N=54

*CA = Chronological Age LT = Learning Trials
YI = Years Institutionalized

None of these correlations were significant at the .05 level. There was no correlation between rate of learning and IQ or CA, nor was there a significant correlation between rate of learning and years institutionalized.

Only one of the two hypotheses was supported. It was predicted that the Word Formation condition would be more facilitative than the Repetition condition. This hypothesis was supported. However, it was also predicted that the Mediation condition would be more facilitative than the Word Formation condition. This hypothesis received absolutely no support on any of the three discrimination tasks. These results were certainly not expected. Figures 7.1D and 7.1E illustrate the assumed beneficial effect of a Mediation condition. The verbal and animated pictorial mediators were expected to facilitate the acquisition of the word recognition association. Results from the Word Formation condition suggest that it is sufficient to focus attention upon the cue word in the criterion word. Nothing was done in the Word Formation condition to provide a mediational link between the printed S-term and the oral R-term. However, pointing out the cue word was more facilitative than merely rote repetition of the criterion word.

The two sentence discrimination tasks were used in order to determine whether cue word training was also producing some negative

transfer. Pointing out the cue word in the criterion word might also cause the subject to respond incorrectly to other words which contained some of the same letters as those found in the cue word. Thus, the sentence 1 transfer task was "Give the panther a party," and the sentence 2 task was "Is the panther in a closet." Inspection of Table 7.5 reveals little difference in performance between these two sentence conditions. Because of these results, it is concluded that no negative transfer was produced by the cue word training.

In general, the results of this investigation are encouraging. While the forced repetition condition did produce learning among the institutionalized sample, greater facilitative effects were observed in the Word Formation and Mediation conditions. These results suggest that it is possible to induce a learning process in retarded learners by the use of elaborate film-cueing techniques. It is assumed that such learners do not spontaneously use elaborate coding devices for memory storage and retrieval and, thus, external stimulus conditions designed to induce facilitative processes can be profitably used in the education of moderately to severely retarded children and adults.

CHAPTER VIII

INTRODUCTION AND REVIEW OF LITERATURE

TELEGRAPHIC PROSE PHASE

Statement of the Problem

There has been no previous time in history when it has been more imperative that educational technology and the psychology of learning combine their technical knowledge in order to improve learning in applied settings. A basic challenge confronting these two technical areas is conducting definitive research on the strategies individuals employ in processing information and on new means and techniques for increasing the efficiency of such information processing.

The rationale for the need to investigate the possibilities of increasing the rate of information input and of increasing comprehension efficiency is twofold. First, scientific information indicates that more efficient learning methods are feasible. Second, with the knowledge explosion and the need to assimilate larger amounts of information in both formal educational and personal endeavors, more efficient learning formats are a necessity.

This project is part of a programmatic research effort. Its objective is the development of text reduction techniques designed to facilitate comprehension and recall of written materials among visually handicapped braille readers and severely hard-of-hearing subjects. The goal is the development of a telegraphic style which will permit efficient information transmission. The term "telegraphic" is used to refer to an abbreviated style similar to that found in telegrams. Economic reasons often necessitate conveying messages in an abbreviated form. The rules governing the construction of sentences and paragraphs are frequently violated without seriously affecting the comprehension of the message. Thus, this research is based upon two major assumptions. First, it is assumed that written and spoken language contains many words and word sequences which are unnecessary for the comprehension of a message. Persons engaged in reading and listening activities have knowledge of certain natural language statistics which permit them to predict, with varying degrees of accuracy, material which has not been presented but which is obvious from the message context. Second, it is assumed that so-called "correct" writing styles have evolved quite independently of the psychological factors involved in encoding processes related to the reading of connected discourse. The concept of a well-formed sentence or paragraph may not be a necessary condition for the comprehension and recall of text information.

The basic direction of this program of research has been the development of methods for optimal presentation of traditional

educational text. Major consideration has been given to those methods of text reduction which minimize reading time and maximize comprehension and recall of factual and inferential information.

Review of the Literature

The presence of redundancy in English prose is an underlying assumption in the development of telegraphic prose. Several techniques have been developed from statistical theory to estimate the amount of redundancy in natural English prose. Some confidence in these methods is warranted in that the various estimates derived from them are quite similar.

Most of the research involving the redundancy of printed English evolved from information theory. Redundancy measures have been obtained in relation to letters and words. In many ways, analysis at the word level as opposed to the letter level appears to be the most useful. Words come closest to the usual conception of the natural units of speech and communication. But there are difficulties because the number of words is large and it is not easy to get homogeneous samples of sufficient size. Therefore, the first attempts to estimate redundancy were made at the level of letters rather than words. It has been shown that subjects are aware of redundancy in printed English. Garner (1962) has written a thorough discussion concerning the redundancy of written English in which he presents a review of the literature concerned with specific problems related to the measurement of redundancy.

Methods of assessing word redundancy have been designed by the use of the cloze procedure. Words are systematically eliminated from a passage and a uniformally spaced blank is provided in the place of the missing words. Taylor (1954) found that the cloze procedure provides a good measure of the degree of redundancy. He reported a correlation of -.87 between cloze scores, based upon the number of words correctly replaced, and a measure of the "information" in a prose passage. Thus, when the ability to correctly replace the missing words is high, the amount of information in the passage is low.

Other researchers in the area of word predictability have not been as successful as Taylor (1954). Morrison and Black (1957) omitted six words from each of 130 sentences. Subjects asked to replace the exact word missing in each blank were only accurate at about 50%, although 75% were able to convey the original idea. Aborn, Rubenstein, and Sterling (1959) report that replacement was accurate at only 40% when one word was omitted from sentences of varying lengths.

It has been pointed out by McLeod and Anderson (1970) that calculation of redundancy among words has not been possible to the same extent as among letters and phonemes performed by Shannon (1951). It has been further argued by Herdan (1966) that among the vast number of vocabulary items, it is not possible to measure redundancy as has been done for the relatively small number of letters and phonemes.

Despite the low performance of those responding to a cloze item by replacing the exact missing word, Aborn and Rubenstein (1958) found that subjects were able to successfully list eight words in decreasing likelihood of occurrence which could be used to replace a missing word.

The cloze procedure has also been used to measure characteristics of redundant elements, which has provided a different aspect to the definition of redundancy. By a technique similar to that used by Aborn and Rubenstein (1958), the size of the distribution from which a subject selects an appropriate response can be measured. Shepard (1963) asked subjects to guess all the words which would make sense in the place of a deleted word during a 5-minute time period. Since the cloze procedure requires a search through a distribution of appropriate words, it is possible to obtain a measure of information based on the rate of responding.

Fries (1952) has written that the English language can be described by two dimensions of meaning: lexical meaning and structural meaning. Structural meaning can be identified by the function words (articles, prepositions, auxiliary verbs, conjunctions, and pronouns) each containing relatively low information, whereas lexical meaning is identified by nouns, verbs, adjectives, and adverbs. From the research available on the distribution of structural and lexical words, it is the structural words which form short restricted categories, while the lexical words form long, sometimes inexhaustible categories (Weaver, 1965). It should also be noted that although the structural words are short and restricted in their distributions, they form the class of very high frequently occurring words in the language (Herdan, 1966).

Another aspect of the more redundant structural elements concerns their effect on the storage capacity of the brain. The capacity of the immediate memory is hampered by length. It is conceivable, therefore, that incoming information must be regrouped or chunked in order to be stored. This coding operation or regrouping must require reducing the redundant or inessential information. It might further be theorized that the redundant words in the language are eliminated in the storage process (Weaver, 1965). Storage of high, frequently occurring words such as the structural words would simply overload the storage capacity. Evidence found by Weaver indicates that the structural elements are primarily used for encoding. He further states that the matrix of structural words within each language producer is not transmitted from one person to another. The function words, which subjects recalled in a story and scientific passage, more closely conformed to the subjects' own spontaneous distribution of function words than to those functors presented in the original passages. The opposite effect was found for the lexical elements.

Redundancy as a feature of language is demonstrated in the preceding research. The implication that the deletion of some redundant elements from printed English is possible without appreciably affecting

comprehension finds some support in these studies. However, none of the studies dealt directly with the problem of the effects of the deletion of redundant elements on comprehension, and it is this problem that is central to the telegraphic concept. Although the studies cited focused on subjects' ability to replace missing elements in a passage and left the question of the effects of deletion on comprehension and reading rate unanswered, they do provide a background against which the feasibility of telegraphic prose can be investigated.

The first attempt to reduce the redundancy in narrative passages and to study the effects of reduction on comprehension and reading time was by Martin and Alonso (1967). In their two-year U.S.O.E. sponsored project, they examined the ability of braille readers to comprehend prose material presented in a telegraphic style. A traditional prose passage written for this experiment was constructed according to the Dawes (1964) model, which provided a basis for defining the essential information in the passage. The story was written so that the central ideas in the passage were set relations which could be used to analyze the essential information gained by reading the passage. The unessential information was comprised of the descriptive material unrelated to the set relations information. Medium and high telegraphic passages were generated by deleting the unessential information from the original passage at 42 and 72%, respectively. Thus, the set relations remained the same in all three passages.

The traditional and medium telegraphic versions were alike in grammar, punctuation, and indentation. The high telegraphic version varied considerably from the usual conventions related to sentence structure. The sentences were shorter than in either of the other two versions. Word-per-sentence reduction was accomplished in part by the substitution of colons and semicolons for unnecessary words.

The subjects participating in the study were 210 sixth, seventh, eighth, and ninth grade students who had completed four or more years of braille instruction. All subjects were assigned to one of the three treatment passages and were tested on one of three recall conditions: set relations, multiple choice, and reconstruction. The reading time for completion of each passage, as well as reading rate, were analyzed with the variables of recall.

The results indicated that the amount of reading time necessary to read the telegraphic versions was significantly less than for the traditional passage. However, reading rate decreased for subjects reading the telegraphic versions in comparison to subjects reading the traditional version. Learning and retention of the important information was comparable among the shortened versions and the traditional passage.

The results of the Martin and Alonso (1967) study supports the feasibility of telegraphic materials as a means of providing important information in a shorter time period. It was further concluded that the ease with which telegraphic learning materials can be

applied to existing materials is dependent upon the development of an objective means of reducing redundancy from traditional materials.

Martin and Hope (1972) continued the work by Martin and Alonso in an effort to examine two hypotheses concerning the reduction of reading rate when high levels of reduction were performed. It was hypothesized that the subjects were either reading at rates that insured a comfortable rate of information input or that the unique style of the high telegraphic format caused a reduction in reading rate. The former hypothesis was tested by presenting college subjects with an aural presentation of highly telegraphic prose. The latter hypothesis was tested by presenting 0, 2, and 4 practice sessions on highly telegraphic prose. The results suggest that subjects decreased their reading rate in order to ensure comfortable rates of information input. The practice sessions had no effect on improving reading rate.

In an effort to improve the identification and reduction procedures of redundant elements in telegraphic prose, further research was completed by Martin and Chitwood (1972), Martin and Pantalion (1972), Martin (1974), and Bassin (1974).

Martin and Chitwood were concerned with the development of a grammatical reduction procedure based upon the objective omission of various parts of speech. A traditional fiction story was reduced of five grammatical categories (nouns and pronouns, verbs, adjectives and adverbs, articles and conjunctions, and prepositions) by deleting 10, 20, 40, 60, and 80% of the words. Thus, with inclusion of the traditional passage, 26 treatment passages were administered along with tests of comprehension to undergraduate students. The reading performance of the college students indicated that in general, comprehension decreased as percent reduction increased. A significant interaction between Percent Deletion and Grammatical Category main effects on comprehension further demonstrated that reduction up to 40% of the nouns and pronouns had no effect as compared with the traditional passage, whereas as many as 80% of the prepositions could be deleted with no effect on comprehension. No differences were found on comprehension between the traditional passage and passages reduced by the remaining categories up to the 60% level of reduction. The results of the Martin and Chitwood study suggested that an objective and efficient reduction method may be possible based upon reduction of grammatical categories if the least informative categories such as prepositions are omitted.

Martin (1974) studied the effects of reading performance of deleting three categories of words based upon word frequency. Analysis of the frequency of each word within the passages used in the study was performed by computer resulting in three categories of high, medium, and low frequently occurring words. The number of words in each category were omitted from each traditional passage at 10, 30, and 50%. When tested on 412 undergraduates, the treatment conditions indicated that passages reduced of high frequency words were generally superior on measures of comprehension to those in which medium or low frequency words were deleted. However, the

reduced passages did not result in less reading time than the traditional, and reading rate tended to decrease significantly when 50% of the high frequency words were deleted.

Martin and Pantalion (1972) developed a reduction procedure designed to delete words which were subjectively ranked according to their importance for the meaning of the sentences in a prose selection. The words of each sentence were numbered allowing the subjects to rank the words on a grid sheet. Those words which were least important for comprehension were ranked first, and those which were most important were ranked last. The index of agreement among subjects on the rank ordering of each sentence was significant. The sentences were reduced of the least significant words resulting in five telegraphic passages reduced at 10, 20, 30, 40, and 50% of the total number of words in the passage.

Martin and Pantalion support the development of subjective telegraphic prose with reduction as great as 40%. Although reading rate tends to decrease at levels of 40% and higher, the total time required to read the reduced passages was significantly less than the traditional without a significant loss in comprehension.

A comparative study of grammatical, frequency, and subjective reduction methods was conducted by Bassin (1974) on normal subjects. The reduction methods were employed at 10, 30, and 50% levels of reduction. On the measures of reading performance, a significant difference was found among the reduction methods on the variables of multiple choice comprehension and efficiency in two of the three types of literature used in the study. The subjective method was superior to the grammatical and frequency methods, and although no interaction was found, the subjective method had the least effect upon comprehension at the 50% level.

Objectives of the Project

The general objectives of this research were concerned with determining the possibility of developing objective reduction procedures whereby existing written materials could be condensed into a telegraphic type format and to assess the effects which these reduction procedures have upon the comprehension of such telegraphic materials among handicapped subjects. Involved in these objectives was the development of general reduction schemes designed to apply the reduction procedures to traditional materials. The goal was to develop reduction procedures which could be applied to a wide variety of materials.

The specific objectives were:

1) To apply 20 and 80% reduction levels on various grammatical categories: nouns and pronouns, verbs, adjectives and adverbs, and articles and conjunctions. Textbook-type information was reduced by grammatical category and administered to hard-of-hearing populations to determine the effects which these reduction techniques have upon the comprehension of textbook-type information.

2) To develop probability distributions for individual words within a passage in order to develop a reduction program based upon word frequency. The goal here is to develop frequency categories so that different reduction percentages may be applied to these categories. This material was administered to hard-of-hearing populations in order to determine the effects which these reduction programs have upon the comprehension of educational materials.

3) To determine the relative effects of the grammatical and word frequency reduction programs, and a subjective program upon the comprehension of educational materials presented in braille to visually handicapped subjects and presented visually to hard-of-hearing subjects.

CHAPTER IX

EXPERIMENT VII -- EFFECT OF A SUBJECTIVE DELETION SCHEME UPON READING PERFORMANCE OF BRAILLE AND REGULAR PRINT READERS

Introduction

The present study was an attempt to increase the reading efficiency of blind and sighted individuals by acknowledging the redundancy that exists in the English language and using it to develop telegraphic prose. The education of visually impaired children has been hampered by slow methods of material presentation. Since use of the tactile and auditory senses is not as efficient as normal sight, visually impaired children require a longer period of time to acquire information equal in amount to that of their seeing contemporaries. Visually impaired individuals read in braille, large type or through auditory means at slower rates than normally sighted individuals read print. While the sighted student can read about 250 words per minute (wpm), the braille reader averages about 90 words per minute.

The most important aspect of telegraphic materials is the elimination of nonessential information. Therefore, if a blind child were to maintain the same reading rate with telegraphic materials as with traditional materials, the rate of information input would be increased. The fact that rate of information input can be increased without appreciable loss in comprehension has been demonstrated in the compressed speech studies.

One of the earliest studies investigating the relationship between amount of time compression and comprehension of connected speech was conducted by Fairbanks, Guttman and Myron (1957). These investigators presented two different technical messages at five different time compression levels (0, 30, 50, 60, and 70%) to Air Force trainees. The 0, 30, 50, 60, and 70% compression levels correspond to 141, 201, 282, 353, and 470 wpm rates, respectively. The results indicated that message efficiency, as measured by the amount of factual comprehension (multiple choice items) per stimulus time, increased up to a message rate of 282 wpm. That is, when compared to the comprehension of the 141 wpm passage (0% compression), the 282 wpm comprehension was 90% effective. The 353 and 370 wpm rates indicate that there is little loss in comprehension up to and including the 282 wpm rate. However, there is a rather marked decrease in comprehension at the faster rates.

This experiment was based in part upon a M.S. thesis by Carol Sheffield submitted to the Graduate College of Texas A&M University.

Similar results have been obtained by Foulke, Amster, Nolan and Bixler (1962). These investigators presented literary and scientific passages to sixth, seventh, and eighth grade braille readers in braille and recorded form. The material was recorded at 175, 225, 275, 325, and 375 wpm. Comprehension of these materials was assessed by multiple choice items. Comparison of mean comprehension scores for each listening group with comprehension scores for braille readers indicated no significant loss in comprehension of the literary material up through 225 wpm. For the scientific material, there was no significant loss up through 275 wpm. However, when the faster rates were compared to the braille condition, there was a significant loss in comprehension. It appears that comprehension is impaired when the rates approach or exceed 300 wpm.

Another study by Foulke (1966) also indicates that comprehension is seriously affected at faster rates. The word rates studied in this experiment were 253, 300, and 350 wpm. In addition, two different methods of compressing speech were examined. While there was no difference in comprehension as a function of the two speech compression methods, there was a significant difference among the word rates. No post-mortem analyses were performed to determine which rates were different, but the mean comprehension scores for the 350 wpm groups were approximately one-half as large as the 253 wpm groups (12.80 and 10.36 for the 350 wpm groups compared to 23.65 and 21.19 for the 253 wpm groups).

The time compression studies demonstrate the fact that the auditory communication rate can be increased up to approximately 275 wpm without an appreciable loss in comprehension. These studies clearly indicate that subjects are able to process information via the auditory modality at rates faster than the ones encountered under normal conditions. These data, plus the redundancy data, suggest that more efficient methods of material presentation may be possible via the tactile modality. However, relatively little attention has been given to this problem as it relates to the preparation of braille materials.

The telegraphic reduction method used in this study was based upon subjects' rankings of words within each sentence of a prose passage on the basis of each word's functional communication value. This method was termed SHORT (Subjective Hierarchy of Relevant Terms) and provided a basis for the generation of different degrees of telegraphic sentences. In this procedure, those words which were judged to be least relevant in communicating the essential message of the sentence were eliminated, the number of words deleted being dependent upon the reduction level desired. On the basis of the subjects' judgments, telegraphic passages were developed. The reduced passages were then read by both sighted and blind students to determine the feasibility of presenting prose material in telegraphic form.

Method

Subjects

The sighted subjects for this study were students from grades seven through twelve attending the Duncanville, Texas, public schools. A total of 144 sighted subjects were used in Phase I of the study. Six subjects from each of three grade levels (7-8, 9-10, 11-12) were randomly assigned to one of the eight sentence sets so that a total of 18 subjects rank ordered the words within each sentence. A total of 174 sighted subjects were used in Phase II.

The blind subjects were seventh through twelfth grade students at the Texas School for the Blind, Austin, Texas. Twenty-four subjects were used in Phase I of the study. One to four subjects were randomly assigned to one of the eight sentence sets. Twenty-seven blind subjects were used in Phase II.

Materials

Phase I. Two forms were used by the sighted subjects in Phase I of the study in addition to the traditional (Trad) prose passage which they were instructed to read before beginning the rank ordering task. The "sentence form" consisted of the traditional passage printed lenthwise on paper measuring 8-1/2 x 14 inches. Each sentence was assigned a number corresponding to its sequential position within the passage. The first sentence was assigned the number one, the last sentence the number 54. In addition, each word within each sentence was numbered sequentially. The second form, the "recording form," was used by subjects to enter the rank order of each word. The form consisted of numbered rows of blocks. Each row of blocks was numbered to correspond to the sentences on the sentence form. Each block within the rows was numbered so that there was a block for every word within a sentence.

Blind subjects were given a traditional version of the passage printed in Grade 2 braille to read before beginning the rank ordering task and to use as a reference during the task. The "sentence form" for the blind subjects was brailled on standard 8-1/2 x 11 inch sheets. The sentences and words within each sentence were numbered on the sentence form as they were for the sighted subjects. In place of a recording form, the blind subjects were each given three blank sheets of paper and a braillewriter.

Phase II. The traditional or reference passage in Phase II was the medium telegraphic version of the story used by Martin and Alonso (1967) and Martin and Herndon (1971). The content of the story was written so that the essential information could be analyzed in terms of the Dawes (1964) model.

The central ideas of the passage were defined as either nested or disjunctive set relationships. The passage consisted of 13 paragraphs, 54 sentences, and 947 words. The sentences averaged 18 words in length. The passage was a story about two warring African nations, Mambo and Yam. The development of the three reduced passages was based upon the data collected from the sighted subjects in Phase I of the study. The 10% reduced passage contained 848 words, the 30% reduced passage contained 657 words, and the 50% reduced passage contained 455 words.

The comprehension for subjects reading one of the four treatment conditions was assessed on the basis of two tests, a 20-item set relations test and a 40-item multiple choice test developed by Martin and Alonso (1967).

Time recording forms, an electronic timer, and IBM answer sheets were also used in Phase II of the study. The time recording forms were used to record the time spent in reading the passage. The recorded time was used to compute reading rate and required reading time. A digital elapsed time display was used as the timing device. The timer was set to change at ten second intervals. The sighted subjects read the clock and recorded their times, while the experimenter recorded the times for the blind subjects. IBM answer sheets were used by sighted subjects to record test answers.

Procedure

Phase I. The materials used in the three subject-generated treatment conditions were based on a subjectively determined mean rank order for each word within each sentence. Sighted subjects in Phase I rank ordered each word within a sentence with respect to its importance in communicating the intended meaning of the sentence. Sighted subjects were divided into three groups on the basis of grade level: Group 1, seventh and eighth grades; Group 2, ninth and tenth grades; Group 3, eleventh and twelfth grades. The passages generated by the three groups were used to make developmental comparisons. The combined data from all three groups of sighted subjects were used to generate the three telegraphic versions of the passage used in Phase II. Blind subjects also participated in Phase I. However, the data obtained from the blind subjects were for comparison purposes only. Their data were not used to generate the reduced passages for the three subject-generated treatment conditions. In Phase I, a rank order of one denoted the least significant word, and the largest rank order denoted the most significant word in each sentence. A mean rank order for each word was computed from the data obtained from the blind subjects, the three groups of sighted subjects, and the combined sighted sample.

To rank the words, the sighted subjects used both the sentence form and the recording form. The subject first read a sentence as presented on the sentence form. He then determined

the least significant word in the sentence and entered on the recording form the number assigned the word on the sentence form. This procedure was repeated until all words within the sentence were ranked.

Blind subjects necessarily used a slightly different procedure for rank ordering words within sentences. They were instructed to read the sentence on the sentence form, write its number on the paper with their braillewriters, and then determine the least significant word in the sentence. They were next instructed to write the number of the least significant word after the sentence number on their paper and then return to the sentence form and cross out the word so that they would know they had deleted that word from the sentence. The subjects were told to continue this procedure until the number of each word within the sentence had been typed on their paper and was thus ranked.

Subjects in each grade were randomly assigned to rank one of eight sets of sentences. Six of the sets consisted of seven sentences, and two sets consisted of six sentences. The subjects were given written and oral instructions prior to their participation.

An IBM 360/65 computer was used to analyze the ranking data and to delete the words from the sentences. The computer printed each sentence at the three levels of reduction and computed the Kendall Coefficient of Concordance (W) for each sentence. The reduced sentences were then placed in paragraph form and punctuation was added by the experimenter.

Phase II. A test package consisting of a randomly assigned version of the passage, a time recording form, the test, and an answer sheet for the sighted subjects or blank paper for the blind subjects was assembled for each subject. The subjects participating in Phase II proceeded as follows: (1) each subject read the passage at a comfortable rate, but was instructed not to reread any portion of the passage; (2) the subject's time was recorded upon completing the reading task; and (3) the subject answered the comprehension tests.

Design and Analysis

Phase I. The data from Phase I of this study were analyzed to determine: (1) the degree of agreement among subjects within the three grade levels for the sighted subjects, within the total sighted group, and within the blind group; (2) the correlation of blind and sighted subjects on the rank order assigned words within each sentence; and (3) differences in the telegraphic passages generated by the three grade levels and differences in the passages generated by the total sighted sample as compared to the blind sample. The index of agreement within the three groups of sighted subjects, the combined group of sighted subjects, and the combined group of blind subjects was assessed

by computing a Kendall Coefficient of Concordance (W) (Ostle, 1963) for each sentence within the passage. A Chi-square value was then calculated from the Kendall coefficients so that the significance of W could be tested (Ostle, 1963). The Kendall Correlation Coefficient was used to compare the blind and sighted subjects' mean rank orderings of the words within each sentence. The Kendall Correlation Coefficient for each sentence was used to calculate a Z-value (Kendall, 1962) in order to test the hypothesis that the rank orderings of the sighted subjects was positively correlated with the rank orderings of blind subjects. For sentences with less than ten words, the Z-value was replaced by an S-value (Kendall, 1962) to test for significance. The reduced passages that resulted from the rank ordering task were used to perform the remaining analyses. Initially, all of the words in the traditional (Trad) passage were classified on the basis of eight grammatical categories: (1) nouns; (2) verbs; (3) articles; (4) pronouns; (5) adjectives; (6) adverbs; (7) conjunctions; and (8) prepositions. The words deleted from the 10, 30, and 50% reduced versions of the passage were then identified. Chi-square analyses (Conover, 1971) were performed to determine whether any significant differences existed among the grammatical categories deleted from the three reduced passages (1) among the three groups of sighted subjects and (2) between the blind and sighted subjects. The Chi-square analog to Scheffé's theorem (Conover, 1971) was used to determine the exact location of the differences.

Phase II. The major analyses in Phase II of this study involved two sets of data: (1) data obtained from sighted subjects and (2) data obtained from blind subjects. In addition to the separate analyses performed on the two sets of data, a third set of analyses compared the performance of blind and sighted subjects.

The three telegraphic versions of the passage and Trad were compared with respect to five dependent variables. Two different types of recall tests, a set relations test and a multiple choice test, were analyzed in order to assess comprehension. A total test score, consisting of the combined number of correct responses on the set relations and multiple choice items, was also used as a measure of comprehension. In addition, reading rate (wpm) and reading time were analyzed separately.

A 3 x 4 ANOVA was used to compare the means of each of the dependent variables for the sighted subjects. One independent variable was Grade Level while the other independent variable was Deletion Level. The data from the sighted subjects were analyzed by grade level so that developmental differences could be investigated. Sighted subjects were divided into the following three groups: Group 1, seventh and eighth grades; Group 2, ninth and tenth grades; and Group 3, eleventh and twelfth grades. Where appropriate,

the Scheffé test was used to determine the precise nature of the differences among treatment means.

A 1 x 4 ANOVA was used for the blind subjects in order to compare the means of each of the dependent variables in the four treatment conditions. The Scheffé test was used to make post hoc comparisons.

A comparison of the performance of blind and sighted subjects on each of the dependent variables was made by the use of a 2 x 4 ANOVA. The three groups of sighted subjects were combined in order to make comparisons between the sighted and blind samples. The Scheffé test was again used to make post hoc comparisons.

Results

The results are organized on the basis of Phases I and II data and the two subject populations.

Phase I

Sighted Subjects. Data from the sighted subjects in Phase I indicated significant agreement among subjects on the rank orders assigned to the words within each sentence. The Kendall Coefficient of Concordance (W), used to determine the degree of agreement among subjects relative to the rank ordering of words within each sentence, indicated agreement at the .05 level of significance for 49 of the 54 sentences rank ordered by Group 1, 48 sentences rank ordered by Group 2, and 45 sentences rank ordered by Group 3. The combined data for seventh through twelfth grade subjects indicated significant ($p<.05$) agreement for each of the 54 sentences.

The grammatical category comparisons among grade levels indicated that there was little difference in the parts of speech deleted by each grade level. The Chi-square analyses comparing the deletions from each grammatical category at the three reduction levels (10, 30, and 50%) indicated a significant ($p<.05$) difference in the 30% reduced passage for verbs. A Chi-square analog to Scheffé's theorem (Conover, 1971) was performed on the number of verbs deleted in the 30% reduced passage. It was found that Group 1 deleted significantly more verbs than did Groups 2 or 3. However, no other significant differences were found in the deletions among the grammatical categories at any reduction level.

Blind Subjects. The Chi-square analysis used to test the significance of the individual subjects indicated that blind subjects agreed ($p<.05$) on only eight of the 54 sentences. The size of the sample (from one to four subjects per sentence) was an important factor contributing to the lack of significance among blind subjects.

Comparison of Blind and Sighted Subjects. The Z-values calculated from the Ws indicated that there was significant agreement between the blind and sighted subjects on the rank ordering of words in 48 of the 54 sentences. The Chi-square analysis performed to compare the passages generated from the data of the blind and sighted subjects revealed no significant differences in deletions by grammatical category in the 10 or 30% reduced passages. The overall Chi-square analysis performed on the grammatical categories deleted in the 50% reduced version did indicate a significant difference ($p<.05$). The individual Chi-square analyses performed on each grammatical category revealed that blind subjects deleted 27% of the nouns while sighted subjects deleted only 13% of the nouns from the Trad passage at the 50% reduction level. No other significant differences were found. The number of words deleted in each grammatical category by the blind and sighted subjects is presented in Figures 9.1 and 9.2.

Phase II

Sighted Subjects. The means and standard deviations for each of the five dependent variables are listed in Table 9.1 by grade level.

The 3 x 4 ANOVA performed on the combined number of correct responses on the two comprehension tests indicated significant differences across grade levels ($F(2,132) = 5.80$, $p<.01$) and across deletion levels ($F(3,132) = 8.74$, $p<.001$). The Scheffé test revealed that Group 1 answered 12% fewer questions correctly than Group 3 and that subjects reading the 50% reduced version answered 16% fewer questions correctly than subjects reading the Trad.

The 3 x 4 ANOVA performed on the multiple choice test yielded a significant difference with the Grade Level main effect ($F(2,132) = 5.11$, $p<.01$) as well as the Deletion Level main effect ($F(3,132) = 8.74$, $p<.001$). The Scheffé test of multiple comparisons revealed that Group 1 answered 15% fewer questions correctly than Group 3. The Scheffé test also revealed that subjects reading the 50% reduced version correctly answered 24% fewer questions than the subjects reading the 10% reduced version and 21% fewer questions than subjects reading the Trad.

Another 3 x 4 ANOVA design for assessing comprehension was performed on the number of correct items on the set relations test. Again, the Grade Level main effect was significant ($F(2,132) = 3.63$, $p<.05$). Due to the conservative nature of the Scheffé test, the exact location of the differences could not be determined from the post-mortem analyses for either of the two main effects. However, it was possible to infer the location of the differences responsible for the significant differences in the ANOVA design by examining the exact p-values. The comparison of Group 1 with Group 3 resulted in the smallest

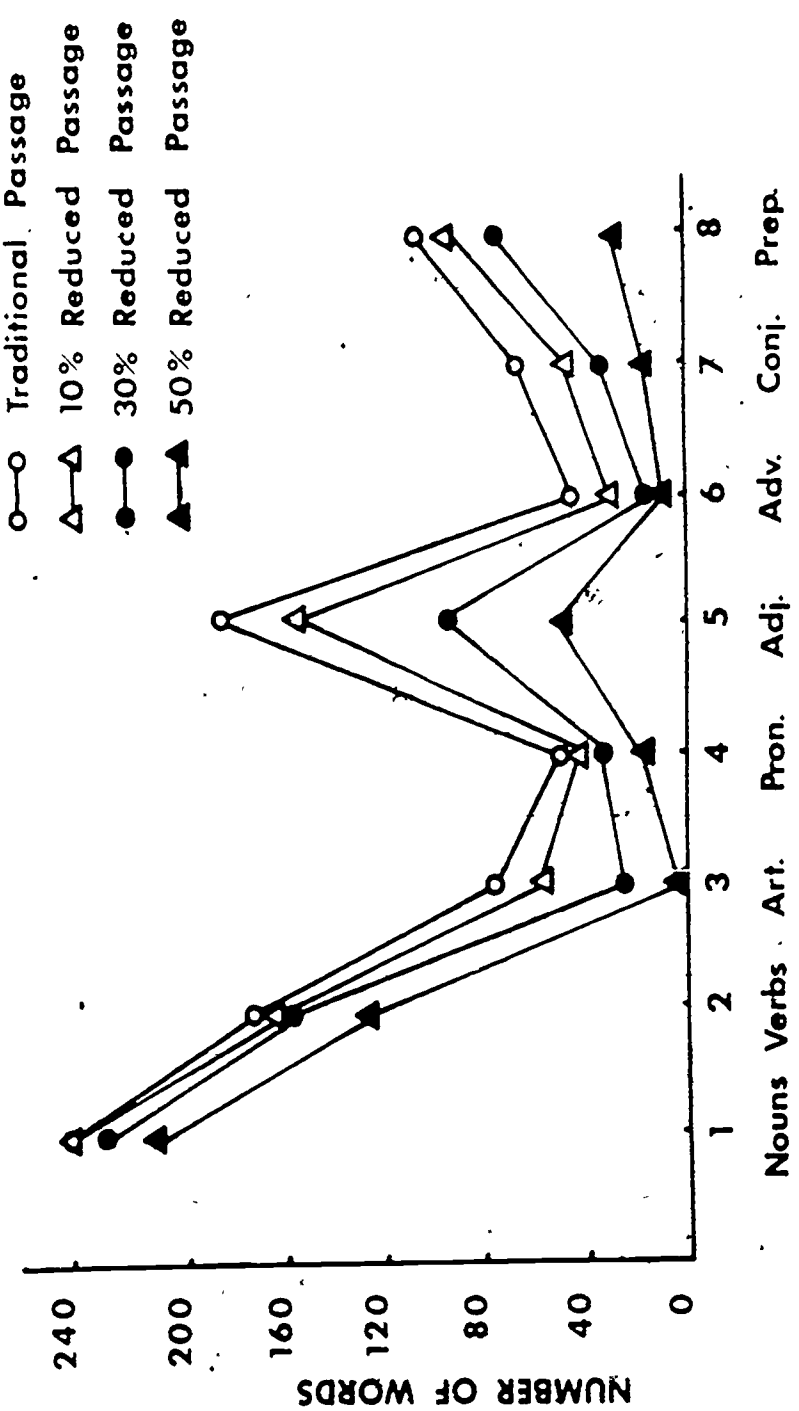


Figure 9.1. Number of words by grammatical category contained in the traditional version and the three reduced versions of the passage generated by sighted subjects.

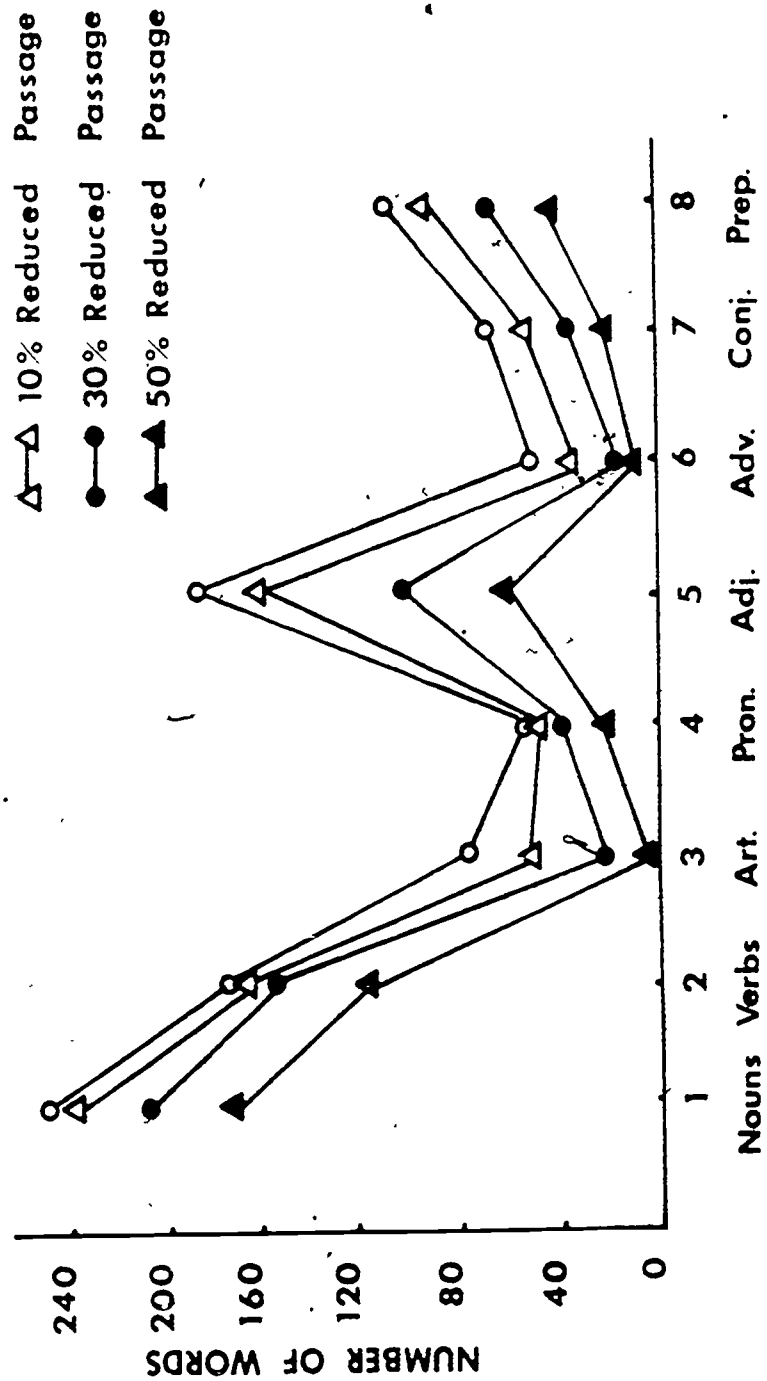


Figure 9.2. Number of words by grammatical category contained in the traditional version and the three reduced versions of the passage generated by blind subjects.

TABLE 9.1

Means and Standard Deviations of Sighted Subjects by Grade Levels for Each Dependent Variable

Variable	Grade Level											
	7 - 8				9 - 10				11 - 12			
	Trad	10%	30%	50%	Trad	10%	30%	50%	Trad	10%	30%	50%
Total Comprehension												
Mean	38.08	40.00	32.50	28.33	37.17	37.92	37.75	33.17	42.50	42.17	38.92	35.08
S.D.	9.56	7.39	5.57	4.29	9.64	5.65	7.55	7.08	6.43	7.52	7.68	6.11
Multiple Choice												
Mean	24.67	26.50	20.25	17.42	24.50	25.42	23.83	22.00	28.42	28.50	25.08	22.00
S.D.	8.65	5.95	3.77	4.46	7.04	5.11	6.53	5.06	5.35	5.87	5.32	5.17
Set Relations												
Mean	13.42	13.50	12.25	10.92	12.67	12.50	13.92	11.17	14.08	13.67	13.83	13.08
S.D.	1.93	2.28	2.22	2.43	2.81	2.58	2.31	2.98	2.68	2.15	3.04	2.54
Reading Rate												
Mean	157.91	158.20	139.60	99.68	156.77	157.87	125.02	90.70	162.49	149.86	130.34	88.92
S.D.	18.70	46.15	38.44	9.97	47.36	34.50	16.77	10.46	29.42	25.34	37.59	15.52
Reading Time												
Mean	6.09	5.82	5.09	4.65	6.54	5.58	5.34	5.08	6.01	5.87	5.44	5.25
S.D.	0.86	1.81	1.58	0.43	1.86	1.10	0.69	0.60	1.08	1.39	1.61	0.87

p-value ($p<.08$) in the Grade Level main effect. Group 1 answered 9% fewer questions correctly than Group 2. Although this difference was not significant, it was the largest difference in the Grade Level main effect. The smallest p-value obtained in the Scheffé analysis of the Deletion Level main effect for the set relations test was in the comparison of the Trad passage and the 50% reduced passage ($p<.051$). Subjects assigned the 50% reduced passage answered 12% fewer set relation questions correctly than subjects assigned Trad.

A significant difference ($F(3,132) = 36.33$, $p<.001$) was obtained for the Deletion Level main effect in the 3 x 4 ANOVA performed on reading rates. The Scheffé analysis revealed that subjects reading the 50% reduced version read at a significantly slower rate than subjects reading the other three passages. Subjects reading the 30% reduced version, while reading significantly faster than subjects reading the 50% reduced version, read significantly slower than subjects reading either the 10% reduced passage or Trad. Subjects reading the 50% reduced passage read at a 42% slower rate while subjects reading the 30% reduced passage read at a 17% slower rate than subjects reading Trad.

The 3 x 4 ANOVA design used to examine total reading time indicated that, although no significant differences were found for the Grade Level main effect, there were significant differences ($F(3,132) = 6.58$, $p<.001$) for the Deletion Level main effect. The Scheffé analysis indicated that subjects assigned Trad required 24% more time to read the passage than subjects reading the 50% reduced version and 17% more time than subjects reading the 30% reduced version.

Blind Subjects. The means and standard deviations of the blind subjects for each of the dependent variables are listed in Table 9.2. The 1 x 4 ANOVA design used to assess the combined multiple choice and set relations comprehension scores yielded ($F(3,23) = 3.25$, $p<.05$). The Scheffé test revealed that subjects reading the 50% reduced version answered 29% fewer questions correctly than subjects reading the 30% reduced version. No other significant differences were found.

No significant differences were obtained in the 1 x 4 ANOVA of the multiple choice test. There was a significant difference ($F(3,23) = 3.03$, $p<.05$) on the set relations test. However, the Scheffé test did not reveal where the differences were. The smallest p-value obtained in the Scheffé analysis was in the comparison of the 50% reduced passage and the 30% reduced passage ($p<.07$). Subjects assigned the 50% reduced passage answered 27% fewer set relations items correctly than subjects assigned the 30% reduced passage. Although this difference was not significant in the Scheffé analysis, it was large enough to result in a significant overall F-value in the ANOVA design.

TABLE 9.2

Means and Standard Deviations of Blind and Sighted Subjects in Grades 7 - 12 for Each Dependent Variable

Variable	Sighted				Blind			
	Trad	10%	30%	50%	Trad	10%	30%	50%
Total Comprehension								
Mean	39.25	40.03	36.39	32.19	39.71	38.17	43.29	30.57
S.D.	8.75	6.93	7.36	6.45	6.27	9.51	6.18	6.91
Multiple Choice								
Mean	25.86	26.81	23.06	20.47	26.71	24.67	29.00	20.14
S.D.	7.17	5.64	5.58	5.25	4.77	7.91	5.15	4.79
Set Relations								
Mean	13.39	13.22	13.33	11.72	13.00	13.50	14.29	10.43
S.D.	2.50	2.33	2.60	2.76	2.83	1.71	2.18	2.38
Reading Rate								
Mean	159.06	155.31	131.65	92.77	72.67	61.49	78.02	63.67
S.D.	33.06	35.51	32.16	12.64	16.92	26.88	38.04	19.25
Reading Time								
Mean	6.21	5.76	5.29	4.99	13.66	15.50	10.49	7.69
S.D.	1.32	1.42	1.33	0.69	2.71	3.99	4.46	1.85

The 1 x 4 ANOVA on reading rates indicated that there were no significant differences across deletion levels for blind subjects. Reading times, however, were significantly different ($F(3,23) = 5.87$, $p<.01$). The Scheffé test revealed that subjects assigned Trad required 82% more time to read the passage than subjects assigned the 50% reduced passage, and subjects assigned the 10% reduced version required 107% more time to read the passage than subjects assigned the 50% reduced passage.

Comparison of Blind and Sighted Subjects. The 2 x 4 ANOVA design was used to analyze the dependent variables in relation to the blind and sighted samples. The means and standard deviations for each of the dependent variables are listed by subject sample in Table 9.2. Significant differences ($F(3,163) = 6.65$, $p<.001$) were found on the combined comprehension measure for the Deletion Level main effect, but no difference was found between the sighted and blind samples. The Scheffé test indicated that subjects assigned the 50% reduced version differed significantly from subjects assigned the 30% reduced version, the 10% reduced version, or the Trad version of the passage. Subjects reading the 50% reduced version answered 21% fewer questions correctly than subjects reading Trad, 20% fewer than subjects reading the 10% reduced version, and 21% fewer than subjects reading the 30% reduced version.

The 2 x 4 ANOVA of the multiple choice test indicated no significant differences between the blind and sighted subject samples. The Deletion Level main effect was significant ($F(3,163) = 5.18$, $p<.01$). The Scheffé test revealed that the subjects reading the 50% reduced version answered significantly fewer items correctly than subjects reading the 30, 10% or Trad passage. Subjects reading the 50% reduced version answered 23% fewer items correctly than subjects reading Trad, 21% fewer than subjects reading the 10% reduced version, and 22% fewer than subjects reading the 30% reduced version.

The 2 x 4 ANOVA of the set relations test revealed a significant difference ($F(3,163) = 5.17$, $p<.01$) across deletion levels, but there was no significant difference between blind and sighted subjects. The Scheffé test indicated that the mean number of correct responses for subjects reading the 50% reduced version was again significantly lower than for subjects reading the 30% reduced, 10% reduced, or the Trad version. Subjects assigned the 50% reduced version answered 16% fewer items correctly than subjects reading Trad.

The 2 x 4 ANOVA performed on reading rates indicated a significant difference ($F(1,163) = 111.38$, $p<.001$) between blind and sighted subjects. A significant difference ($F(3,163) = 6.93$, $p<.001$) was also obtained for the Deletion Level main effect, a finding which parallels the results of the 3 x 4 ANOVA and the 1 x 4 ANOVA performed on the separate samples.

In addition, a significant interaction effect ($F(3,163) = 5.81$, $p<.01$) was found. Figure 9.3 illustrates the differential effects of increased deletion for the two groups of subjects. The Scheffé test revealed that the reading rates for the blind subjects were not influenced by deletion level, while the reading rates of sighted subjects were reduced 42% in the 50% deleted passage and 17% in the 30% deleted passage as compared to subjects reading Trad.

Reading times were found to be significantly different ($F(1,163) = 279.80$, $p<.001$) between the two subject samples and across deletion levels ($F(3,163) = 27.19$, $p<.001$) in the 2 x 4 ANOVA design. A significant interaction effect ($F(3,163) = 16.26$, $p<.001$) was also found (Figure 9.4). The Scheffé test revealed that while reading times for the sighted subjects did not significantly differ across deletion levels, blind subjects assigned the Trad version required more time to read the passage than subjects assigned the 50% reduced version. These results correspond to the results found in the 1 x 4 ANOVA which assessed the reading times of blind subjects.

Discussion and Conclusions

As expected, the index of agreement among subjects on the rank ordering of words within each sentence was significant for the combined sighted data. While there were sentences which did not yield a significant index of agreement from the three grade levels, there was no trend present in the data to suggest that younger subjects showed less agreement in their rank orderings than older subjects. The comparisons made of the passages generated by the three groups of sighted subjects in terms of which words were deleted by grammatical category revealed that Group 1 deleted significantly more verbs than Groups 2 or 3. However, no differences were found among the three grade levels in any of the other seven grammatical categories. Thus, analysis of the subjectively reduced passages in terms of grammatical categories deleted produced negligible developmental differences.

The index of agreement for the sentences rank ordered by the blind subjects was not significant for 46 of the 54 sentences in the passage. The size of the sample greatly influenced the Chi-squares calculated from the Kendall coefficients. A total of 24 blind subjects (from one to four subjects per sentence) was used in Phase I. Consequently, the degree of agreement among blind subjects on the rank ordering of words within the sentences was not comparable to the degree of agreement among sighted subjects. This study should be replicated with a larger blind sample to determine whether the degree of agreement among blind subjects does compare favorably with the degree of agreement among sighted subjects when the sample sizes are comparable.

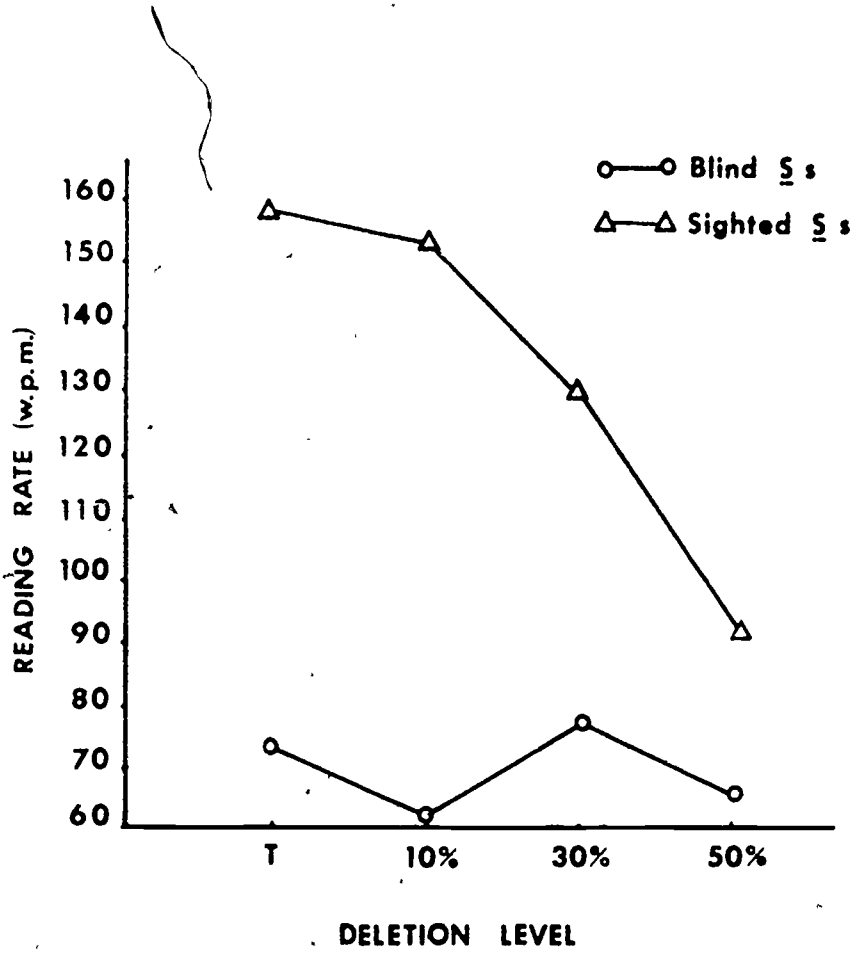


Figure 9.3. Interaction of Deletion Level and the two subject samples on reading rate.

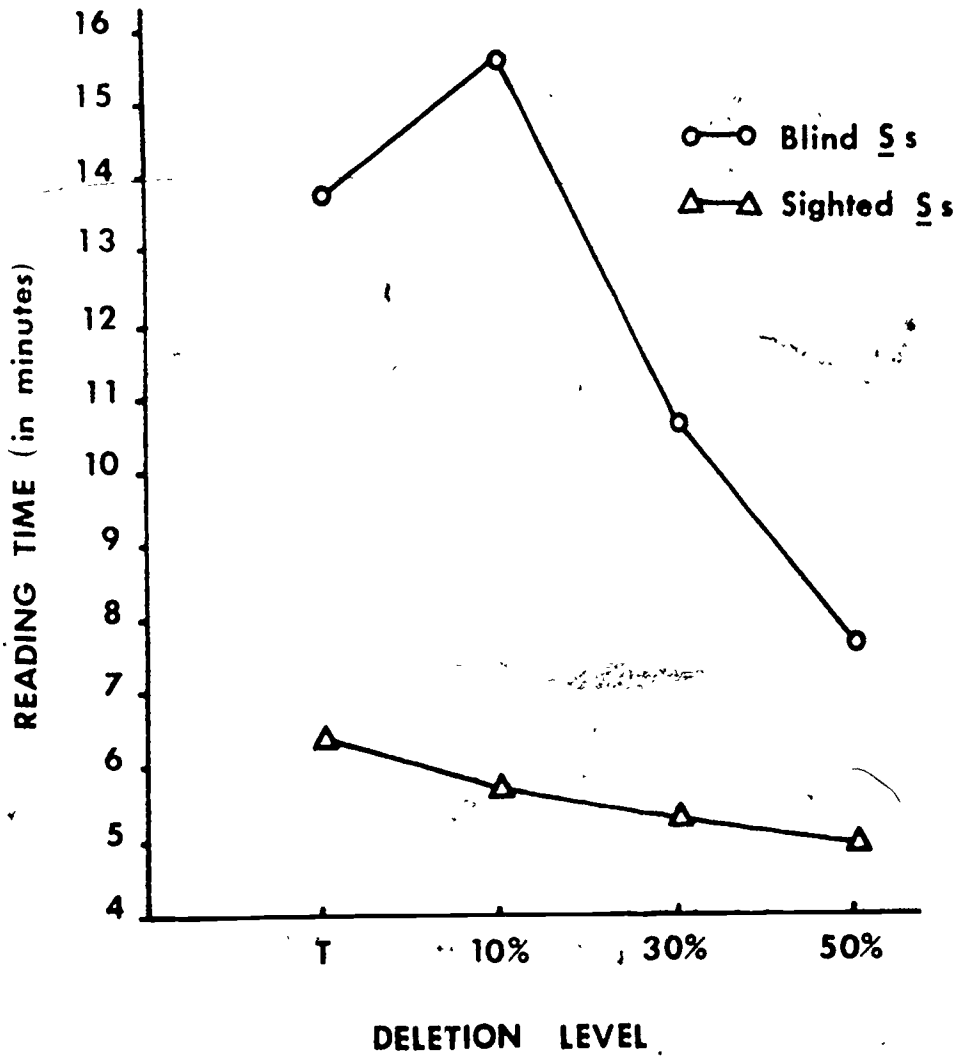


Figure 9.4. Interaction of Deletion Level and the two subject samples on reading time.

The results of the Kendall Correlation Coefficients and their corresponding Z-values (or S-values) support the hypothesis that there was significant agreement between blind and sighted subjects on the rank orders assigned words within the sentences of the passage. Comparison of Figures 9.1 and 9.2 reveals the similarities of the blind and sighted subjects' reduced passages in terms of grammatical categories deleted. The only significant difference was found in the 50% reduced passage, in which sighted subjects deleted fewer nouns than blind subjects.

The degree of agreement on the rank order assigned words within the sentences of the passage as well as the degree of agreement among the grammatical categories deleted in the reduced versions of the passage indicated that both blind and sighted subjects were in agreement with respect to their judgments of the important informational words within the sentences. Consequently, according to the analyses of the deletion data, regardless of the sample participating in Phase I, the resulting telegraphic passages were similar. Generally, articles and adverbs were the first parts of speech to be eliminated while nouns, verbs, and pronouns were the last to be deleted in the development of the telegraphic passages.

The data obtained from the blind subjects in Phase II strongly supported the feasibility of the telegraphic concept. Reading rates were not reduced in the deleted passages for blind subjects, comprehension was not affected, and reading times for blind subjects assigned the 50% reduced version were shortened 82% in comparison to blind subjects assigned Trad. The performance of sighted subjects assigned the 50% reduced version was affected more than the performance of blind subjects assigned the same passage. Comprehension as well as reading rates for sighted subjects assigned the 50% reduced passage were decreased, although reading time was shortened in comparison to sighted subjects assigned Trad. However, at the 30% deletion level, comprehension was not affected and reading times were decreased in spite of the reduced reading rates. From these data, it appears that the 30% level of reduction is the optimum level for sighted subjects, since comprehension was not affected at this level and the time required to read the passage was reduced.

Of the five dependent variables, two of the comprehension variables were the only ones to differ significantly among grade levels. The seventh and eighth grade students had significantly lower scores than the eleventh and twelfth grade students on the combined comprehension score and on the multiple choice test. The significant difference found on the combined score can be attributed to the differences in the multiple choice scores. No differences were found among the grade levels on any of the remaining dependent variables.

The difference between the effects of increased reduction for blind and sighted subjects should be examined more closely. Figures 9.3 and 9.4 illustrate the interaction of deletion level and the two subject samples on reading rate and reading time, respectively. It may be that the blind, since their reading medium is braille which requires more time to read than traditionally written materials, may benefit more from highly telegraphic materials than sighted subjects who normally read at a comparatively rapid pace. Possibly, sighted students are disturbed by the telegraphic style more than are the blind since their reading style is different. It may be the intrinsic differences in reading braille as opposed to reading traditionally written material that results in differential effects of telegraphic passages on blind and sighted subjects. A possible hypothesis is that while blind readers read and process each word in a passage separately, sighted readers read and process several words at a time. Kolers' (1972) studies show that in reading traditionally written materials the sighted reader is not concerned as much with letters and words as he is with meaning. The reader is not involved in the perception of individual words but rather in the process of generating coherent messages. Whether or not Kolers' findings are generalizable to braille reading is a question to be answered through further research. However, the present study implies a fundamental difference in the processing of materials by blind and sighted readers.

The results of the present study indicate that the application of the telegraphic concept to the development of reading materials would be especially beneficial to blind students, since the time they required for reading telegraphic materials was considerably less than for reading traditional materials, while the amount of information obtained remained unchanged. The findings of this study also indicate that sighted readers in general save time without a loss in comprehension when reading telegraphic materials, although the effects are less striking than the effects of telegraphic materials on the performance of blind readers. It may be that slow sighted readers would benefit more from telegraphic materials than average or rapid readers. Perhaps the reading style of the slow reader approaches that of the blind reader; that is, the slow reader's difficulties may stem from his inability to read and process several words at a time. If each word in a passage is processed separately by the slow reader, then telegraphic materials would facilitate his task by eliminating the low information words which the rapid reader has learned to process within the framework of the high information words in the passage. Further research may indicate that telegraphic reading materials will provide an effective means of enhancing the learning process for slow sighted readers as well as for blind readers.

CHAPTER X

EXPERIMENT VIII -- APPLICATION OF A SUBJECTIVE DELETION SCHEME UPON READING PERFORMANCE OF VISUALLY HANDICAPPED LARGE PRINT READERS

Introduction

The feasibility of telegraphic prose was confirmed by Martin and Alonso (1967) on a population of blind subjects. In Experiment VII the effect of a subjective reduction method was examined on the reading responses of braille readers and sighted readers. Experiment VII found that both braille and sighted readers assigned subjectively reduced passages read efficiently when as many as 30% of the words in the traditional passage were deleted. However, the blind readers as a group benefited from reduced passages to a greater extent than the sighted readers. Blind subjects assigned the 50% version compared favorably with the blind subjects assigned the traditional passage on comprehension. In addition, reading rate did not decrease and required reading time shortened considerably.

The primary purpose of this experiment was to determine the effects of a subjective reduction procedure for generating telegraphic passages on the reading behavior of visually handicapped large print readers. Additionally, further analyses were conducted to compare the reading responses of large print readers, braille readers, and sighted readers. Data from Experiment VII were used in this comparison.

Method

Subjects

The subjects were 29 seventh through twelfth grade large print readers at the Texas School for the Blind in Austin, Texas. Subjects in each of four treatment conditions were matched on the basis of reading achievement and IQ.

Materials Development

A 947 word prose story entitled, "Mambo and Yam," was selected from among the passages developed by Martin and Alonso (1967). The story concerns the events of two warring African nations.

A total of three treatment conditions were generated from the traditional passage. The traditional passage was reduced by a subjective method developed by Martin and Pantalion (1973).

The passages were subjectively reduced by 144 normal sighted high school students in the Duncanville, Texas, school system (Sheffield, 1972).

The subjective reduction procedure is a method of identifying the words in each sentence which contribute the least amount of information to the meaning of the sentence. The words of each sentence are assigned a numeral for identification. Subjects are required to rank the words in each sentence by the identifying numeral according to their importance to the meaning of the sentence. Three reduced passages at 10, 30, and 50% deletion levels were developed from the data derived from the subjective deletion analysis. Thus, four treatment conditions (traditional, 10, 30, and 50% reduced passages) were typed in traditional format on a 16-point primary typewriter (Appendix A).

Instrumentation

Two comprehension tests (set relation and multiple choice) used in this study were the same as those used in Experiment VII (Appendix A).

Procedure

One of four passages were randomly assigned to the members of each matched group. The subjects were instructed to (1) read the passage at a comfortable rate, (2) raise their hands when they finished reading so that their reading times could be recorded, and (3) answer the two comprehension tests.

Design and Analyses

Eight dependent variables were analyzed in the present study: total comprehension score, multiple choice test score, set relation test score, nested score, disjunctive score, reading rate, reading time, and the efficiency measure (E_t). The 1 x 4 factorial analysis of variance (ANOVA) design was used to compare the means of the large print readers within the four groups for each dependent variable. The Scheffé test was used to make post hoc comparisons.

In addition to the analyses performed on the data collected from the large print readers, a second set of analyses was performed to compare the performance of the sighted readers and the braille readers who participated in Experiment VII with the performance of the large print readers in the present study. The 3 x 4 factorial ANOVA design was used to compare the three subject samples on each of the eight dependent variables. The Scheffé test was again used to make post hoc comparisons.

Results

Table 10.1 presents the means and standard deviations for each of the eight dependent variables for the four reading passages. No significant differences were found in the two 1 x 4 ANOVA designs used to assess either the total comprehension scores or the multiple choice scores. The 1 x 4 ANOVA performed on the set relation test did, however, reveal a significant difference ($F(3,25) = 3.22$, $p<.05$) across the four treatment conditions. The smallest p-value ($p<.10$) to result from the Scheffé analysis was in the comparison of the scores of subjects assigned the 10% reduced version ($\bar{X} = 14.00$) with the scores of those assigned the traditional ($\bar{X} = 10.00$). Although this difference was not significant at the .05 level, it was the largest difference among the four treatment conditions. While the number of nested test items did not differ significantly across treatment conditions, a significant difference was found in the number of disjunctive items answered correctly ($F(3,25) = 3.92$, $p<.05$). The Scheffé analysis indicated a significant difference ($p<.05$) in the comparison of subjects assigned the 10% reduced version ($\bar{X} = 7.88$) with subjects assigned the 30% reduced version ($\bar{X} = 4.86$). Subjects assigned the 30% reduced version answered 38% fewer items correctly than subjects assigned the 10% reduced version.

The 1 x 4 ANOVA performed on reading rates yielded an F of 4.52, $df = 3,25$, $p<.05$. The Scheffé analysis revealed that subjects assigned the 10 and 50% reduced versions of the passage read at a significantly slower word per minute (wpm) rate than subjects assigned the traditional.

Reading times were also found to differ significantly across treatment conditions in the 1 x 4 ANOVA design ($F(3,25) = 3.17$, $p<.05$). The Scheffé analysis indicated that subjects assigned the 50% reduced passage required 46% less time than subjects assigned the 10% reduced version. No other significant differences were found in the Scheffé comparisons.

No significant differences were found in the 1 x 4 ANOVA design used to assess E_t.

Comparison of Large Print, Braille, and Sighted Readers

The 3 x 4 ANOVA performed on the total comprehension test scores indicated a significant difference across subject samples ($F(2,225) = 9.50$, $p<.001$) and across deletion levels ($F(3,225) = 11.91$, $p<.001$). The Scheffé test indicated that large print readers answered significantly fewer questions correctly than either the braille readers or the sighted readers. In addition, subjects assigned the 50% reduced passage answered significantly fewer questions correctly than subjects assigned the remaining three passages. Subjects assigned the 10% reduced passage answered significantly more items correctly than subjects

TABLE 10.1

Means and Standard Deviations for Each of Eight Dependent Variables for the Four Reading Passages

Variable	Subject Sample											
	Large Print Readers				Braille Readers				Sighted Readers			
	Trad	10%	30%	50%	Trad	10%	30%	50%	Trad	10%	30%	50%
Total Comprehension												
Mean	32.71	37.25	27.43	26.43	39.31	40.47	37.35	29.19	39.25	40.03	36.39	32.19
S.D.	10.48	8.83	8.08	7.79	9.10	9.98	8.64	6.10	8.75	6.93	7.36	6.45
Multiple Choice												
Mean	22.71	23.25	17.29	15.71	25.88	26.93	25.12	18.94	25.86	26.81	23.06	20.47
S.D.	7.93	6.96	5.88	5.41	7.64	7.38	6.11	4.51	7.17	5.64	5.58	5.25
Set Relations												
Mean	10.00	14.00	10.14	10.71	13.44	13.53	12.24	10.25	13.39	13.22	13.33	11.72
S.D.	2.71	2.88	3.18	2.87	2.61	3.04	3.21	2.29	2.50	2.33	2.60	2.76
Nested												
Mean	4.29	6.13	5.29	3.43	6.19	6.13	5.47	5.06	5.86	5.33	5.89	5.58
S.D.	1.25	2.03	2.21	2.64	2.23	1.96	2.29	1.69	1.79	1.85	2.04	2.32
Disjunctive												
Mean	5.71	7.88	4.86	7.29	7.25	7.40	6.76	5.19	7.53	7.89	7.44	6.14
S.D.	1.70	1.96	2.19	1.70	1.45	1.49	1.99	1.87	1.78	1.41	1.54	1.82

TABLE 10.1

(continued)

Variable	Subject Sample											
	Large Print Readers				Braille Readers				Sighted Readers			
	Trad	10%	30%	50%	Trad	10%	30%	50%	Trad	10%	30%	50%
Reading Time												
Mean	9.29	13.60	10.60	7.36	14.49	14.05	11.29	8.41	6.21	5.75	5.29	4.99
S.D.	2.18	5.39	4.62	2.88	7.51	5.98	4.65	2.55	1.32	1.42	1.33	.69
Reading Rate												
Mean	107.33	68.87	71.11	68.78	76.30	71.43	69.11	59.66	159.06	155.31	131.65	92.77
S.D.	26.83	20.65	25.36	21.80	27.46	29.62	31.14	20.52	33.06	35.51	32.16	12.64
E_t												
Mean	3.73	3.15	2.81	4.18	3.29	3.53	4.01	3.79	6.71	7.33	7.28	6.55
S.D.	1.54	1.61	.99	2.26	1.67	1.94	2.35	1.45	2.42	1.99	2.38	1.51

assigned the 30% reduced passage. Figure 10.1 presents the average total comprehension scores for the 12 samples.

The 3 x 4 ANOVA performed on the multiple choice items again indicated a significant difference across subject samples ($F(2,225) = 8.82$, $p<.001$) and across deletion levels ($F(3,225) = 11.22$, $p<.001$). The Scheffé analysis revealed the same differences as were found in the total comprehension test scores. That is, the large print readers answered significantly fewer questions correctly than either the braille readers or the sighted readers, while subjects assigned the 50% reduced passage answered significantly fewer questions correctly than subjects assigned the remaining three passages. Also, subjects assigned the 10% reduced passage answered significantly more items correctly than subjects assigned the 30% reduced passage.

The 3 x 4 ANOVA performed on the set relation test items yielded an F of 5.56, $df = 2,225$, $p<.01$ for the Subject Sample main effect. The Scheffé analysis indicated that large print readers answered 13% fewer set relation test items correctly than sighted readers. Within the Deletion Level main effect, an F of 6.85, $df = 3,225$, $p<.001$ was found. The Scheffé analysis indicated that subjects assigned the 50% reduced passage answered significantly fewer set relation questions correctly than subjects assigned the traditional or the 10% reduced passage. Subjects assigned the 10% reduced passage also scored significantly higher on the set relation test items than subjects assigned the 30% reduced passage. In addition to the significant differences found within both main effects, a significant interaction effect was also found in the 3 x 4 ANOVA performed on the set relation test items ($F(6,225) = 2.59$, $p<.05$).

The 3 x 4 ANOVA performed on the nested set relation items revealed a significant difference within the Subject Sample main effect ($F(2,225) = 3.50$, $p<.05$). Although the Scheffé analysis did not indicate a significant difference, the smallest p-value obtained was in the comparison of the large print readers with the sighted readers ($p<.11$).

Significant differences were found in the 3 x 4 ANOVA performed on the disjunctive set relation test items within the Subject Sample main effect ($F(2,225) = 3.03$, $p<.05$), the Deletion Level main effect ($F(3,225) = 5.92$, $p<.001$), and a significant interaction effect was found ($F(6,225) = 4.53$, $p<.001$). The smallest p-value obtained in the Scheffé test performed on the means within the Subject Sample main effect was in the comparison of the large print readers with the sighted readers ($p<.08$). The Scheffé analysis performed on the means within the Deletion Level main effect indicated that subjects assigned the 10% reduced passage answered significantly more disjunctive items correctly than subjects assigned the 30 and 50% reduced passages.

Reading rates were found to differ significantly across subject samples ($F(2,225) = 180.30$, $p<.001$), across deletion levels ($F(3,225) = 13.68$, $p<.001$), and a significant interaction

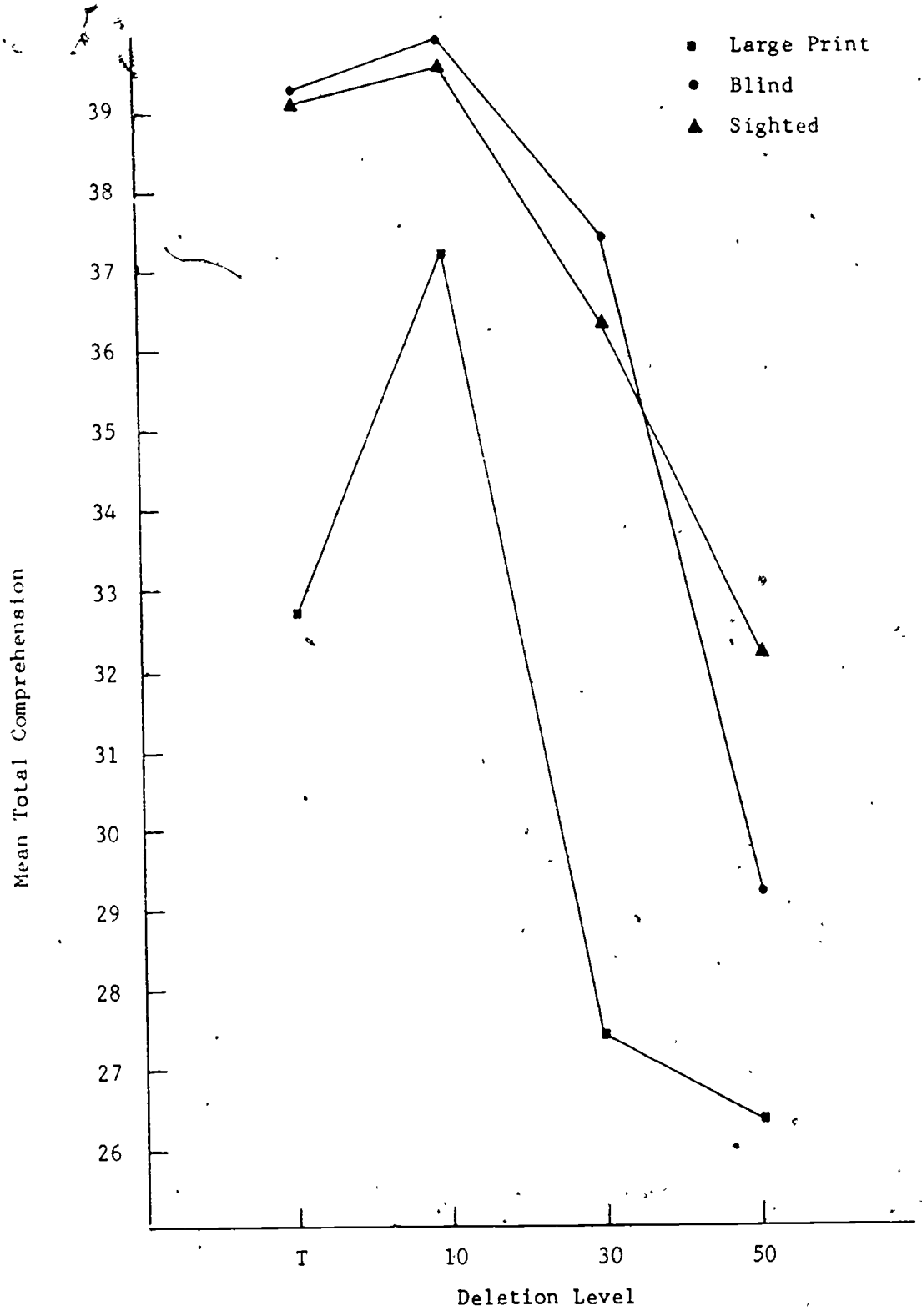


Figure 10.1. Mean total comprehension as a function of deletion level and type of subject sample.

effect was found ($F(6,225) = 3.88$, $p<.01$). Figure 10.2 presents the interaction effect for the reading rate variable. The Scheffé analysis indicated that both large print readers and braille readers read at a significantly slower wpm rate than sighted readers. Within the Deletion Level main effect, the Scheffé analysis indicated that subjects assigned the three telegraphic versions of the passage read at a significantly slower wpm rate than subjects assigned the traditional. In addition, subjects assigned the 10 and 30% reduced passages read at a significantly faster rate than subjects assigned the 50% reduced passage. The Scheffé analysis indicated that large print readers assigned the 10, 30, and 50% reduced passages; braille readers assigned the traditional, 10, 30, and 50% reduced passages; and sighted readers assigned the 50% reduced passage read at a significantly slower rate than sighted subjects assigned the traditional, 10, and 30% reduced passages.

The 3 x 4 ANOVA used to assess reading time indicated a significant difference within the Subject Sample main effect ($F(2;225) = 54.88$, $p<.001$), within the Deletion Level main effect ($F(3,225) = 11.72$, $p<.001$), and a significant interaction effect was found ($F(6,225) = 3.38$, $p<.01$). Figure 10.3 presents the average reading time in minutes for the 12 groups. The Scheffé test performed on the means within the Subject Sample main effect indicated that each of the three groups of subjects differed significantly from the other two groups of subjects. That is, large print readers differed significantly from braille readers and sighted readers. The Scheffé test performed on the means within the Deletion Level main effect indicated that subjects assigned the 50% reduced passage required 31% less time than subjects assigned the traditional passage. Subjects assigned the 50% reduced passage also required significantly less reading time than subjects assigned the 10 or 30% reduced passages. In addition, reading times for subjects assigned the 30% reduced passage were found to be significantly less than the reading times of subjects assigned the 10% reduced passage. The Scheffé analysis indicated that large print readers assigned the 10% reduced passage and braille readers assigned the traditional, 10, and 30% reduced passages required significantly more reading time than sighted subjects assigned any of the four experimental passages. Large print readers assigned the 50% reduced passage required 49% less reading time than braille readers assigned the traditional. Finally, braille readers assigned the 50% reduced passage required 42% less reading time than braille readers assigned the traditional.

A significant difference was found in the 3 x 4 ANOVA performed on reading efficiency (E_t) across subject samples ($F(2,225) = 169.99$, $p<.001$). The Scheffé analysis indicated the E_t scores for both large print and braille readers were significantly different from the E_t scores of sighted readers.

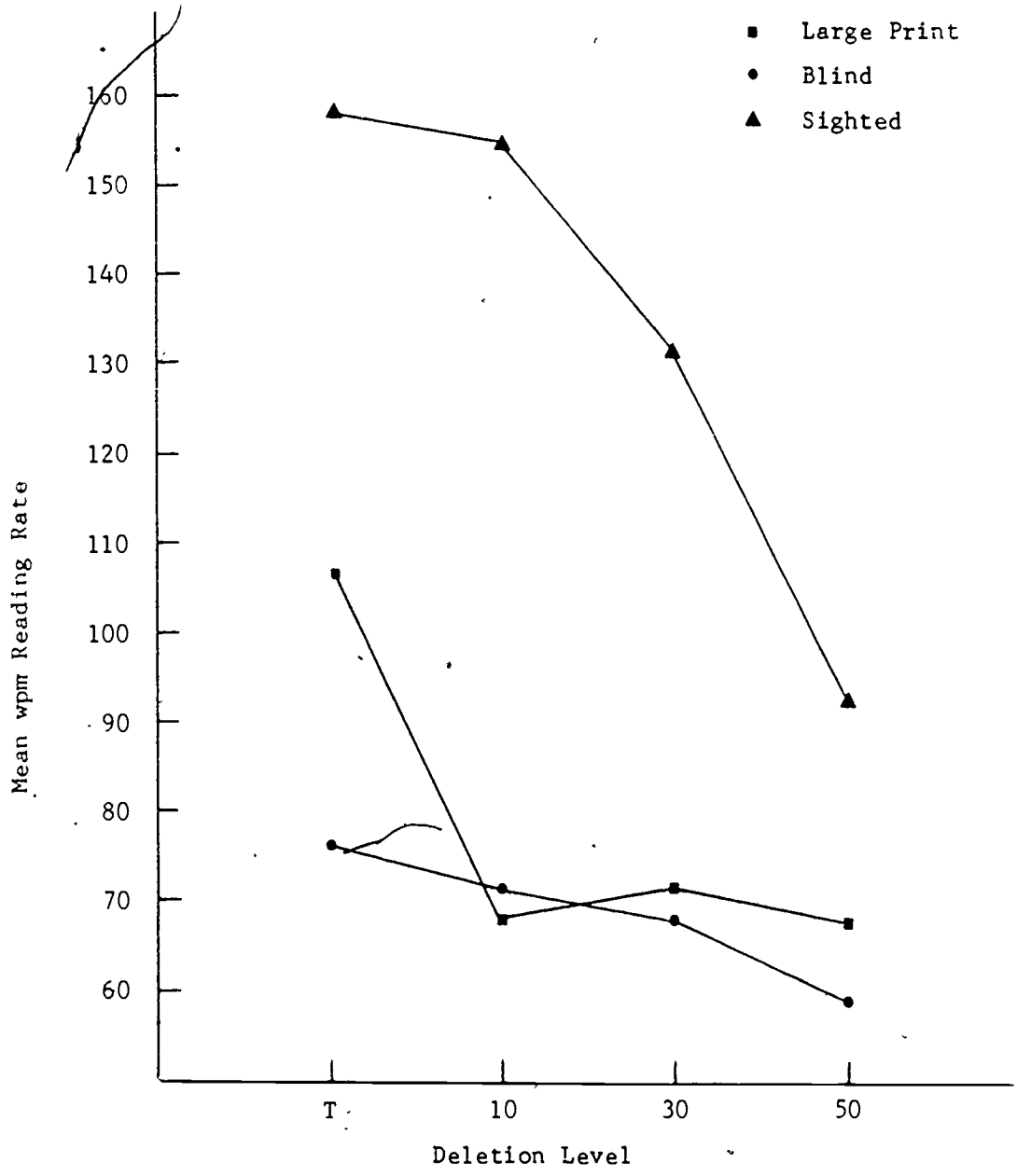


Figure 10.2. Mean reading rate (wpm) as a function of deletion level and type of subject sample.

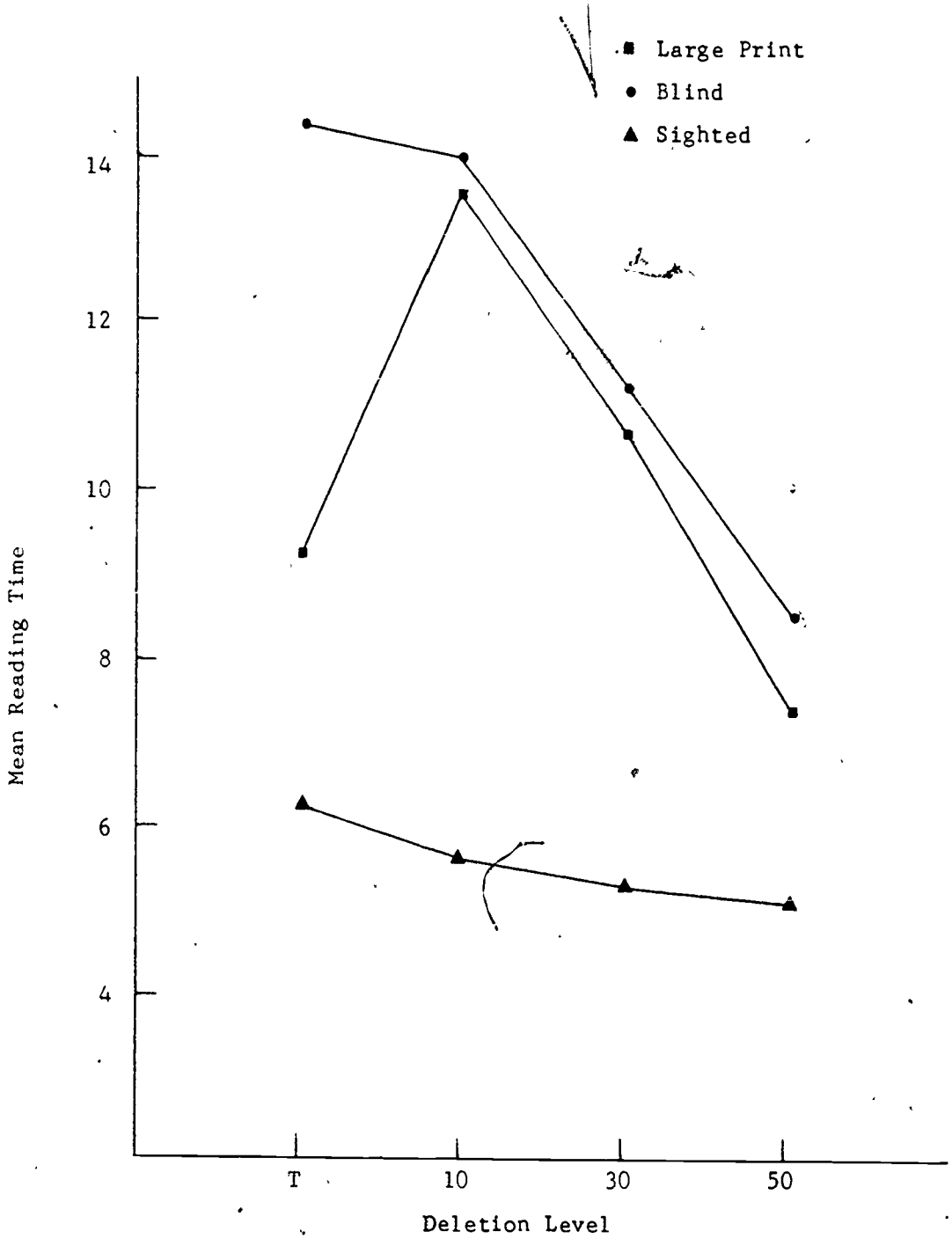


Figure 10.3. Mean reading time (minutes) as a function of deletion level and type of subject sample.

Discussion and Conclusions

Large Print Readers

No significant loss in comprehension was found in comparing the traditional passage with the three reduced passages in either the multiple choice test or the total comprehension measure. However, there was a significant effect for the set relation test. Inspection of Table 10.1 shows that the 10% passage yielded higher comprehension scores than either the traditional or the 30 and 50% reduced versions. The relatively better comprehension of the set relation material was due to the fact that performance on the 10% reduced version was higher than on any other version. This was true for both the nested and disjunctive items.

Although the reading rates for large print readers assigned the 10 and 50% reduced passages were significantly slower than the reading rates of large print readers assigned the traditional, the subjects assigned the 50% reduced passage required significantly less reading time than subjects assigned the 10% reduced passage. Also, no differences were found in the reading times of large print readers assigned the traditional as compared to the large print readers assigned the three reduced passages.

The fact that there were no comprehension differences on the multiple choice test for the telegraphic passages and that there were no differences among the four groups on reading time questions the feasibility of the telegraphic concept as applied to large print readers. Also disappointing was the finding of a 36% reduction in reading rate for the 50% reduced passage compared to the traditional passage.

Large Print, Braille, and Sighted Readers

The scores of the large print readers on the comprehension measures were found to be significantly lower than the scores of the braille readers or the sighted readers. Also, the effect of deleting 50% of the words had an adverse effect upon comprehension. A significant decrement in comprehension was found at the 50% level for each of the comprehension dependent variables.

It was expected that reading rate for large print and braille readers would be slower than for sighted readers. The reading rates for the two visually handicapped samples were quite similar as shown in Figure 10.2. Also observed in this figure is an interaction effect due to the rather marked reduction in reading rate for the sighted readers on the 50% passage. No such dramatic reductions were observed for the 50% passage among the handicapped readers.

The effect of reducing words from the traditional passage had a significant effect upon reading time. Generally, amount of reading time required for all subjects to read the 50% passage

was significantly less than the time required to read the 10 or 30% passages. Also, reading time for subjects assigned the 30% passage was significantly less than the time required to read the 10% passage. The braille readers required more time to read the passages than the large print readers, and both groups required significantly more reading time than the sighted readers.

As a group, the large print readers were much less cooperative than the braille readers or the sighted readers. Reaction to the assigned task was negative and few of the large print readers seemed to take their assignments seriously. Inspection of the means for the total set relation test and for the disjunctive items reveals the inconsistency of the performance of the large print readers across the four treatment conditions.

In conclusion, telegraphic prose has been shown to be a relatively effective means of attaining a level of comprehension comparable to a traditional version in a shorter amount of time for the braille and sighted readers. Although the 50% version was generally the more difficult treatment and affected the dependent variables most severely, braille readers attained the greatest success at this level than either the large print or sighted readers. Neither the braille nor large print readers equalled the reading performance of the sighted subjects.

The feasibility of applying the telegraphic reduction technique employed in this study to the development of instructional materials for large print readers is questioned in this study. Although there was a significant savings in reading time associated with the 50% telegraphic passage, there was a 36% reduction in reading rate and a 20% reduction in total comprehension compared to the traditional reading passage. However, before any firm conclusions regarding the feasibility of telegraphic prose can be made for large print readers, the study should be replicated using a larger sample and a more cooperative one than used in the present experiment.

CHAPTER XI

EXPERIMENT IX -- EFFECT OF A SUBJECTIVE DELETION SCHEME UPON READING PERFORMANCE OF HEARING IMPAIRED STUDENTS

Introduction

The increase in printed information in every area of knowledge has been accompanied by intensified pressure to absorb this material. This pressure is more intense for handicapped individuals such as the deaf and the hard of hearing, since the deaf students are retarded scholastically about three years compared to their normal hearing peers (Kirk, 1972). This academic retardation is partially caused by reading inefficiency of deaf students.

The purpose of the present study was to facilitate the acceleration of information input and to explore the feasibility of the use of the telegraphic concept in the education of the deaf. The underlying rationale for the development of the concept of telegraphic prose is the presence of redundancy and superfluous information in English prose material.

Research in redundancy has been done at both the word and letter level. In many respects deletion at the word level is more useful since words constitute the natural units of written and spoken language. In the successful estimates of letter redundancy, the fact that the number of letters is limited facilitates the statistical analysis of the data. This advantage does not exist when one deals with estimating word redundancy, since there is a tremendous number of words in printed English (Aborn, Rubenstein, & Sterling, 1959; Morrison & Black, 1957).

The elimination of redundant elements from prose passages has been examined in a variety of studies designed to omit differing categories of redundancy so that the effect of the eliminations on reading responses may be assessed. Martin and Alonso (1967) were the first experimenters who studied the applicability of the use of telegraphic prose with visually handicapped braille readers. In the development of the reduced or telegraphic versions, the authors used Dawes' (1964) set relations model as a basis for defining the essential information. The traditional passage was deleted in order to arrive at a medium and short telegraphic version. The short version, which had the greatest number of words omitted, was written in outline form. The traditional and medium telegraphic versions were written in traditional English format.

This experiment was based in part upon a M.S. thesis by Simin Partovi submitted to the Graduate College of Texas A&M University.

All three versions were then translated into braille and each one was administered to 70 braille readers. Results of the study showed that time required for reading telegraphic versions was significantly less than that for the traditional version. Results for reading rate did not show a uniform pattern among the three versions. There were, however, few significant differences among the three versions on the comprehension measures.

Martin and Pantalion (1973) conducted a study in which, rather than condensing the traditional version into telegraphic versions on the basis of the information contained in the set relations, the sentence was used as the basic unit and deletion was made on the basis of the relative importance of the words within each sentence. By this method the general structure of the sentence in both the traditional and the telegraphic versions remained the same.

To overcome the problem of lack of logical deletion, Martin and Pantalion (1973) used a subjective scheme of deletion involving the deletion of insignificant words in relation to their significance in understanding the meaning of the sentence. They then assessed the effect of the subjectively deleted prose upon the reading rate, comprehension, reading efficiency, and required reading time on a college population.

Results of the Martin and Pantalion (1973) study support the feasibility of the telegraphic concept based on a subjective deletion scheme. Results indicated considerable amount of saving in time for telegraphic versions when compared to the traditional version. Also, there was no significant difference among telegraphic versions and the traditional versions on comprehension.

Thus far, no study has been conducted to determine the effect of subjectively deleted prose material on the above mentioned dependent variables using deaf and hard-of-hearing subjects.

The purpose of the present study was to assess the effect of subjectively deleted prose upon the comprehension, reading efficiency, reading rate, and required reading time among deaf subjects. The traditional passage for the experiment was the medium telegraphic version of the story,"Mambo and Yam" used by Martin and Alonso (1967). The passage was previously deleted by use of a subjective deletion scheme at 10, 30, and 50%. Subjects for this study were matched on the basis of age, IQ, reading comprehension, and average hearing loss. Subjects were then divided into four groups which were randomly assigned to one of the four treatment conditions. After reading the assigned passages, subjects took a comprehension test consisting of a multiple choice test and a set relation test developed by Martin and Alonso (1967). Subjects were then asked to record the time spent on reading a passage on a time recording form. The specific hypotheses tested were:

1) There will be no significant differences between the traditional version, 10, and 30% deletion versions on the comprehension dependent variable.

2) There will be significant differences between the traditional and the 10% deleted passage when compared to the 50% deleted passage on the comprehension dependent variable.

3) There will be a significant decrease in reading rate as the amount of deletion increases.

Method

Subjects

Subjects for this study were 97 students from grades nine through twelve at the Texas School for the Deaf in Austin, Texas. Subjects were matched on the basis of age, IQ, reading comprehension, and average hearing loss as determined from their admission records.

Materials

The prose passage used in this experiment was the medium telegraphic version of the 'Mambo and Yam' story used in the Martin and Alonso (1967) and Martin and Herndon (1971) studies. The medium telegraphic version was assigned to be the reference passage. This passage had been previously reduced by 10, 30, and 50% by means of a subjective deletion scheme (Sheffield, 1972). For development of the three reduced passages, subjects were given the traditional passage and a set of six or seven sentences. Each word within each sentence was assigned a number which corresponded to the numbered blocks in the recording form. Subjects were then asked to rank order each word with respect to its significance for understanding the meaning of the sentence and then to enter the number assigned to this word into the corresponding block in the recording form. Subjects were asked to follow the same procedure until each word within each sentence had been ranked. Data obtained from the above procedure were then entered into a computer and used to reconstruct the three reduced versions at 10, 30, and 50% deletion levels (Appendix A).

Test Materials

Comprehension across the four different treatment conditions was assessed on the basis of two tests: a 20-item, two-choice set relation test and a 40-item, four-choice multiple choice test developed by Martin and Alonso (1967) (Appendix A).

Additional Materials

A time recording form, a clock, and IBM answer sheets were used in the study. The time recording form was used by subjects to record the time spent in reading an assigned version of the passage. The recorded time was used to compute reading rate and required reading time. An electronic timer was used as the timing device. The IBM answer sheets were used by the subjects to record test answers.

Design and Analysis

A 1 x 4 factorial analysis of variance (ANOVA) design was employed to determine if any differences existed among treatment conditions with respect to the five comprehension measures and the three other dependent variables. Reading efficiency, which is a ratio existing between comprehension (C) and reading time ($E_t = \frac{C \times 100}{R_t}$), was computed for each subject.

The specific treatment conditions were the traditional version and the three reduced versions consisting of 10, 30, and 50% deletion levels. The differences between the four treatment conditions were assessed with respect to the following dependent variables: total comprehension, multiple choice, set relations, nested and disjunctive indices, reading time, reading rate, and reading efficiency.

Subjects in this study were divided into three age levels: Group 1 included 15 and 16-year-old subjects; Group 2 included 17-year-old subjects; and Group 3 included 18, 19, and 20-year-old subjects. An additional ANOVA was performed to determine if any interaction existed between the four treatment conditions at the three different age levels. Scheffé's (Snedecor & Cochran, 1967) test of multiple comparison was used to determine the specific nature of the differences among the four treatment conditions for the 1 x 4 and the 3 x 4 ANOVAs.

Procedure

A test package consisting of one of the four treatment versions of the passage, a time recording form, the test, and an IBM answer sheet was assembled for each subject. A digital clock was placed in the center of the room where all subjects were able to see and record the elapsed time. As the subjects received their packages, they were asked to put their names on the answer sheet and the time recording sheet. The instructions to take the test, which were immediately translated into sign language, were then read aloud by the experimenter. Subjects were then told to start reading the story. After reading the passage, subjects were instructed to record the elapsed time and then to answer the test questions.

Results

Table 11.1 presents the means and standard deviations for the five comprehension measures, reading time, reading rate, and reading efficiency.

Results of the 1 x 4 ANOVA showed no significant differences for any of the five comprehension measures. Reading time was not significant for any of the four treatment conditions. A significant F-ratio ($F(3,93) = 18.99$, $p < .001$) was obtained for reading rate between subjects assigned the traditional passage and subjects assigned the 30 and 50% reduced passages. Subjects assigned the 30% reduced passage read at a 28% slower word per minute (wpm) rate than subjects assigned the traditional passage. Subjects reading the 50% reduced passage read at a 40% slower wpm rate than subjects assigned the traditional passage.

In addition, the Scheffé analysis indicated that subjects reading the 10% reduced passage read at a 32% slower wpm rate than subjects reading the traditional version.

The efficiency measure was not found to be significant for any of the four treatment conditions.

A 3 x 4 ANOVA was performed across the four treatment conditions in order to examine possible developmental differences. Table 11.2 presents the means and standard deviations for the five comprehension measures across the four treatment conditions for the three age levels. Table 11.3 presents the means and standard deviations for reading time, reading rate, and reading efficiency for the three different age groups across the four treatment conditions.

The 3 x 4 ANOVA revealed no significant differences across the Age Level main effect or the Percent Deletion main effect for the total comprehension scores. However, a significant interaction effect was found ($F(6,85) = 2.43$, $p < .05$). Figure 11.1 illustrates the interaction effect found in the 3 x 4 ANOVA for total comprehension.

No significant differences were found in the 3 x 4 ANOVA for the multiple choice dependent variable. A significant interaction was found for the set relation dependent variable ($F(6,85) = 2.70$, $p < .05$). Figure 11.2 illustrates the interaction effect found in the 3 x 4 ANOVA for the set relation dependent variable. A significant interaction was also found for the nested dependent variable ($F(6,85) = 3.79$, $p < .01$). Figure 11.3 illustrates the interaction effect found in the 3 x 4 ANOVA for the nested dependent variable.

A significant difference was found in the 3 x 4 ANOVA for reading time across the Age Level main effect ($F(2,85) = 4.01$, $p < .05$). Although the Scheffé analysis failed to show this

TABLE 11-1

Means and Standard Deviations of the Dependent Variables for the 1 x 4 ANOVA

Variable	Percent Deletion			
	Traditional	10	30	50
Total Comprehension				
Mean	27.33	27.08	26.39	23.42
S.D.	9.62	9.81	7.47	5.16
Multiple Choice				
Mean	16.25	17.17	16.39	14.08
S.D.	6.98	7.27	6.13	5.21
Set Relations				
Mean	11.08	9.91	10.00	9.34
S.D.	3.35	3.57	1.93	2.77
Nested				
Mean	5.25	4.29	4.21	4.38
S.D.	1.94	2.33	1.00	1.92
Disjunctive				
Mean	5.95	5.62	5.78	4.96
S.D.	2.05	2.06	1.73	1.61
Reading Time				
Mean	5.73	5.76	5.44	4.87
S.D.	1.35	1.17	1.00	1.85
Reading Rate				
Mean	174.10	153.00	125.20	104.90
S.D.	43.47	31.43	26.29	35.21
Reading Efficiency				
Mean	5.10	4.79	5.08	5.52
S.D.	2.59	1.66	1.98	2.35

TABLE 11.2

Means and Standard Deviations of the Comprehension Measures for the 3 x 4 ANOVA

Variable	Age Group											
	15 - 16				17				18 - 19			
	Trad	10%	30%	50%	Trad	10%	30%	50%	Trad	10%	30%	50%
Total Comprehension												
Mean	22.66	36.75	23.25	21.00	29.57	23.75	26.16	23.88	28.45	26.08	27.46	24.08
S.D.	7.09	2.00	10.34	6.96	15.82	11.18	5.51	7.15	2.87	8.29	9.73	5.81
Multiple Choice												
Mean	13.16	23.00	14.25	13.00	17.85	14.25	15.66	13.88	16.90	17.16	17.38	14.66
S.D.	4.58	3.94	8.78	5.77	10.58	8.01	4.54	5.80	0.96	6.65	7.42	6.33
Set Relations												
Mean	9.50	13.75	9.00	8.00	11.71	9.50	10.50	10.00	11.54	8.91	10.07	9.41
S.D.	3.39	3.08	1.76	2.64	5.97	4.11	2.06	1.98	2.16	2.33	2.81	3.12
Nested												
Mean	4.83	7.50	4.25	3.40	5.42	3.75	4.33	4.88	5.36	3.58	4.15	4.41
S.D.	1.94	2.30	0.82	1.73	3.00	2.64	1.05	1.14	0.96	1.49	1.57	2.23
Disjunctive												
Mean	4.66	6.25	4.75	4.60	6.28	5.75	6.16	5.11	6.18	5.33	5.92	5.00
S.D.	2.34	1.14	1.94	2.23	3.10	2.21	1.27	1.75	1.26	1.28	1.60	2.04

TABLE 11.3

Means and Standard Deviations of Reading Time, Reading Rate, and Reading Efficiency for the 3 x 4 ANOVA

Variable	Age Group											
	15 - 16				17				18 - 19			
	Trad	10%	30%	50%	Trad	10%	30%	50%	Trad	10%	30%	50%
Reading Time												
Mean	6.77	5.95	6.08	5.90	5.30	5.79	5.27	4.61	5.44	5.68	5.32	4.63
S.D.	1.70	2.43	1.07	1.34	0.74	1.13	1.21	1.07	0.45	1.19	1.05	1.99
Reading Rate												
Mean	145.96	144.12	108.49	87.06	186.95	151.61	129.19	104.74	181.21	156.94	128.43	112.49
S.D.	30.39	31.55	28.65	37.16	17.81	47.95	26.92	28.19	8.63	29.41	43.11	41.48
Reading Efficiency												
Mean	3.53	6.36	3.83	4.19	5.67	4.19	5.00	5.64	5.59	4.66	5.51	5.99
S.D.	1.44	1.21	1.77	0.94	2.95	2.13	2.43	2.26	0.57	1.43	3.11	2.58

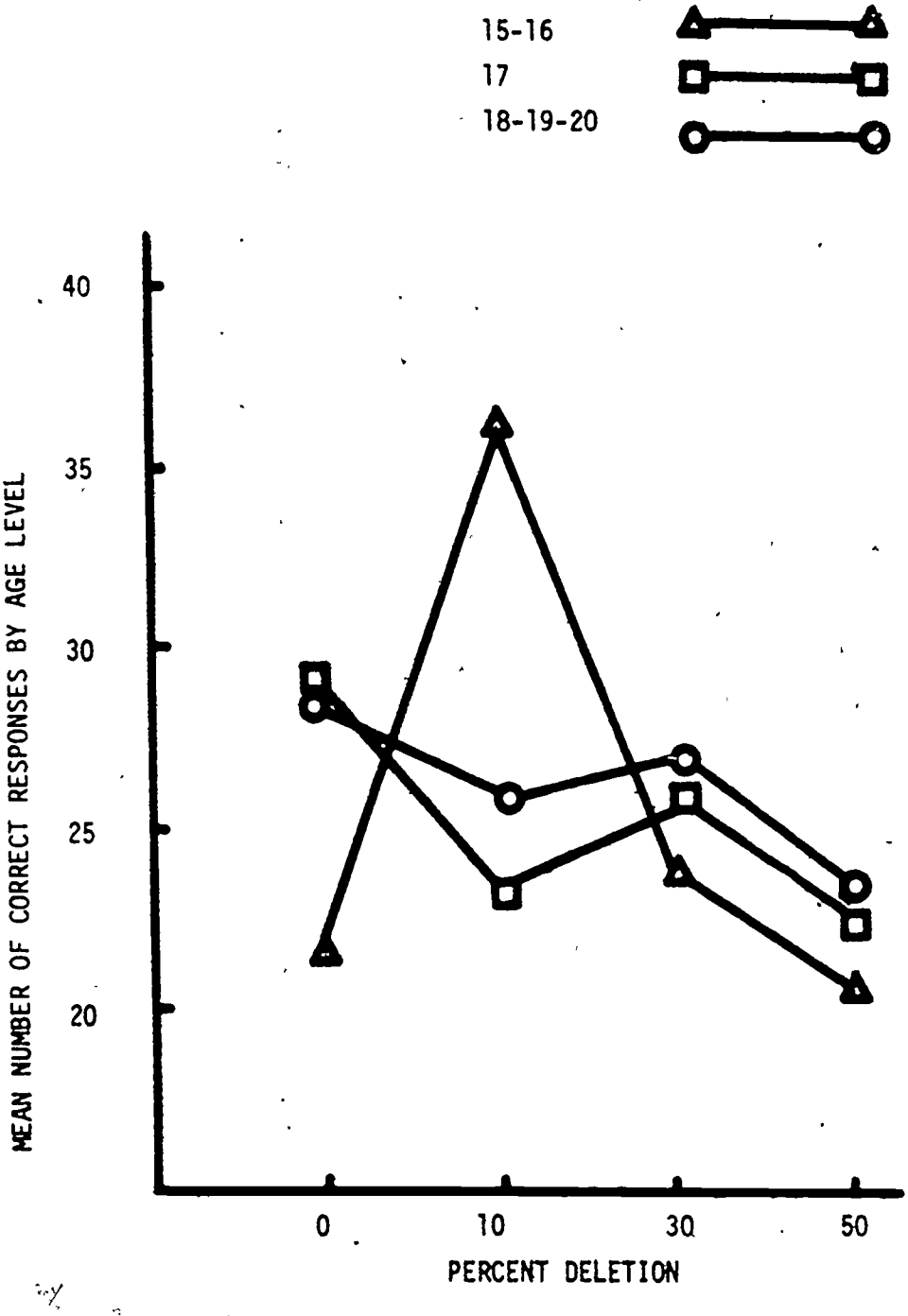


Figure 11.1. Interaction effect for total comprehension dependent variable in 3 x 4 analysis of variance.

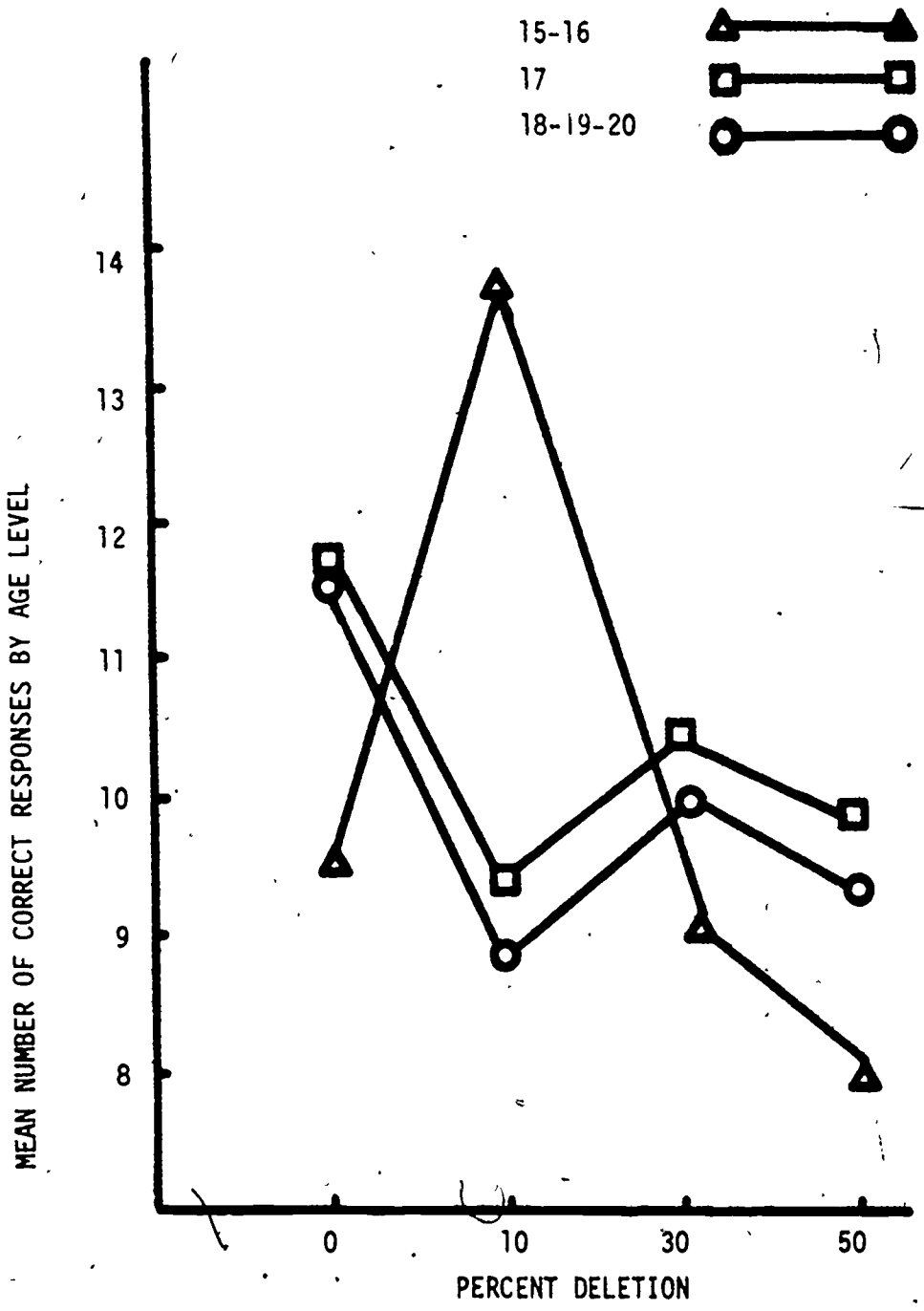


Figure 11.2. Interaction effect for the set relation dependent variable in 3 x 4 analysis of variance.

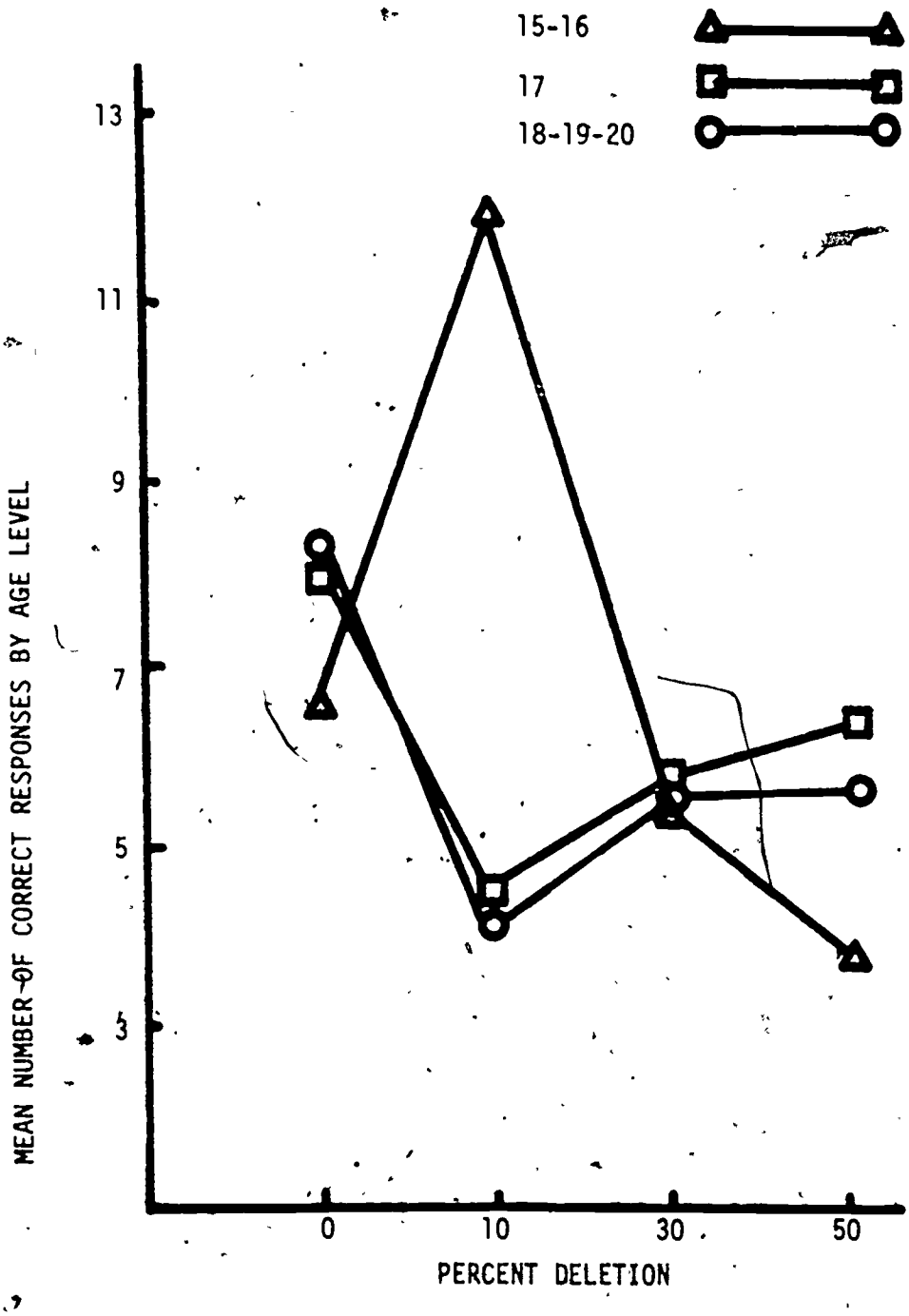


Figure 11.3. Interaction effect for the nested dependent variable in 3 x 4 analysis of variance.

difference, the exact p-value of Groups 1 (15 to 16-year-olds) and 2 (17-year-olds) approached significance.

A significant difference was found for the Age Level main effect ($F(2,85) = 3.90$, $p < .05$) and for the Percent Deletion main effect ($F(3,85) = 16.42$, $p < .001$) for the reading rate dependent variable. The Scheffé analysis indicated that the significant difference in the Percent Deletion main effect for reading rate was between subjects assigned the traditional or the 10% reduced versions and subjects assigned the 30 and 50% reduced versions. Subjects assigned the 30% reduced passage read at a 28% slower wpm rate than subjects reading the traditional passage. The Scheffé analysis for subjects reading the 10% reduced version and subjects reading the 30 or 50% reduced versions revealed the following results: subjects assigned the 30% reduced version read at a 19% slower wpm rate than subjects reading the 10% reduced passage; while subjects assigned the 50% reduced passage read approximately at a 32% slower wpm rate than subjects reading the 10% reduced version.

No significant difference was found in the 3 x 4 ANOVA for reading efficiency.

Discussion and Conclusions

Results of the analysis of the data for the eight dependent variables of this study confirmed all but one hypothesis.

As predicted, data analysis revealed no significant differences in comprehension between the traditional passage and the telegraphic passages at 10 and 30% deletion levels. Thus, the first hypothesis was confirmed. A significant interaction effect between the Age Level and Percent Deletion was found in the 3 x 4 ANOVA for total comprehension. Hypothesis 2, which predicted a significant difference in comprehension between the traditional and 10% deleted passage when compared to the 50% deletion, was not confirmed by the analysis. There was no significant difference in comprehension between groups reading the traditional passage and groups reading any of the telegraphic passages. Hypothesis 3, which predicted a decrease in reading rate with increase in percentage deletion, was confirmed. Both the 1 x 4 and the 3 x 4 ANOVAs revealed a significant difference in reading rate for groups reading the traditional passage and groups reading the telegraphic passages. Subjects assigned the telegraphic passages read at considerably slower rates than subjects reading the traditional version of the story. The traditional and 10% deleted passages did not differ significantly in reading rate, but there was a marked decrease in reading rate in the subjects reading the 30 and 50% reduced passages. A possible explanation for this reduction might be the lack of familiarity of the subjects with the unique style of the telegraphic passages. Since the telegraphic passages were written

in a different format and contained more compact information, subjects actually read at a slower speed than their normal reading speed in order to understand the intended meaning of the sentences.

Analysis of the data showed no significant difference for reading time. However, a significant difference ($p < .05$) was found for the Age Level main effect on the reading time variable.

Analysis of the data showed no difference in reading efficiency among groups reading the traditional version and the telegraphic versions of the prose passage.

Results of this study support the feasibility of the use of the telegraphic concept in education of the handicapped individual such as the deaf and hard of hearing. The major conclusion of this research was the finding of no significant difference across the different treatment conditions for the comprehension variable.

The study failed to show any difference in required reading time for groups reading the telegraphic passages as compared to the groups reading the traditional passage. Earlier studies concerning telegraphic prose (Martin & Alonso, 1967; Martin & Herndon, 1967; Sheffield, 1972) all revealed a considerable savings in time for telegraphic versions.

The fact that reading rates decreased markedly for the telegraphic passages is a serious problem which requires further research in this area.

CHAPTER XII

EXPERIMENT X -- EFFECT OF A GRAMMATICAL DELETION SCHEME UPON READING PERFORMANCE OF HEARING IMPAIRED STUDENTS

Introduction

Brown and Bellugi (1964) in their analysis of the speech of two young children found that they were most likely to retain nouns, verbs, and adjectives in their sentences while omitting auxiliary verbs, articles, prepositions, and conjunctions. In spite of the telegraphic nature of the children's utterances, such utterances are frequently effective in communicating the kernel message of the sentence.

It appears obvious that all grammatical categories are not of equal importance in conveying the essential or kernel meaning of a prose selection. Since the telegraphic concept is concerned with the maximum deletion of low information words from sentences, the analysis of the functional contribution made by different parts of speech may lead to more objective standards for determining the high information words that should be retained in generating telegraphic prose.

Martin and Chitwood (1972) reported the results of a study designed to determine the effects upon comprehension of randomly deleting 10, 20, 40, 60, and 80% of the words from each of five grammatical categories: nouns and pronouns; verbs; adjectives and adverbs; prepositions; articles and conjunctions. It was assumed that there would be differential effects upon comprehension as a function of the two independent variables: Grammatical Category and Percent Deletion. It was hypothesized that comprehension would be affected more by the deletion of nouns and verbs and less by the deletion of adjectives and adverbs, prepositions, and articles and conjunctions. More specifically, it was hypothesized that deletion levels below 40% would not significantly affect comprehension, but deletion levels above 40% in the noun and verb categories would produce a significant decrease in comprehension. In the Martin and Chitwood experiment, a total of 468 introductory psychology subjects were tested. The subjects were randomly assigned to one of 26 experimental passages making a total of 18 subjects assigned to each passage. A 2696-word passage was written for this experiment. The story, "San Francisco," described the impact of a devastating earthquake on a major urban area. The story described the interaction of city and state officials as they participated in evacuation and rescue work. The story was written so that the passage was analyzable in terms of Dawes' (1964) set relation model. The major feature of this model is the definition of the structure of prose material in terms of set relationships and makes possible the testing of some rather complex relationships in the passage.

The control group for this experiment read the traditional version of the story. Twenty-five additional versions of this passage were generated through use of a computer program designed to randomly delete set percentages of certain grammatical categories. Each word in the traditional passage was first assigned to one of eight parts of speech and grouped into five categories for use in the experiment: (1) nouns and pronouns, (2) verbs, (3) adjectives and adverbs, (4) prepositions, and (5) articles and conjunctions. Deletion levels of 10, 20, 40, 60, and 80% were selected for reducing each of the five categories. For any one version of a story, only one category of words was deleted at a specified level of reduction. Thus, five of the reduced passages eliminated only nouns and pronouns at the 10, 20, 40, 60, and 80% levels.

Each subject was administered a 60-item multiple choice test and a 20-item set relation test. The set relation questions were constructed to test the comprehension of nested and disjunctive relations defined by Dawes (1964).

The results of the multiple choice test indicated no differences between the traditional passage and the passages in which 10, 20, and 40% of the nouns and pronouns had been eliminated. However, for the verb category, no differences on the multiple choice test were obtained between the traditional passage and all passages up to and including the 60% level. Elimination of prepositions had no effect whatsoever upon performance on the multiple choice test. Performance on this test was not affected by the elimination of up to 60% of the articles and conjunctions. No significant differences were observed on the multiple choice test among the traditional, 10, 20, 40, and 80% versions when adjectives and adverbs were eliminated. However, the 60% version did differ significantly from the traditional version.

The set relation test was less sensitive to the elimination techniques than the multiple choice test. Elimination of 80% of the nouns and pronouns did tend to produce a decrement in comprehension in comparison to the traditional passage ($p < .09$). In general, performance on the set relation test was not affected by the amount of deletion or by the grammatical category when compared to the traditional passage. While performance on the comprehension tests tended to decline with increasing deletions in the noun and pronoun category, none of the other grammatical categories produced consistent declines in comprehension with increasing deletion levels.

The present experiment was designed to investigate the effects upon comprehension of randomly deleting 20 and 80% of the words from four grammatical categories: nouns and pronouns; verbs; adverbs and adjectives; and articles and conjunctions among college-age deaf and hard-of-hearing subjects. Because the omission of prepositions had little effect upon comprehension in the Martin and Chitwood (1972) experiment, prepositions were not included as a grammatical deletion category.

Based upon prior research, the following hypotheses were expected to be confirmed in this experiment.

1) A significant difference will be found among the two means of the Percent Deletion main effect on the variable of comprehension.

2) A significant difference will be found among the means of the Grammatical Category main effect on the variable of comprehension.

3) A significant interaction will be found among the main effects on the variable of comprehension.

4) Reduction at 80% of the nouns and pronouns will result in significantly lower comprehension than reduction at 80% of the articles and conjunctions.

Upon completion of the present experiment additional analyses were performed so that the results of college deaf and hard-of-hearing subjects in this experiment could be compared with normal college subjects in the Martin and Chitwood (1972) experiment.

Method

Subjects

The subjects were 152 deaf male and female entering freshmen at the National Technical Institute for the Deaf, Rochester, New York.

Materials

The materials were a traditional prose passage and eight experimental passages. The traditional passage used in the present study was originally written for use in another study conducted by the author (U.S. Office of Education research grant OEC-6-71-0527-(509)). The story, "San Francisco," is a 2696-word fictional story presented in Appendix B. It was written to involve Dawes' (1964) concept of changing set relationships. This model provides a basis for assessing the reader's comprehension of the logical structure within a passage.

The passage was written in narrative style not unlike that of a novel. The story is briefly described in the following paragraph.

> "San Francisco" described the impact of a devasting earthquake on a major urban area. The interaction of the city government, headed by Mayor St. John, and the state government, was terminated with the death of most of the younger city

councilmen, senators, police officers, and the mayor in the disaster. A young councilman, Will Atkins, away at the time of the earthquake, returned to assume leadership of the rescue and evacuation work. He had previously established workable rapport with the youth of the city; he now welcomed their aid in the work. A group of young people from a mountain valley commune, led by a girl named Helda, was described as they gradually overcame previous resentment existing between the surviving policemen and their type of groups. Forming a group known as the "Volunteers for Hope," the young people reclaimed their rightful place in modern urban society.

Readability of the traditional passage was calculated at the 11th grade level according to the Flesch (1949) formula of reading ease.

The experimental passages were reduced versions of the traditional passage. The actual reduction process was accomplished through the use of a specially designed computer program. Prior to reduction, each word in the traditional passage was assigned a number which corresponded to a grammatical category. The number of words found in each category is presented in Table 12.1.

TABLE 12.1

Number of Words in Each Grammatical Category of the Traditional Version

Grammatical Category	Number of Words
Nouns	648
Verbs	533
Prepositions	346
Adjectives	324
Articles	280
Adverbs	232
Pronouns	200
Conjunctions	130
TOTAL	2696

The computer program was designed to randomly delete any specified percentage of words from any grammatical category or combination of categories. The program was written in COBOL programming language with FORTRAN subprograms to generate the random numbers used to identify words to be deleted.

To generate the experimental materials, deletion levels were set at 20 and 80% for the four grammatical categories: nouns and pronouns; verbs; adverbs and adjectives; and articles and conjunctions. Hence, there were eight experimental categories, one for each deletion level and grammatical category combination.

Each of the experimental passages as well as the traditional version were typed double space on 8-1/2 x 11 inch paper. In the event that the first word(s) of the sentence were deleted, the first remaining word was capitalized. The original structure of sentences and paragraphs was maintained. The length of all passages is given in Table 12.2.

TABLE 12.2

Number of Words Remaining in Each Grammatical Category After the 20 and 80% Reductions

Grammatical Category	Percent Deletion 20	80
Nouns & Pronouns	2527	2018
Verbs	2590	2270
Adjectives & Adverbs	2586	2252
Articles & Conjunctions	2614	2368

Traditional -- 2696

Table 12.3 presents the percentage of words in each experimental passage as compared with the traditional form.

TABLE 12.3

Percentage of Total Word Count in Traditional Passage Contained in the Eight Deleted Versions

Grammatical Category	Percent Deletion 20	80
Nouns & Pronouns	93.0	74.0
Verbs	96.0	84.0
Adjectives & Adverbs	95.0	83.0
Articles & Conjunctions	96.0	87.0

Construction of the Comprehension Tests

Two tests were constructed in order to assess the subjects' comprehension. Sixty, four-choice multiple choice questions were based on factual material contained in the passage. Twenty, two-choice set relation questions were designed to assess comprehension of the changing set relations in the story. Ten of these questions were designed to test for comprehension of disjunctive relationships and 10 were designed to test comprehension of nested relationships.

Table 12.4 summarizes the test item statistics for the multiple choice and set relation tests.

TABLE 12.4

Test Item Statistics for the Two Comprehension Tests

Item	Multiple Choice Test	Set Relation Test
Number of Subjects	52	52
Mean Correct	49.77	13.96
Standard Deviation	7.36	2.52
Number of Items	60	20
Standard Error of Measurement	2.52	1.74
Average r_{pbis}	.27	.28
Kuder-Richardson #20	.88	.45

Procedure

All of the materials were assembled into individual packets. Each packet contained: one version of the story, a time recording form, a multiple choice test, a set relation test, and an IBM 503 answer sheet.

The test packets were randomly assigned and administered to all subjects at the same time in an auditorium classroom on the campus of the Rochester Institute of Technology. The purpose and instructions for taking the test were given by the experimenter and an interpreter who signed for him. All subjects began reading at the same time. When finished reading, each subject recorded his reading time from a digital clock at the front of the room. Subjects then took the comprehension tests, recording their answers on the answer sheets.

Design and Analysis

The basic design was a 2 x 4 factorial ANOVA with percent deletion and grammatical category as the independent variables. A 1 x 9 factorial ANOVA was used to compare the traditional version to the experimental treatments. The dependent variables were total correct responses on the multiple choice test, the set relation test, reading time, reading rate, and efficiency.

Scheffé's post hoc test of multiple comparisons was used to determine the exact nature of differences as revealed by the ANOVA.

In addition, the data from the present experiment were compared to that of a similar experiment conducted using subjects who were normal hearing college freshmen and sophomores. The design for this analysis was a 2 x 2 x 4 factorial ANOVA in which the independent variables were type of population, grammatical category, and percent deletion. The dependent variables analyzed were the results of the multiple choice test, set relation test, reading time, and reading rate.

Results and Discussion

The IBM answer sheets were machine graded with individual scores obtained for each subject's total number of multiple choice items correct and total number of set relation items correct. These data, each subject's reading time, and the length of each subject's passage were keypunched on computer cards for analysis through the use of statistical computer programs.

Multiple Choice Test Performance

The means and standard deviations for total number of multiple choice items correct are presented in Table 12.5. The 1 x 9 ANOVA on the multiple choice test revealed a significant difference ($F(8,141) = 2.17$, $p < .05$). The 2 x 4 ANOVA showed no significant differences due to the main effects. However, the interaction effect was significant ($F(3,124) = 2.84$, $p < .05$). Figure 12.1 shows the nature of the interaction. Using data from the 1 x 9 ANOVA, a Scheffé post hoc test was made of all pairwise combinations. The results did not reveal any statistically significant comparisons. The lowest p-value was obtained between the 80% article and conjunction condition and the 80% noun and pronoun condition ($F(8,141) = 1.64$, $p = .12$). It is interesting to note that the 80% article and conjunction deleted passage produced the highest comprehension score. Although not significant, this passage produced a higher comprehension score than the traditional passage.

TABLE 12.5

Means and Standard Deviations of the
2 x 4 ANOVA on the Multiple Choice Test

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	27.30	29.53	28.75	32.45
S.D.	8.93	9.76	9.58	11.42

Percent Deletion	20	80
Mean	30.81	28.21
S.D.	10.53	9.53

Nouns & Pronouns	Percent Deletion 20	80
Mean	32.47	22.13
S.D.	9.27	4.69

Verbs	Percent Deletion 20	80
Mean	30.47	28.59
S.D.	11.14	8.40

Adjectives & Adverbs	Percent Deletion 20	80
Mean	29.63	27.88
S.D.	10.49	8.89

Conjunctions & Articles	Percent Deletion 20	80
Mean	30.67	34.24
S.D.	11.63	11.25

Traditional Mean = 32.39 S.D. = 6.36

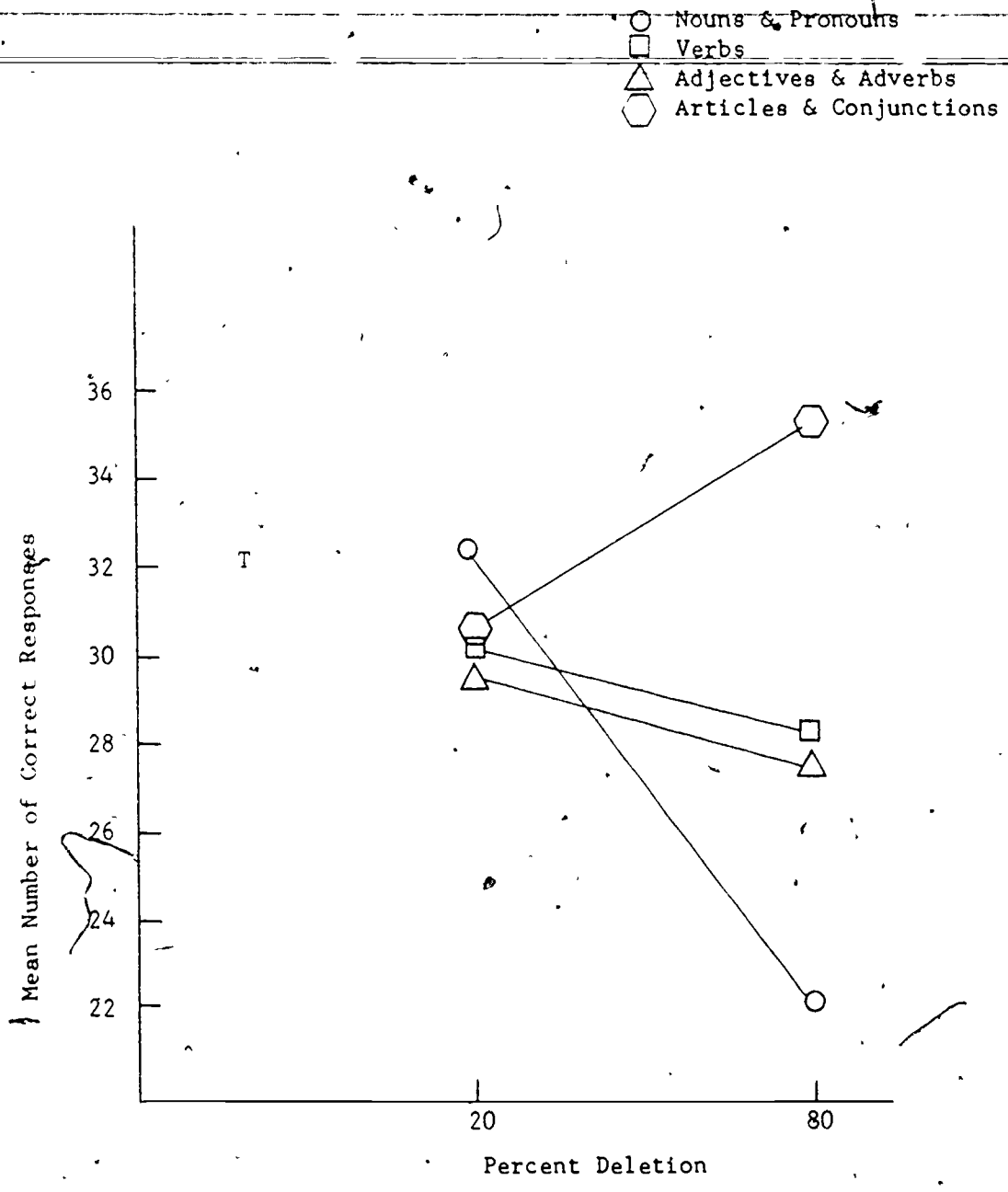


Figure 12.1. Interaction effect on the multiple choice test.

Set Relation Test Performance

Means and standard deviations for total number of correct set relation items are found in Table 12.6. None of the F values were significant, indicating that performance on the set relation test was comparable regardless of the type of treatment passage assigned. The most disturbing aspect of the set relation items was their apparent difficulty. An expected chance score on this test is 10.00. The means on this test ranged from a low of 8.47 to a high of 11.20. When each of the nine means was analyzed to determine whether it was significantly different from chance, none of the resulting z-scores was significant. These results were entirely unexpected inasmuch as similar items had been pretested on two regular classes of normal hearing children in grades five and six. Thus, the chance performance of the deaf and hard-of-hearing subjects made it impossible to assess the effectiveness of the treatment passages or to assess the type of cognitive distortion.

Reading Rate Performance

Analyses of reading rate performance revealed no significant differences among any of the nine treatment passages. Table 12.7 presents the means and standard deviations of the word per minute (wpm) reading rates for each treatment passage. The wpm reading rate ranged from a high of 276.26 for the 20% noun and pronoun deleted passage to a low of 171.26 for the 20% verb deleted passage. The reading rate for the traditional passage was 211.05 wpm.

Reading Time Performance

Similar to the results of reading rate, differences among the nine treatment passages revealed no significant differences on reading time. Means and standard deviations for reading time are presented in Table 12.8.

Efficiency Performance

Table 12.9 presents the means and standard deviations for the efficiency dependent variable. The magnitude of the efficiency measure indicates the degree a treatment passage can transmit a given amount of information in a given time period.

Results of the 2 x 4 ANOVA revealed no significant differences for the Grammatical Category and Percent Deletion main effects; however, the interaction effect was significant. ($F(3,124) = 3.08$, $p < .05$). As in the results of the multiple choice test, there was a marked decrement in efficiency for the 80% noun and pronoun deleted passage. This result is not unexpected in that this measure is influenced by the degree of comprehension. Since there were no differences in reading times among the passages and there

TABLE 12.6

Means and Standard Deivations of the
2 x 4 ANOVA on the Set Relation Test

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	10.60	9.50	10.48	10.68
S.D.	2.31	3.31	2.98	2.73

Percent Deletion	20	80
Mean	10.69	9.94
S.D.	3.05	2.67

Nouns & Pronouns	Percent Deletion 20	80
Mean	11.20	10.00
S.D.	2.48	2.04

Verbs	Percent Deletion 20	80
Mean	10.53	8.47
S.D.	3.47	2.87

Adjectives & Adverbs	Percent Deletion 20	80
Mean	10.25	10.71
S.D.	3.32	2.71

Conjunctions & Articles	Percent Deletion 20	80
Mean	10.78	10.59
S.D.	3.00	2.50

Traditional Mean = 10.50 S.D. = 2.68

TABLE 12.7

Means and Standard Deviations of the
2 x 4 ANOVA on Reading Rate

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	223.92	171.29	191.40	187.04
S.D.	174.78	51.86	61.28	44.93

Percent Deletion	20	80
Mean	208.80	178.03
S.D.	123.86	61.28

Nouns & Pronouns	Percent Deletion 20	80
Mean	276.26	171.57
S.D.	231.00	63.61

Verbs	Percent Deletion 20	80
Mean	171.25	171.34
S.D.	49.76	55.42

Adjectives & Adverbs	Percent Deletion 20	80
Mean	194.41	188.40
S.D.	67.97	56.23

Conjunctions & Articles	Percent Deletion 20	80
Mean	193.27	180.82
S.D.	47.27	42.79

Traditional Mean = 211.05 S.D. = 91.98

TABLE 12.8

Means and Standard Deviations of the
2 x 4 ANOVA on Reading Time

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	12.78	15.85	14.89	14.05
S.D.	5.49	6.55	7.86	3.32

Percent Deletion	20	80
Mean	14.82	13.86
S.D.	6.99	4.94

Nouns & Pronouns	Percent Deletion 20	80
Mean	11.89	13.68
S.D.	4.84	6.11

Verbs	Percent Deletion 20	80
Mean	16.89	14.80
S.D.	7.29	5.74

Adjectives & Adverbs	Percent Deletion 20	80
Mean	16.20	13.18
S.D.	10.17	4.66

Conjunctions & Articles	Percent Deletion 20	80
Mean	14.31	13.79
S.D.	3.48	3.24

Traditional Mean = 15.91 S.D. = 10.92

TABLE 12.9

Means and Standard Deviations of the
2 x 4 ANOVA on Efficiency

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	3.58	2.83	3.17	3.24
S.D.	2.10	1.43	1.46	1.14

Percent Deletion	20	80
Mean	3.33	3.08
S.D.	1.77	1.30

Noung & Pronouns	Percent Deletion 20	80
Mean	4.40	2.76
S.D.	2.48	1.24

Verbs	Percent Deletion 20	80
Mean	2.78	2.87
S.D.	1.46	1.45

Adjectives & Adverbs	Percent Deletion 20	80
Mean	3.04	3.30
S.D.	1.48	1.48

Conjunctions & Articles	Percent Deletion 20	80
Mean	3.01	3.39
S.D.	1.26	1.00

Traditional Mean = 3.39 S.D. = 1.60

was a large decrement in comprehension for the 80% noun and pronoun deleted passage on the multiple choice test, the efficiency data were expected to produce an interaction effect.

Comparison of Normal Subjects to Deaf and Hard-of-Hearing Subjects

A 2 x 2 x 4 ANOVA was computed for each of the following variables: multiple choice test, set relation test, reading rate, and reading time.

Means and standard deviations for the 2 x 2 x 4 ANOVA on the multiple choice test are reported in Table 12.10. Significant differences were obtained for the Subject Population main effect ($F(1,260) = 140.10$, $p < .001$), Grammatical Category main effect ($F(3,260) = 8.40$, $p < .001$), and Percent Deletion main effect ($F(1,260) = 27.14$, $p < .001$). In addition, a significant interaction was obtained between Subject x Percent Deletion ($F(3,260) = 4.15$, $p < .01$). The normal subjects scored significantly better than the deaf subjects on the multiple choice test. According to Figure 12.2, the interaction between Subject Population and Percent Deletion indicated that the 80% deletion level had a greater effect on the normal group than on the deaf group. The interaction between Grammatical Category and Percent Deletion is illustrated in Figure 12.3.

The means and standard deviations for the 2 x 2 x 4 ANOVA on the number of correct responses on the set relation test are reported in Table 12.11. There were significant differences found among the Subject Population main effect ($F(1,260) = 53.00$, $p < .001$) and the Percent Deletion main effect ($F(1,260) = 9.76$, $p < .01$). As expected, the normal subjects scored higher than the deaf and hard-of-hearing subjects, and a higher comprehension score was attained on the 20% passages than on the 80% passages. None of the interaction terms was significant.

On the variable of reading time, the 2 x 2 x 4 ANOVA yielded a significant difference only among the Subject Population main effect ($F(1,260) = 4.36$, $p < .05$). The deaf and hard-of-hearing subjects required more reading time than the normal subjects. The means and standard deviations are reported in Table 12.12. Again, none of the interaction terms approached significance at the .05 level.

Among the main effects of the 2 x 2 x 4 ANOVA on reading rate, the Percent Deletion main effect was significant ($F(1,260) = 7.42$, $p < .01$). A significant interaction effect ($F(3,260) = 3.95$, $p < .05$) was found between Subject Population and Grammatical Category and is illustrated in Figure 12.4. Reading rate generally decreased at the 80% level as compared to the 20% level. The significant interaction between Grammatical Category and Subject Population indicated that reduction of nouns and pronouns and verbs produced the greatest effect upon both the normal and deaf and hard-of-hearing subject groups. Means and standard deviations for the 2 x 2 x 4 ANOVA on reading rate are reported in Table 12.13.

TABLE 12.10

Means and Standard Deviations of the
2 x 2 x 4 ANOVA on the Multiple Choice Test

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	31.92	37.41	36.28	38.89
S.D.	10.50	11.89	11.48	12.45
Percent Deletion	20		80	
Mean	39.01		33.38	
S.D.	12.01		11.00	
Subject Population	Normals		Deaf	
Mean	42.26		29.58	
S.D.	9.97		10.07	
Nouns & Pronouns	Normals		Deaf	
	20	80	20	80
Mean	42.50	29.06	32.47	22.13
S.D.	7.41	8.13	9.27	4.69
Verbs	Normals		Deaf	
	20	80	20	80
Mean	49.22	40.50	30.47	28.59
S.D.	6.41	8.11	11.14	8.40
Adjectives & Adverbs	Normals		Deaf	
	20	80	20	80
Mean	44.44	41.94	29.63	27.88
S.D.	7.73	8.88	10.49	8.89
Conjunctions & Articles	Normals		Deaf	
	20	80	20	80
Mean	50.11	40.27	30.67	34.24
S.D.	5.94	10.95	11.63	11.25

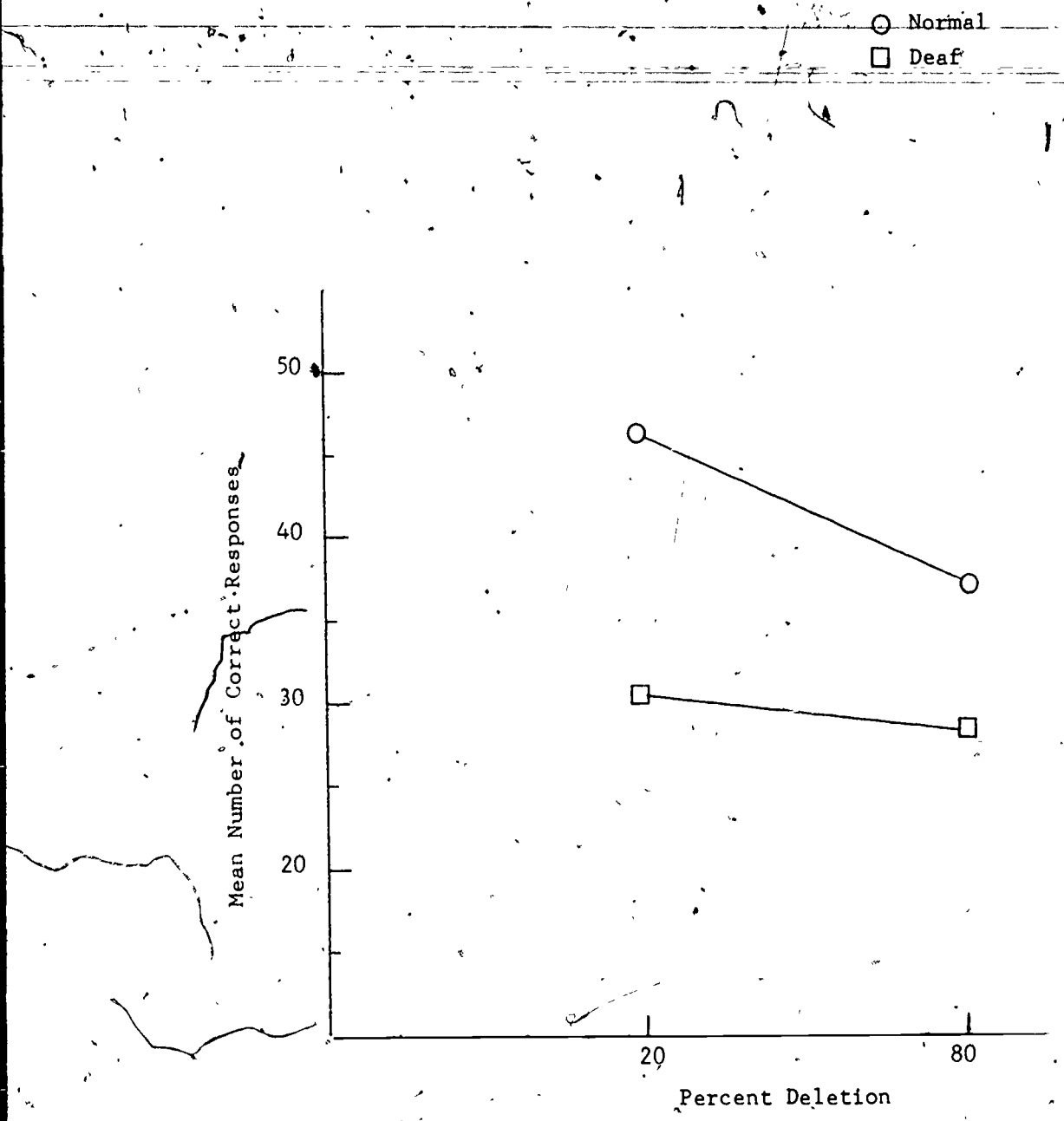


Figure 12.2. Interaction between Subject Population and Percent Deletion in the 2 x 2 x 4 ANOVA on multiple choice comprehension.

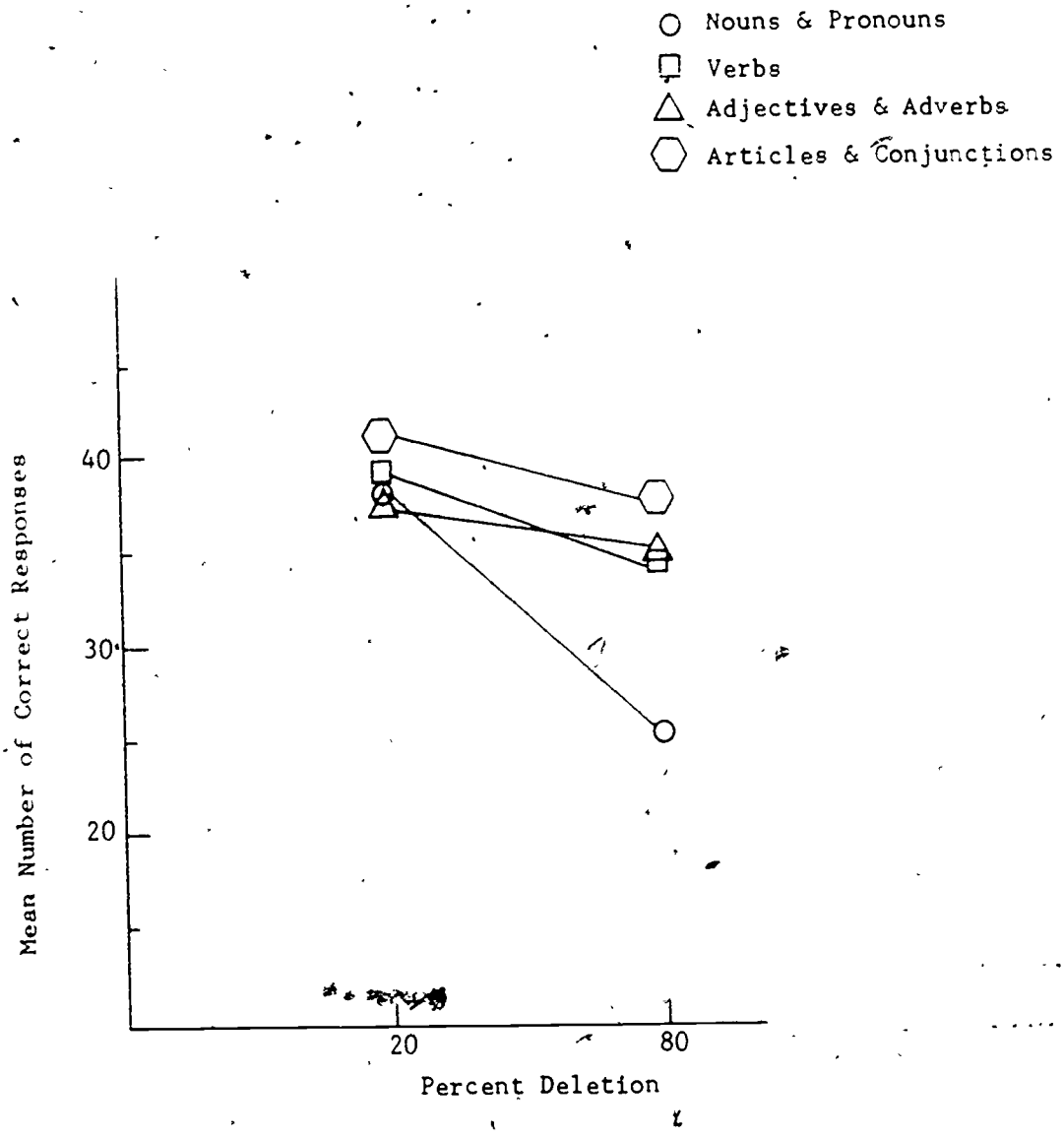


Figure 12.3. Interaction between Grammatical Category and Percent Deletion in the 2 x 2 x 4 ANOVA on multiple choice comprehension.

TABLE 12.11

Means and Standard Deviations of the
2 x 2 x 4 ANOVA on the Set Relation Test

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	11.59	11.40	11.74	11.72
S.D.	2.55	3.73	3.29	2.88
Percent Deletion	20		80	
Mean	12.15		11.07	
S.D.	3.18		3.01	
Subject Population	Normals		Deaf	
Mean	12.81		10.31	
S.D.	2.89		2.88	
Nouns & Pronouns	Normals		Deaf	
	20	80	20	80
Mean	13.61	11.22	11.20	10.00
S.D.	2.37	1.99	2.48	2.04
Verbs	Normals		Deaf	
	20	80	20	80
Mean	13.50	12.89	10.53	8.47
S.D.	2.90	3.55	3.47	2.87
Adjectives & Adverbs	Normals		Deaf	
	20	80	20	80
Mean	13.11	12.67	10.25	10.71
S.D.	3.14	3.29	3.32	2.71
Conjunctions & Articles	Normals		Deaf	
	20	80	20	80
Mean	13.78	11.67	10.78	10.59
S.D.	2.34	2.68	3.00	2.50

TABLE 12.12

Means and Standard Deviations of the
2 x 2 x 4 ANOVA on Reading Time

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	13.14	14.26	13.99	13.52
S.D.	4.24	5.53	5.91	2.88
Percent Deletion	20		80	
Mean	14.16		13.31	
S.D.	5.36		4.10	
Subject Population	Normals		Deaf	
Mean	13.15		14.37	
S.D.	3.12		6.05	
Nouns & Pronouns	Normals		Deaf	
	20	80	20	80
Mean	13.81	13.06	11.89	13.68
S.D.	2.84	2.92	4.84	6.11
Verbs	Normals		Deaf	
	20	80	20	80
Mean	13.60	11.92	16.89	14.80
S.D.	4.63	2.84	7.29	5.74
Adjectives & Adverbs	Normals		Deaf	
	20	80	20	80
Mean	13.59	13.20	16.20	13.18
S.D.	2.38	4.05	10.17	4.66
Conjunctions & Articles	Normals		Deaf	
	20	80	20	80
Mean	13.01	12.99	14.31	13.79
S.D.	2.34	2.35	3.48	3.24

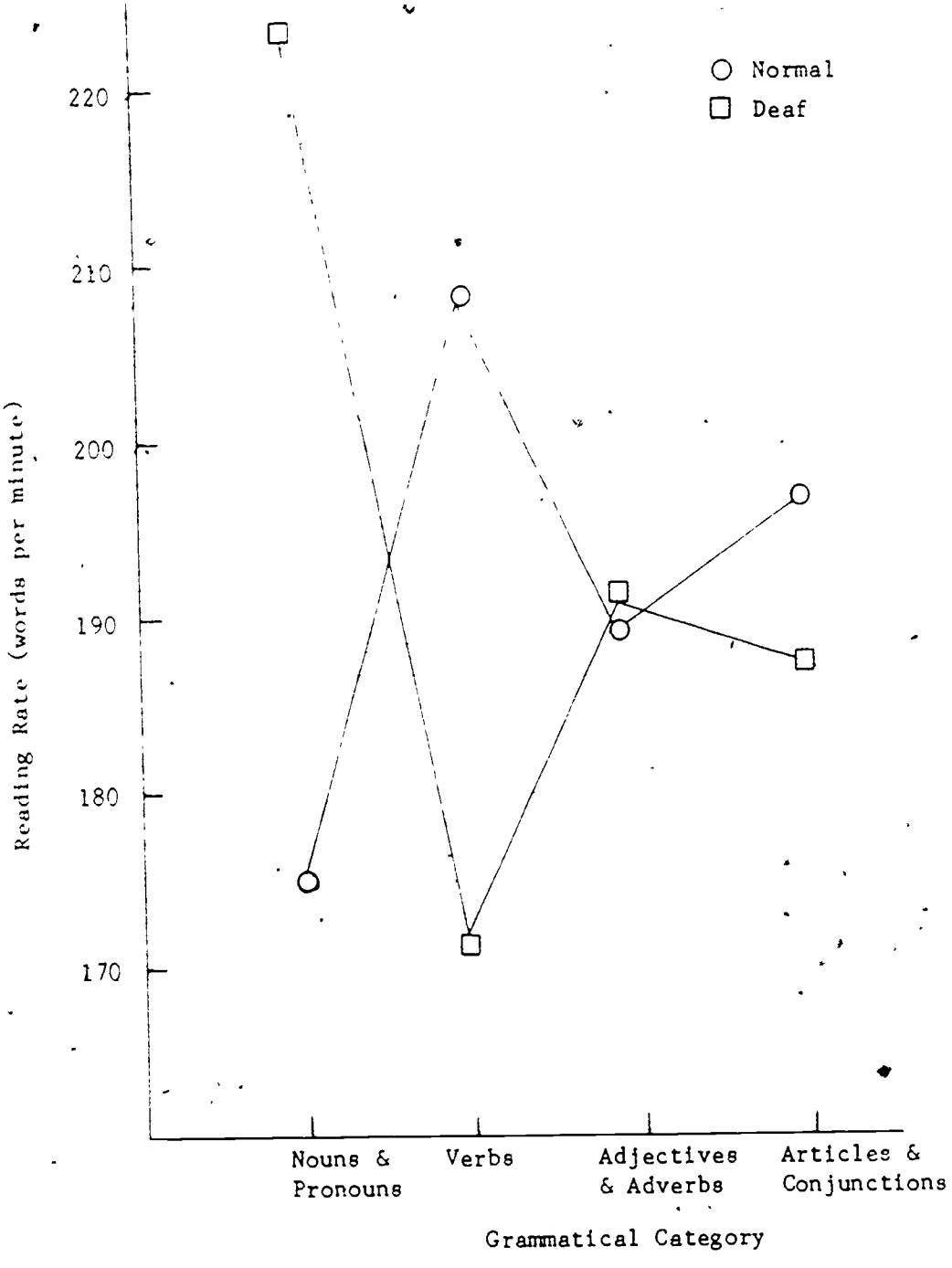


Figure 12.4. Interaction between Grammatical Category and Subject Population in the 2 x 2 x 4 ANOVA on reading rate.

TABLE 12.13

Means and Standard Deviations on the 2 x 2 x 4 ANOVA on Reading Rate

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Conjunctions & Articles
Mean	198.16	190.72	190.58	192.53
S.D.	123.19	65.02	52.10	41.67
Percent Deletion	20		80	
Mean	204.41		181.45	
S.D.	93.40		50.94	
Subject Population	Normals		Deaf	
Mean	193.34		192.48	
S.D.	51.37		96.09	
Nouns & Pronouns	Normals		Deaf	
	20	80	20	80
Mean	190.73	162.66	276.26	171.57
S.D.	41.03	40.79	231.00	63.61
Verbs	Normals		Deaf	
	20	80	20	80
Mean	214.59	203.55	171.25	171.34
S.D.	81.99	60.68	49.76	55.42
Adjectives & Adverbs	Normals		Deaf	
	20	80	20	80
Mean	196.26	183.57	194.41	188.40
S.D.	36.51	48.67	67.97	56.23
Conjunctions & Articles	Normals		Deaf	
	20	80	20	80
Mean	207.54	187.86	193.27	180.82
S.D.	41.22	33.06	47.27	42.79

Conclusions

It was concluded from the analyses on the deaf and hard-of-hearing subjects that elimination of 80% nouns and pronouns produced a decrement in comprehension in comparison to the traditional passage. Elimination of verbs and adjectives and adverbs had no appreciable effect upon comprehension at either the 20 or 80% levels. There was some indication that 80% elimination of articles and conjunctions was associated with superior performance for the deaf and hard of hearing on the multiple choice comprehension test. Performance on the 20-item set relation test was unexpectedly low. None of the nine treatment means exceeded chance performance. Thus, it was not possible to assess comprehension of the complex set relationships among the deaf and hard-of-hearing subjects in the present study.

It was expected in the 2 x 2 x 4 ANOVAs that normal subjects would perform higher on the dependent variables than the deaf and hard-of-hearing subjects. On both measures of comprehension, the normal subjects did score significantly higher than the hearing handicapped subjects. In addition, the normal subjects required significantly less time to read the reduced passages. Reading rate, however, was not significantly different between the two subject populations. The interaction found between the Subject Population and Percent Deletion indicated that although the normal subjects read faster than the deaf and hard-of-hearing subjects at both the 20 and 80% levels, reduction at the 80% level had a greater effect upon the normal subjects than upon the deaf and hard-of-hearing subjects.

One of the assumptions upon which this study was based is that written and spoken language contains many words and word sequences which are unnecessary for the comprehension of a message. Another assumption is that so-called "correct" writing styles have evolved quite independently of the psychological factors involved in learning from written or spoken language. Further, it may be that thought itself is telegraphic in nature. Vigotsky (1934) has argued that the speech of pre-school children is highly egocentric in nature. According to him egocentric speech becomes "inner speech" as we grow older. Inner speech is verbalized thought that is for oneself. Since it requires no outside auditor, it does not have to meet the requirements of the formal speech community. Thus, such speech may be highly telegraphic in nature in that it strives for minimal redundancy. The results of this experiment have demonstrated that it is possible to eliminate rather large percentages of certain grammatical categories without seriously affecting the comprehension of hearing handicapped subjects. Since the deaf have difficulty in the verbal area, reduction of verbage in written messages may result in more efficient reading materials for these students.

CHAPTER XIII

EXPERIMENT XI -- APPLICATION OF THE SUBJECTIVE DELETION SCHEME TO FILM CAPTIONING FOR THE DEAF

Introduction

The purpose of the present study was to examine the feasibility of applying the telegraphic concept to film captioning for the deaf. The film and videotape media are increasingly being used in the education of the deaf. In a study by Gates (1970), it was found that the amount of information received by deaf students viewing instructional television was significantly greater when captions were included in the presentation. Gates suggested that the printed word facilitates the acquisition of verbal information among deaf students more than does either speech or manual communication.

The telegraphic concept is based on the presence of redundant and superfluous information in the English language (Garner, 1962). Recent studies by Martin and Pantalion (1973) and Sheffield and Martin (1973) demonstrated the feasibility of applying the telegraphic concept in the development of prose materials for normal college and high school students as well as for blind high school students. Both studies used the sentence as the basic unit for deletion, and deletion was made on the basis of the relative importance of the words within each sentence. This deletion method is termed the SHORT (Subjective Hierarchy of Relevant Terms) method, and the generation of different levels of telegraphic prose is accomplished by the deletion of words judged least important by subjects who are instructed to rank the words within a sentence in the order of their importance for communicating the kernel idea of a sentence. The results of both the Martin and Pantalion study and the Sheffield and Martin study indicated a considerable savings in time and no significant loss in comprehension for the SHORT telegraphic versions when compared to the traditional versions of the passages.

Partovi (1973) examined the effects of SHORT telegraphic passages upon the reading behavior of deaf subjects. The results of this study indicated no significant differences in comprehension between the telegraphic versions of the passage and the traditional passage.

This study was concerned with examining the effects of telegraphic communication on the level of comprehension of deaf students. Two sets of films, one set with signing only, the other set with signing and captions, were developed so that it could be determined which format would be most advantageous for the deaf audience. Based on results from the Gates (1970) study, it was hypothesized that the films with signing and captions would be superior to the films with signing only.

Deletion levels of 10, 30, and 50% were chosen for both sets of films. The telegraphic passages were those developed using the SHORT method by Sheffield and Martin (1973) and also used in the Partovi (1973) study. This study was designed to determine the effects of telegraphic captions on comprehension, the comprehensibility of telegraphic signing, and the levels of telegraphic captioning and signing that are tolerable when performance on the comprehension test for subjects watching the telegraphic films are compared with the performance of subjects watching the traditional films.

Method

Subjects

Subjects were 79 students in grades eight through twelve attending the Pennsylvania School for the Deaf. Each of the eight treatment groups contained from 6 to 17 subjects. Data obtained on subject IQ, vocabulary, and paragraph comprehension were available in order to perform analyses of covariance in the event that the groups were unequal with respect to these variables.

Materials

Eight 16mm color films were developed for this study. Each film told the story of two warring African nations, Mambo and Yam. Two film formats were used, one in which the prose was presented by a manual communicator using signs as described in A Basic Course in Manual Communication (National Association of the Deaf, 1970), the other in which captions of the prose were superimposed across the lower one-third of the screen and were presented simultaneously as the words were signed. The traditional, 10, 30, and 50% reduced passages of "Mambo and Yam" (Appendix A) were presented in each of the two film formats. The telegraphic versions of the story were the same as those developed by the SHORT method and described in the First Year Interim Report (February 28, 1973). Some of the words in the passages did not have equivalent signs, in which case an attempt was made to use an acceptable synonym. The translator pronounced each word with emphasis as it was signed.

A 40-item multiple choice test (Appendix A) was used to assess comprehension for the eight groups of subjects. An IBM answer sheet was used by each subject to record the test answers.

Procedure

Treatment conditions were randomly assigned to classroom groups. Thus, each of eight film presentations was viewed by a single class. Following the film presentations, each subject was administered a multiple choice test and provided an IBM answer sheet for recording test answers.

Design and Analysis

Because intact classes were used, records for each subject were obtained from the school and three 1 x 8 ANOVA designs were used to determine whether any differences existed among the eight groups on IQ, vocabulary, or paragraph comprehension scores. After the multiple choice comprehension scores were obtained, correlations were performed to determine which of the three factors correlated positively with the comprehension measures. Multiple regression analysis was then performed to determine which of the possible combinations of the three factors was most highly correlated with multiple choice scores. Finally, a 2 x 4 analysis of covariance and a 1 x 8 analysis of covariance were performed on the multiple choice scores to determine whether any significant differences existed among the eight treatment conditions on the adjusted means.

Results

Test item statistics were computed on 78 of the subjects who responded to the multiple choice comprehension test. The Kuder-Richardson #20, mean point-biserial, mean item discrimination, and mean item difficulty were .69, .27, .31, and .37, respectively.

Three 1 x 8 ANOVAs were used to determine whether any significant differences existed among the eight treatment conditions for IQ, vocabulary, or paragraph comprehension scores. Significant differences were found for each of the three variables. An F of 2.40, $df = 7, 71$, $p < .05$ was found for IQ; an F of 6.99, $df = 7, 71$, $p < .001$ was found for vocabulary scores; and an F of 6.99, $df = 7, 71$, $p < .001$ was found for paragraph comprehension scores. Table 13.1 presents the means and standard deviations for each of the variables.

The intercorrelation matrix (Table 13.2) indicated that each of the three variables was positively correlated with the multiple choice scores. The multiple regression analysis indicated that the best model for analyzing the multiple choice scores was a composite of the three variables ($R = .61$, $df = 78$). Consequently, the multiple choice scores were analyzed using the three variables as covariates so that differences in the three uncontrolled variables were adjusted among the eight treatment groups.

The means, adjusted means, and standard deviations for the number of multiple choice items answered correctly are presented in Table 13.3. Figure 13.1 illustrates the performance of the eight groups on the test. Also presented on the right ordinate is the presentation time for the four different passage lengths. The 2 x 4 analysis of covariance yielded a significant difference between presentation modes (F (1,68) = 21.67, $p < .001$) and across deletion levels (F (3,68) = 3.45, $p < .05$). The Scheffé

TABLE 13.1

Means and Standard Deviations for IQ, Vocabulary Meaning, and Paragraph Meaning for Each of the Eight Treatment Conditions

Variable	Signing				Signing and Captions			
	T	10%	30%	50%	T	10%	30%	50%
IQ								
Mean	100.00	103.43	105.25	99.06	110.29	106.33	112.00	114.88
S.D.	9.72	8.55	9.72	14.65	11.84	10.99	13.32	9.00
Vocabulary Meaning								
Mean	33.88	45.57	40.50	33.76	56.14	50.67	54.14	58.38
S.D.	6.40	13.30	10.44	5.07	6.82	4.23	11.78	23.75
Paragraph Meaning								
Mean	38.00	43.57	40.92	35.12	58.14	53.17	68.14	63.75
S.D.	6.85	9.71	10.68	5.48	8.69	6.77	14.58	23.49

TABLE 13.2

Correlations (r) Among the Three Covariates and the Multiple Choice Criterion Test

	Multiple Choice	IQ	Vocabulary Meaning	Paragraph Meaning
Multiple Choice	1.000	0.236	0.509	0.604
IQ	0.236	1.000	0.302	0.292
Vocabulary Meaning	0.509	0.302	1.000	0.859
Paragraph Meaning	0.604	0.292	0.859	1.000

TABLE 13.3

Means, Adjusted Means, and Standard Deviations for the Multiple Choice Scores for Each of the Eight Treatment Conditions

	Mean	Adjusted Mean *	Standard Deviation
Signing			
Traditional	12.625	13.391	3.662
10%	14.429	14.678	1.989
30%	11.833	12.330	3.433
50%	11.824	12.808	2.721
Signing & Captions			
Traditional	20.429	19.494	4.791
10%	20.333	19.817	5.125
30%	22.714	21.042	4.152
50%	16.500	15.129	4.276

*Using IQ, vocabulary, and paragraph comprehension as covariates.

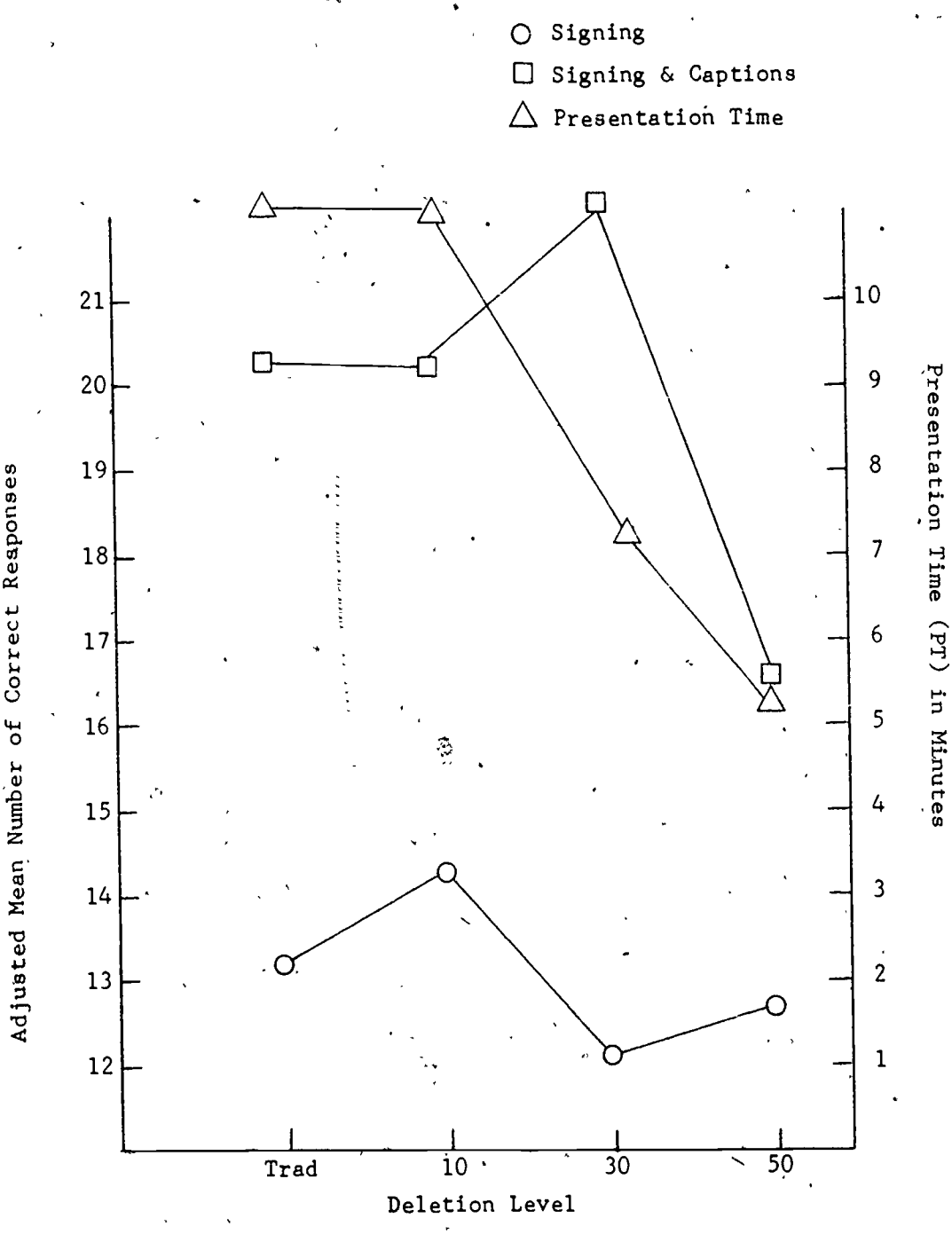


Figure 13.1. Adjusted mean multiple choice comprehension scores by film type and deletion level. Presentation time is presented on the right ordinate.

analysis indicated that multiple choice scores were significantly less (29%) for subjects watching the films with signing only than they were for subjects watching the films with signing and captions. Although the Scheffé analysis performed on the Deletion Level main effect did not yield any significant differences, the smallest p-value to result from the pairwise comparisons was between the 10% reduced versions and the 50% reduced versions of the story ($p < .10$). Subjects assigned the two 50% reduced versions answered 16% fewer multiple choice items correctly than subjects assigned the 10% reduced versions of the story.

A significant F value was found in the 1 x 8 analysis of covariance performed on multiple choice scores ($F(7,68) = 5.34$, $p < .001$). The Scheffé analysis indicated that subjects watching each of the four versions presented with signing only answered significantly fewer questions correctly than subjects watching the 30% reduced version of the story presented with signing and captions. In addition, subjects presented the 30 and 50% reduced versions with signing only answered significantly fewer questions correctly than subjects presented the traditional and 10% reduced versions with signing and captions. No significant differences were found among the four versions of the story presented with signing and captions.

Discussion and Conclusions

Results of the 2 x 4 analysis of covariance confirmed the results found by Gates (1970). Presentation of captions facilitated comprehension. Subjects watching the films in which both signing and captions were used performed better than subjects watching the films with signing only.

Inspection of Figure 13.1 shows that deletion levels of 30 and 50% in the signing only conditions had little effect upon comprehension in comparison to the traditional and 10% versions. However, the signing only condition was associated with extremely low comprehension scores for all four treatment conditions. There was a rather decided drop in comprehension at the 50% deletion level in the signing and caption condition. It is interesting to note that while there was a 23% drop in comprehension between the traditional and 50% signing and caption conditions, there was a corresponding reduction of 54% less time devoted to the presentation of the 50% deleted message. Also noteworthy, is the fact that there was a slight increase in comprehension (7%) at the 30% level for the signing and caption condition in comparison to the traditional message, in spite of the 37% reduction in presentation time.

In conclusion, the results of this experiment are encouraging. They suggest that at least 30% deletion levels can be tolerated by deaf and hard-of-hearing students when telegraphic signing and

telegraphic captions are employed simultaneously. Telegraphic captioning for the deaf may be a viable alternative to present-day methods of captioning employed in the preparation of educational materials for hearing impaired students.

CHAPTER XIV

EXPERIMENT XII -- EFFECT OF A GRAMMATICAL AND WORD FREQUENCY DELETION SCHEME UPON READING PERFORMANCE OF HEARING IMPAIRED STUDENTS

Introduction

Reduction of traditionally written materials to telegraphic prose is based upon the assumption that the language is redundant. Studies by Fries (1952), Weaver (1965), and Herdan (1966) support the existence of redundancy by demonstrating the predictability of certain parts of speech. Based upon the findings of this research, two dimensions of meaning termed lexical and structural meaning have been identified. It is the structural words, such as articles, prepositions, auxiliary verbs, conjunctions, and pronouns which provide the least amount of meaningful information. Structural words are described as forming short and restricted distributions. For example, when a structural word is omitted in a cloze test, the number of different words which can be used to replace the missing word is very limited. In addition, it is the structural words that form the class of very high frequently occurring words in the language (Herdan, 1966).

Two methods of identifying and reducing redundancy were used in this study. One method was based on the systematic omission of words based upon their parts of speech. The second method was based upon word frequency. The methodology used in this experiment was developed from research completed by Martin and Chitwood (1972) and Martin (1974) on populations of normal hearing subjects.

Martin and Chitwood examined the development of telegraphic materials by a reduction procedure based upon the objective elimination of various parts of speech. For this reduction procedure, a computer program was written to randomly delete designed parts of speech at varying levels of reduction. Each word in the original passage was first labeled as to its part of speech. With the aid of an IBM 360/65 computer, passages were generated based upon the random deletion of the following categories: nouns and pronouns; verbs; adjectives and adverbs; prepositions; and articles and conjunctions. Each of the five categories was deleted at 10, 20, 40, 60, and 80% reduction levels. Thus, 25 treatment passages were developed and typed in traditional format.

The original passage and 25 reduced versions were used for testing 468 sophomore psychology students at Sam Houston State University. Significant differences were associated with each independent variable (Percent Deletion and Grammatical Category) on the variable of comprehension. The interaction between the two main effects was also significant. In general, comprehension decreased as percent reduction increased. With respect to grammatical category, up to 40% deletion of nouns caused no significant

decrease in comprehension in comparison to the traditional passage. Deletions within the verb category, as well as the articles and conjunctions category, revealed no differences in comprehension between the traditional passage and all passages up to and including the 60% deletion level. Deletion up to and including 80% of the preposition category showed no significant differences with respect to comprehension. Thus, the reduction of nouns resulted in the greatest effect upon comprehension, whereas reduction of prepositions resulted in the least effect upon comprehension. The effect of reducing the remaining categories could not be differentiated, but their effect was not as great as that found for the noun category.

Martin (1974) examined the variable of word frequency as it relates to redundancy. As was noted earlier by Herdan (1966), the words of restricted distributions, such as the function words, occur with the greatest frequency in the language. It is not surprising, therefore, to find a close similarity between the high frequently occurring words in a passage and the relatively unimportant grammatical parts of speech.

Two passages were prepared for reduction based upon word frequency in the Martin study. Analysis of the frequency of each word within the passages was performed on an IBM 360/65 computer. The resulting distribution of words within the passages were divided into three categories of high, medium, and low frequently occurring words, each containing approximately one-third of the total number of words in the passages. The computer was programmed to reduce the number of words in each of the three categories at 10, 30, and 50% deletion levels. The nine reduced versions and the traditional for each passage were tested on 412 undergraduate students with the following results. In general, passages in which the high frequency words were deleted were superior to the passages in which the medium or low frequency words were deleted with respect to comprehension measured by a multiple choice test. All 10% versions were significantly superior to the 50% medium and low frequency versions. The reduced passages did not result in less reading time than the traditional, and reading rates tended to decrease significantly when 50% of the high frequency words were deleted.

The present study consists of two experiments designed to examine the effects of deleting different parts of speech and of deleting different word frequency categories on a sample of deaf and hard-of-hearing subjects. The effects of deletion level and type of reduction were examined in relation to: comprehension, reading rate, reading time, and the efficiency measure.

Method

Subjects

The subjects were 210 deaf and hard-of-hearing male and female students at the Texas School for the Deaf in Austin, Texas. Students were selected from grades eight through twelve. Information pertaining to age, IQ, reading achievement, and hearing loss were obtained from each student's admission records.

A number of subjects were eliminated from the study because of incomplete background data. Therefore, 201 subjects were tested in the frequency deletion study, and 197 subjects were tested in the grammatical deletion study.

Materials

The prose selections that were analyzed for use as the criterion passages were "San Francisco" and "Mambo and Yam." "San Francisco" describes the impact of a devastating earthquake on a major urban area. "Mambo and Yam" is a story about two warring African nations. According to the Flesch (1949) Readability Formula, "San Francisco" is in the 10th through 12th grade level of difficulty, while "Mambo and Yam" is in the fairly easy 7th grade level of difficulty.

The analysis of the frequency of each word within the "San Francisco" passage was performed on an IBM 360/65 computer with a computer program written in FORTRAN IV-G computer language. The resulting printout listed the word types (each different word in a passage is one type regardless of its frequency of occurrence) in order of descending frequency. The token count (number of times each word appeared in the passage) was given for each type as was the rank. The most frequent word had a rank of one, the second most frequent a rank of two, etc. In addition, a cumulative frequency was given for each type based on the frequency of that type plus the frequencies of all types having a lower rank number. The frequency analysis performed on the passage was also stored on a computer disk for use in the telegraphic materials' generation program. Figure 14.1 presents the frequency curves of the words as a function of their ranks from "San Francisco." The graph shows the points at which the tokens were divided into thirds to designate the low, medium, and high word frequency categories. Table 14.1 indicates the rank, frequency range, number of tokens, and percent of corpus for each frequency category for the passage. Since there is no empirical basis for dividing types within frequency categories, the frequency categories were divided at points where frequencies change, so that the number of tokens in each frequency category was only approximately equal to one-third of the total number of tokens.

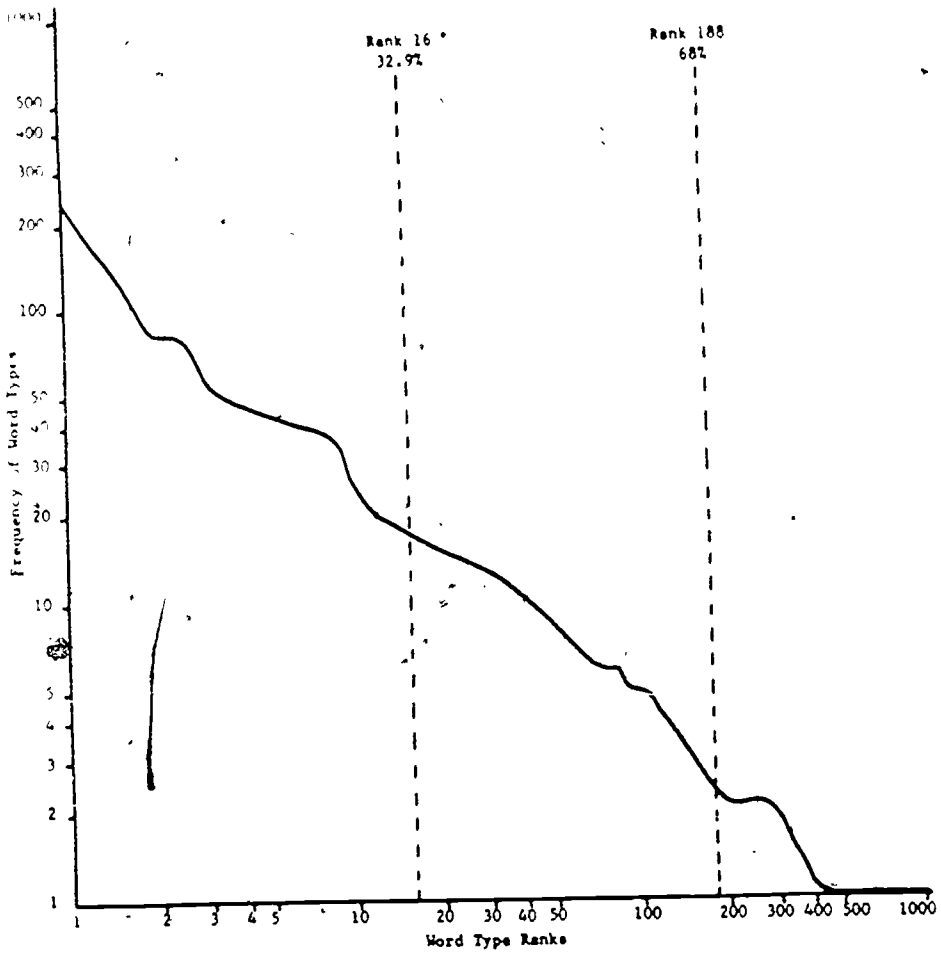


Figure 14.1. Frequency curve of the words from San Francisco.

TABLE 14.1

Classification of Frequency Category by Frequency Range

(San Francisco)

Frequency Category	Rank	Frequency Range	# of Tokens	% of Corpus
High	1-20	233-16	891	32.9
Medium	21-188	17-3	952	35.3
Low	189-905	2-1	860	31.8

The generation of the telegraphic materials was performed by a computer program designed to delete specified percentages of tokens within one of the three frequency levels. In the preliminary stages, the design specified percentages of each type to be deleted within one of the three frequency levels. However, because there were words in the low frequency category with a frequency of one or two, the program was altered to randomly delete specified percentages from the entire frequency category of tokens, with each token having an equal chance of being deleted. This change in the computer program did not appreciably affect the type of telegraphic materials produced from the high frequency category; however, it allowed for any specified percentage to be deleted from the low frequency category.

Deletion levels of 10, 30, and 50% were selected for each of the three frequency levels. The traditional version and each reduced version of the passage was printed double spaced on 8-1/2 x 11 inch paper. The original sentence and paragraph formats were maintained in the reduced versions of the passage. A 60-item multiple choice test and 20-item set relation test were used to measure comprehension. A test only treatment condition was also added to the study. Thus, there were 11 treatment conditions: the traditional passage, nine reduced versions, and the test only condition.

This study was also concerned with developing a deletion scheme based on grammatical categories. "Mambo and Yam" was chosen as the traditional passage for this activity. Eight additional versions of this passage were generated by a computer program designed to randomly delete selected percentages of words from specified grammatical categories. The main processing program was written in the COBOL programming language because of the relative ease with which it handles alphabetical data. Subprograms which generated the random numbers for the deletions were written in FORTRAN. Each word in the traditional passage was first

assigned to one of each parts of speech and grouped into four categories for use in the experiment: nouns and pronouns, verbs, adjectives and adverbs, and articles and conjunctions. In a similar study by Martin and Chitwood (1972), deletion of prepositions had no effect upon comprehension. Therefore, this category was omitted from the study in order to conserve the limited number of subjects available for the remaining treatments. Deletion levels of 20 and 80% were selected for reducing each of the four categories. Only one category of words was deleted at a specified level of reduction so that there were four versions of the passage at each deletion level.

The number of words in each grammatical category in the traditional passage were: 395 nouns, 111 pronouns, 291 verbs, 289 adjectives, 84 adverbs, 135 articles, and 110 conjunctions. The percentage of each grammatical category to the total number of words in the passage is as follows: 25% nouns, 7% pronouns, 18% verbs, 18% adjectives, 5% adverbs, 8% articles, and 7% conjunctions. Table 14.2 presents the percentage of words omitted from the traditional passage for each of the reduced treatment versions.

TABLE 14.2

Percentage of Words Omitted from the Traditional Passage for Each of the Reduced Treatment Versions

(Mambo and Yam)

Grammatical Category	Percent Deletion 20%	80%
Nouns & Pronouns	6%	25%
Verbs	3%	14%
Adjectives & Adverbs	4%	18%
Articles & Conjunctions	3%	12%

Each of the eight reduced versions and the traditional version were printed double spaced on 8-1/2 x 11 inch paper. The original sentence and paragraph formats were maintained in the reduced versions of the passage. A 20-item set relation test and 40-item multiple choice test developed in the Martin and Alonso (1967) study were used in the present study. The grammatical deletion phase of this experiment involved the administration of the 40-item multiple choice test two days prior to the administration of the treatment passages. This was done so that pre-test comprehension measures could be used as a covariate in the final analyses. Each subject was administered this test in one of his regular classes.

Procedure

The procedure for administering the treatment packages to the subjects was the same for both experiments. All the materials were assembled into individual packets. Each packet contained: one version of the passage, a time recording form, an IBM answer sheet, a multiple choice test, and a set relation test. The materials for the test only condition consisted of: an IBM answer sheet, a multiple choice test, and a set relation test. The test was conducted on the campus of the Texas School for the Deaf in one of their classroom auditoriums. Testing was divided into nine sessions with each session containing 20 to 30 subjects. Instructions were given orally to an interpreter while she translated the instructions to the subjects. Tests were distributed randomly to subjects. Subjects were instructed to begin at the same time. When each subject finished reading the passage, the elapsed reading time was recorded on the time recording form. Each subject then responded to the two comprehension tests.

Design

The frequency study was analyzed apart from the grammatical study. Analysis of variance and analysis of covariance were used to evaluate the results of the comprehension multiple choice and set relation tests, reading rate, reading time, and the efficiency measure.

Among the independent variables (Percent Deletion and Level of Frequency) in the word frequency study, a 3 x 3 ANOVA was performed. A 1 x 10 ANOVA was also used to assess the comparison between the reduced versions and the traditional passage.

Analysis of covariance was performed in order to control for IQ, reading comprehension, hearing loss, and pre-test comprehension. Passages developed by the word frequency reduction method were examined in 3 x 3, 1 x 10, and 1 x 11 ANOCOV designs. The Scheffé test of multiple comparisons was performed when differences among effects were significant.

Again, analysis of variance and analysis of covariance was performed on the data from the grammatical reduction study. A 2 x 4 ANOVA design (Percent Deletion x Grammatical Category) and a 1 x 9 ANOVA design were used. Adjustments of the means were made for subject IQ, reading comprehension, hearing loss, and pre-test comprehension data and analyzed in the 2 x 4 and 1 x 9 ANOCOV designs.

Results and Discussion

Grammatical Deletion Data

The grammatical deletion data were examined in a 2 x 4 ANOVA design. Differences between treatment means for the Deletion Level main effect on the multiple choice test were not significant. However, for the Grammatical Category main effect, differences between the noun/pronoun and article/conjunction categories approached significance at the .05 level (F (3,173) = 2.47, $p < .06$). Means and standard deviations for the number of correct responses on the multiple choice test are presented in Table 14.3. Among the treatments on the set relation test, grammatical category was significant (F (3,166) = 2.72, $p < .05$). The reduction of verbs from the passages resulted in the lowest performance on the set relation test, whereas the reduction of articles and conjunctions had the least effect upon comprehension. Means and standard deviations on the number of correct responses on the set relation test are reported in Table 14.4.

The efficiency measure is based upon the total number of correct responses on the multiple choice and set relation tests times 100 and divided by the reading time devoted to the passage. The larger the resulting value is, the greater is the degree of efficiency. Differences on the efficiency measure yielded no significant differences among treatment effects. Means and standard deviations are reported in Table 14.8.

Again, the Grammatical Category main effect was significant for reading time (F (3,166) = 3.83, $p < .01$). Less time was required to read the passages reduced of the noun/pronoun or verb categories than the passages reduced of articles and conjunctions. Analyses for the reading rate variable produced no significant differences. Means and standard deviations are presented in Tables 14.6 and 14.7 for reading time and reading rate, respectively.

Results of the 1 x 9 ANOVAs yielded no significant differences on any of the dependent variables except reading time (F (8,188) = 2.36, $p < .02$). The passages in which 80% of the nouns and pronouns were deleted required the least amount of reading time.

The effect of adjusting for pre-test information, IQ, reading comprehension, and hearing loss in the analyses of covariance generally did not change the results obtained in the analyses of variance.

Differences among treatment conditions in the grammatical reduction study were examined in the 2 x 4 and 1 x 9 ANOCOV on each dependent variable.

Comprehension. Multiple choice scores, set relation scores, and total comprehension were analyzed for differences among treatment

effects. None of the comprehension measures yielded significant differences. Means, adjusted means, and standard deviations are presented for the multiple choice scores, set relation scores, and total comprehension scores in Table 14.3, 14.4, and 14.5, respectively, for each treatment condition.

Reading time. The obtained means of reading time were adjusted for the variables of reading comprehension, IQ, and hearing loss. Means, adjusted means, and standard deviations are reported in Table 14.6. The adjustment was significant only for the variable of hearing loss. In the 2 x 4 ANOCOV, deletion level had no effect on reading time, but grammatical category yielded significant differences among conditions (F (3,153) = 4.02, $p < .01$). A significant difference among treatment conditions on the 1 x 9 ANOCOV was also found (F (8,175) = 2.46, $p < .02$). Inspection of Table 14.6 reveals that considerably less time was taken to read the passages in which 80% of the nouns/pronouns and verbs were omitted in comparison to the passages in which articles/conjunctions were omitted.

Reading rate. Reading comprehension, IQ, and hearing loss had little effect upon the adjustment of means for reading rate. Neither the 2 x 4 nor 1 x 9 ANOCOVs yielded significant differences among treatment conditions. Means, adjusted means, and standard deviations on reading rate for each condition are presented in Table 14.7.

Presentation efficiency. The reading efficiency measure was obtained for each subject by summing the total number of correct responses on the two comprehension tests (C) and multiplying by 100 and then dividing by reading time (Efficiency = $\frac{C \times 100}{\text{Reading time}}$). This measure provides an index of the amount of comprehended information per unit of time. The obtained means of presentation efficiency were adjusted for reading comprehension, IQ, and hearing loss, but no significant differences resulted in the 2 x 4 or 1 x 9 ANOCOVs. IQ had a significant effect upon the adjustment of the efficiency means. Means, adjusted means, and standard deviations for each treatment condition are reported in Table 14.8.

Word Frequency Deletion Data

The passages developed by reduction of word frequency categories were examined in the 3 x 3 and 1 x 10 ANOVA designs. Across all dependent variables, no significant differences were found among treatment effects.

Mean scores obtained on the word frequency passages were adjusted for pre-test data, subject IQ, reading comprehension, and hearing loss in the 3 x 3, 1 x 10, and 1 x 11 ANOCOV design. The results of the analyses of covariance were insignificant. Across the effects of frequency class and deletion level, no significant differences were found with respect to multiple choice comprehension, set relation comprehension, total comprehension,

TABLE 14.3

Means, Adjusted Means, and Standard Deviations of the Number of Correct Responses on the Multiple Choice Test for Each of the Nine Treatment Conditions

(Mambo and Yam)

Category	Mean	Adjusted* Mean	S.D.
Noun/Pronoun			
20%	14.48	15.17	5.10
80%	12.39	13.04	3.80
Verb			
20%	14.57	14.31	5.64
80%	13.55	14.02	3.05
Adjective/Adverb			
20%	13.52	13.76	4.92
80%	13.35	14.65	4.26
Article/Conjunction			
20%	15.86	14.62	6.84
80%	16.23	15.20	6.64
Traditional	13.74	14.43	4.95

*Using IQ, reading comprehension scores, hearing loss, and pre-multiple choice test scores as covariates.

TABLE 14.4

Means, Adjusted Means, and Standard Deviations of the Number of Correct Responses on the Set Relation Test for Each of the Nine Treatment Conditions

(Mambo and Yam)

Category	Mean	Adjusted* Mean	S.D.
Noun/Pronoun			
20%	10.17	10.45	2.79
80%	10.35	10.42	3.16
Verb			
20%	9.67	9.73	3.10
80%	9.36	9.21	2.70
Adjective/Adverb			
20%	10.14	10.12	3.07
80%	9.10	9.24	3.14
Article/Conjunction			
20%	11.05	10.77	2.57
80%	11.14	10.70	2.61
Traditional	8.78	9.02	2.21

*Using IQ, reading comprehension scores, hearing loss, and pre-set relation test scores as covariates.

TABLE 14.5

Means, Adjusted Means, and Standard Deviations of the Number of Correct Responses on the Total Comprehension Scores for Each of the Nine Treatment Conditions

(Mambo and Yam)

Category	Mean	Adjusted* Mean	S.D.
Noun/Pronoun			
20%	24.65	25.80	6.26
80%	22.74	23.36	5.37
Verb			
20%	24.24	24.22	7.16
80%	22.91	23.18	4.17
Adjective/Adverb			
20%	23.19	23.83	7.32
80%	22.95	24.24	5.78
Article/Conjunction			
20%	26.91	25.35	8.44
80%	27.36	25.89	8.43
Traditional	22.96	24.01	7.73

*Using IQ, reading comprehension scores, hearing loss, and pre-total comprehension test scores as covariates.

TABLE 14.6

Means, Adjusted Means, and Standard Deviations of Reading Times for Each of the Nine Treatment Conditions

(Mambo and Yam)

Category	Mean	Adjusted* Mean	S.D.
Noun/Pronoun			
20%	9.22	9.02	2.89
80%	7.13	6.71	2.74
Verb			
20%	7.86	7.74	2.69
80%	8.27	8.01	2.31
Adjective/Adverb			
20%	8.86	8.75	2.80
80%	7.80	7.93	3.00
Article/Conjunction			
20%	10.18	10.01	4.18
80%	10.09	9.95	4.90
Traditional	8.00	7.90	2.81

*Using IQ, reading comprehension scores, and hearing loss as covariates.

TABLE 14.7

Means, Adjusted Means, and Standard Deviations of Reading Rates for Each of the Nine Treatment Conditions

(Mambo and Yam)

Category	Mean	Adjusted* Mean	S.D.
Noun/Pronoun			
20%	179.85	180.34	62.74
80%	187.79	194.72	57.59
Verb			
20%	222.09	229.88	89.63
80%	177.95	181.00	50.69
Adjective/Adverb			
20%	194.86	198.80	87.29
80%	189.78	186.86	66.75
Article/Conjunction			
20%	170.97	171.35	52.71
80%	171.20	175.22	86.60
Traditional	223.57	224.57	75.29

*Using IQ, reading comprehension scores, and hearing loss as covariates.

TABLE 14.8

Means, Adjusted Means, and Standard Deviations of Efficiency for Each of the Nine Treatment Conditions

(Mambo and Yam)

Category	Mean	Adjusted* Mean	S.D.
Noun/Pronoun			
20%	286.17	293.81	87.93
80%	351.46	372.46	131.26
Verb			
20%	353.05	360.77	176.47
80%	294.79	304.39	84.99
Adjective/Adverb			
20%	299.19	313.80	163.24
80%	326.68	341.04	121.31
Article/Conjunction			
20%	291.87	277.37	116.83
80%	341.20	333.29	204.45
Traditional	309.82	325.07	111.76

*Using IQ, reading comprehension scores, and hearing loss as covariates.

reading time, reading rate, or presentation efficiency. In addition, no differences were found between the traditional, test only, and reduced treatment passages.

Means, adjusted means, and standard deviations reported by each treatment condition for the dependent variables: multiple choice scores, set relation scores, total comprehension scores, reading time, reading rate, and presentation efficiency are presented in Tables 14.9, 14.10, 14.11, 14.12, 14.13, and respectively.

Reading comprehension and IQ were consistently significant as predictors of all dependent variables except the set relation test score and reading rate. Additionally, pre-multiple choice test data predicted the multiple choice score in the 1 x 10 and 1 x 11 ANOCOVs. Hearing loss had no effect on the mean adjustment of any dependent variable.

Conclusions

Deletion of words by grammatical category tended to have relatively little effect. None of the analyses in the grammatical deletion study showed deletion level to be a significant main effect. Differences between 20 and 80% deletions among the four grammatical categories were not sufficient to produce any detectable effects. When 20% of the noun/pronoun category was deleted, this resulted in a 6% reduction in the total number of words omitted in comparison to the traditional passage. The 80% reduction of the noun/pronoun category resulted in a 25% reduction compared to the traditional passage. This category produced the greatest difference in total number of words omitted at the 20 and 80% levels. Because of the greater number of words omitted in the noun/pronoun and verb categories, reading time was less. However, there were no differences in either the reading rate or the efficiency measures. Consideration of the various covariates used in this experiment had little effect upon the overall results.

Most surprising was the fact of no significant differences anywhere in the frequency study. Deletion levels of 10, 30, and 50% in each of the low, medium, and high frequency categories produced no significant effects. These results are contrary to results obtained by Martin (1974) on normal hearing samples in which comprehension decreased with increasing levels of deletion in the medium and low word frequency categories but not the high frequency categories. Judging from the results obtained on the comprehension tests, the reading passages were too difficult for the deaf students used in these two experiments. Before definitive statements can be made with respect to the variables under study in these two experiments, replication of the studies should be undertaken with easier reading materials. There is some indication that readability of telegraphic materials is less than traditional materials. Martin (1974) has shown that 50% reduced versions were

TABLE 14.9

Means, Adjusted Means, and Standard Deviations of the Number of Correct Responses on the Multiple Choice Test for Each of the Ten Treatment Conditions

(San Francisco)

Category	Mean	Adjusted* Mean	S.D.
High Frequency			
10%	14.05	14.68	5.30
30%	14.67	15.64	5.24
50%	15.82	15.35	6.66
Medium Frequency			
10%	15.24	14.66	6.16
30%	14.83	14.52	6.43
50%	13.13	14.96	3.58
Low Frequency			
10%	12.73	14.14	5.22
30%	13.56	13.66	4.45
50%	15.71	14.58	5.78
Traditional	14.06	13.64	4.26

*Using IQ, reading comprehension scores, hearing loss, and pre-multiple choice test scores as covariates.

TABLE 14.10

Means, Adjusted Means, and Standard Deviations of the Number of Correct Responses on the Set Relation Test for Each of the Ten Treatment Conditions

(San Francisco)

Category	Mean	Adjusted* Mean	S.D.
High Frequency			
10%	9.33	9.36	2.96
30%	10.39	10.57	2.83
50%	10.41	10.06	3.34
Medium Frequency			
10%	10.53	10.55	2.92
30%	9.56	9.37	2.96
50%	9.40	9.71	2.35
Low Frequency			
10%	9.33	10.60	2.60
30%	9.72	9.71	3.16
50%	11.07	10.55	2.62
Traditional	10.72	10.57	2.32

*Using IQ, reading comprehension scores, hearing loss, and pre-set relation test scores as covariates.

TABLE 14.11

Means, Adjusted Means, and Standard Deviations of the Total Comprehension Scores for Each of the Ten Treatment Conditions

(San Francisco)

Category	Mean	Adjusted* Mean	S.D.
High Frequency			
10%	23.38	24.19	7.32
30%	24.50	26.41	7.59
50%	26.82	26.04	8.83
Medium Frequency			
10%	25.76	25.28	6.99
30%	24.39	23.71	8.40
50%	22.53	24.50	4.41
Low Frequency			
10%	12.73	25.64	5.22
30%	23.28	23.17	6.42
50%	26.79	25.01	7.32
Traditional	24.78	24.26	5.17

*Using IQ, reading comprehension scores, hearing loss, and pre-total comprehension scores as covariates.

TABLE 14.12

Means, Adjusted Means, and Standard Deviations of Reading Time for Each of the Ten Treatment Conditions

(San Francisco)

Category	Mean	Adjusted* Mean	S.D.
High Frequency			
10%	7.95	7.85	2.82
30%	9.39	8.57	5.28
50%	8.12	8.46	2.00
Medium Frequency			
10%	7.71	7.07	3.26
30%	8.89	9.15	3.46
50%	9.27	9.09	4.51
Low Frequency			
10%	7.87	7.38	3.07
30%	8.72	9.12	2.40
50%	10.07	9.69	3.00
Traditional	9.00	9.12	2.91

*Using IQ, reading comprehension scores, and hearing loss as covariates.

TABLE 14.13

Means, Adjusted Means, and Standard Deviations of Reading Rates for Each of the Ten Treatment Conditions

(San Francisco)

Category	Mean	Adjusted* Mean	S.D.
High Frequency			
10%	369.82	378.88	129.99
30%	325.79	341.13	162.43
50%	292.75	284.72	70.49
Medium Frequency			
10%	391.06	412.14	143.36
30%	302.89	295.85	94.85
50%	283.51	285.24	108.19
Low Frequency			
10%	390.26	393.01	178.38
30%	301.91	289.98	89.95
50%	242.74	254.13	64.75
Traditional	327.66	327.24	95.38

*Using IQ, reading comprehension scores, and hearing loss as covariates.

TABLE 14.14

Means, Adjusted Means, and Standard Deviations of Efficiency for Each of the Ten Treatment Conditions

(San Francisco)

Category	Mean	Adjusted* Mean	S.D.
High Frequency			
10%	320.62	339.43	122.05
30%	331.48	366.39	194.01
50%	348.52	336.35	138.87
Medium Frequency			
10%	380.18	392.40	143.50
30%	282.28	271.46	56.57
50%	294.24	318.27	141.47
Low Frequency			
10%	347.42	375.73	202.12
30%	282.55	266.66	98.79
50%	291.50	286.50	122.37
Traditional	302.01	296.30	113.36

*Using IQ, reading comprehension scores, and hearing loss as covariates.

significantly more difficult to read than were traditional or 10% versions. However, 30% versions did not differ significantly from either the traditional or the 10% versions. Since none of the passages used in these two experiments exceeded the 30% reduction level, it is not clear whether or not the telegraphic passages were more difficult to read than the traditional passages. It may be that deaf and hard-of-hearing students are more sensitive to differences in readability levels than are hearing students.

In conclusion, the results show that elimination of nouns/pronouns and verbs does adversely affect comprehension of telegraphic materials among deaf and hard-of-hearing students. The elimination of adverbs/adjectives and articles/conjunctions had no affect upon reading performance. The deaf and hard-of-hearing students used in this experiment were not sensitive to changes in telegraphic passages based upon a word frequency reduction scheme.

CHAPTER XV

EXPERIMENT XIII -- COMPARISON OF TWO DELETION SCHEMES ON THREE TYPES OF PROSE AMONG BLIND AND DEAF STUDENTS

Introduction

Three reduction methods designed to delete redundant words have been developed in an effort to improve the efficiency of reading written materials among normal and handicapped populations (Martin, 1974; Martin & Chitwood, 1972; Martin & Pantalion, 1973).

The purpose of this study was to compare two of the reduction methods applied to fiction, science, and news passages on the reading performance of handicapped children. A subjective reduction method developed by Martin and Pantalion and a word frequency reduction method were used in the study at two levels of reduction, 20 and 40%.

Redundancy is formally measured by the information theorists as the predictability or dependency one unit has on another (Pollio, 1974). Various amounts of redundancy have been found to exist in written prose when measures of word predictability have been used (Aborn, Rubenstein, & Sterling, 1959; McLeod & Anderson, 1970; Morrison & Black, 1957; Taylor, 1954). Among the redundant words in the language, certain types of words, identified by their grammatical use and frequency of occurrence, are more predictable. Briefly, it is the structural words in the language, which also occur more frequently in written prose, that are most predictable (Herdan, 1966; Weaver, 1965).

Thus, an attempt was made in this study to compare two methods of identifying and reducing redundant words in the language. A subjective reduction method based upon subjects' opinion of the least important words, and a word frequency reduction method based upon the reduction of high frequently occurring words in selected experimental passages were utilized in this study on blind and deaf children.

A comparative study of three reduction methods was conducted by Bassin (1974) on normal college subjects and the effects of the reduction methods were assessed for each of three types of literature: science, fiction, and news passages. The subjective and word frequency methods were used as well as a grammatical reduction method developed by Martin and Chitwood. The reduction methods were employed at 10, 30, and 50% levels of reduction.

Bassin found a significant difference among the reduction methods on the variables of multiple choice comprehension and presentation efficiency in the science and news passage designs. The subjective method was superior to the grammatical and frequency methods, and although no interaction was found, the subjective

method had the least detrimental effect upon comprehension at the 50% level. Among the reduction levels, significant differences were generally found favoring the traditional and 10% versions in comparison to the 50% versions. Generally, the 30% version did not differ from either the 10 or 50% versions. Thus, among normal college subjects the subjective method of reduction was most efficient and had the least effect upon comprehension. The variables of reading time and reading rate were influenced by levels of reduction. Reading time decreased significantly at the 50% level, whereas reading rate decreased significantly at both the 30 and 50% levels.

It was apparent from the findings of the Bassin study that the reduction levels at 10, 30, and 50% were sufficiently broad to distinguish gross differences among reduction methods. In this study the 30% reduction level appeared to be near the critical level above which reading performance was impaired and below which little effect was noted. Because of the Bassin results, the 20 and 40% reduction levels were selected in order to more closely identify the critical reduction point.

No differences had been found in the Bassin study between the frequency and grammatical reduction methods. Thus, in the present study, the grammatical reduction procedure was eliminated in order that the number of available subjects for each condition could be maximized by reducing the number of treatment conditions. The frequency method is entirely computer based and provides an objective approach for comparison with the subjective procedure.

Method

Subjects

The blind subjects were eight to twelfth graders at the Texas School for the Blind in Austin, Texas. A total of 35 subjects, who volunteered to participate in the study, were matched in five treatment groups of six to seven subjects based upon IQ, reading achievement, and grade level. Table 15.1 presents the means for the matching variables.

TABLE 15.1

Means for the Five Groups of Blind Subjects Matched on the Bases of IQ, Reading Achievement and Grade Level

Variables	Group 1	Group 2	Group 3	Group 4	Group 5
IQ	105.87	102.00	102.37	107.16	105.25
Reading Achievement	9.12	8.75	8.59	9.48	8.42
Grade Level	9.00	9.57	9.85	10.57	9.12

The deaf subjects were eight to twelfth graders at the Texas School for the Deaf in Austin, Texas. From the total 195 subjects, 37 to 40 subjects were randomly assigned to each of five treatment conditions. Information on the subjects concerning IQ and reading achievement were obtained for inclusion in an analysis of covariance design. Analysis of these data are included in the results section.

Materials

The materials selected for use in this experiment consisted of three traditional reading passages and represented three types of literature: scientific, fiction, and news. These passages were selected from an original group of six traditional passages on the basis of the results from pilot testing and item analysis on six groups of normal subjects. Each of these passages was selected to meet four criteria. First, each traditional passage was to contain from 500 to 700 words. Second, each traditional passage was to be representative of its respective type of literature. Third, each traditional passage was to contain enough factual information to permit the construction of a multiple choice test. Fourth, each traditional passage was to have a sixth or seventh grade readability level.

From the review of literature, it was discovered that the Reader's Digest Reading Skill Builders contained stories which would meet the four criteria for the scientific and fiction passages to be used in this experiment. One of the fiction passages selected was "My Uncle John's Place," Reader's Digest Reading Skill Builder, 1959, 94-96. This is the story of a young man's memories of the sights, smells, and activities on his uncle's farm when he visited it as a child. The second fiction story was "Grandfather's Store," Reader's Digest Reading Skill Builder, 1959, 129-131. In this story, a grandson tells how his grandfather's small country store was the hub of the community, the events that took place there, and the importance of the grandfather to the townsfolk.

The scientific passages were also taken from the Reader's Digest Reading Skill Builder, 1959, 5-7 and 104-106, respectively. The first story, "Blue River in the Sea," describes the history, movement, and effects of the Gulf Stream. The second story, "Hoofs on the Prairie," told the history of the Arabian Horse, its migration to the United States, its use among the Indians and settlers, and its evolvement to its present state. Permission to reprint and use these articles for experimental purposes was granted by Reader's Digest Inc.

Since the search for a news story which met the four criteria used in the experiment was unsuccessful, this type of passage was written for the specific requirements of this experiment. Each of the passages concerned an actual news event. One of the news passages, "Action at the White House," relates the story of a frustrated young soldier who stole a helicopter and flew all around the White House in an attempt to prove he could be a pilot. The second news

passage, "It's No Joke," is the story of the toilet paper shortage. It concerns the origin of the shortage story and the near panic it caused among shoppers across the nation.

The Flesch (1949) readability measure was used to determine the reading difficulty level for each traditional passage. Flesch readability scores for the fiction and scientific passages ranged from 80 to 85, indicating these were easy stories to read and met the criteria that they be suitable for sixth or seventh grade reading levels. On the news stories, the Flesch readability scores ranged from 70 to 75, indicating that the news stories were fairly easy reading and were at the sixth or seventh grade reading levels. Table 15.2 presents the readability scores and word lengths of the six passages.

TABLE 15.2

Flesch Readability Scores and Total Word Length of Each Passage

Passage	Total Words	Difficulty Level
My Uncle John's Place	742	85 (easy) (6th grade)
Grandfather's Store	660	80 (fairly easy) (7th grade)
Blue River in the Sea	614	85 (easy) (6th grade)
Hoofs on the Prairie	567	85 (easy (6th grade)
It's No Joke	528	77 (fairly easy) (7th grade)
Action at the White House	500	75 (fairly easy) (7th grade)

The traditional passages were reduced by 20 and 40% levels by two reduction methods. The frequency method of word reduction was first developed by Martin (1974). Using this method, the frequency which words occurred in a passage was calculated, and based on this, a specified percentage of high frequently occurring words within the passage were omitted. The computer program written in Fortran IVG computer language for the Martin experiment provided for the production of several printouts. For each traditional passage, a word list was produced of the word types (each different word in the passage), the token count (the number of times each word appears in the passage), and a cumulative frequency of the types starting with the most frequently occurring type in the passage. From the list of high frequently occurring words, 20 and 40% of the words in the traditional passages were identified. A computer program was developed to delete the words identified and to print reduced passages which subsequently contained 20 and 40% fewer words than the original. In cases where only a percentage of the token of a specific word type was to be omitted, the program was designed to delete these words randomly. All other

identified words were deleted 100%. The reduced passages generated by the computer were then typed in sentence format for duplication.

The second reduction method applied to the traditional passages was the subjective method developed by Martin and Pantalion (1973). This method involves the rank ordering of each word in the sentence from least important to the most important in terms of each word's contribution to the essential meaning of the sentence. Past studies have involved a number of subjects rank ordering the words within the sentences of a traditional passage. Results from these studies have shown a high degree of interjudge reliability in the subjective ranking. Therefore, it was decided to employ three project personnel for the ranking phase in the generation of the telegraphic materials.

An IBM 360/65 computer analyzed the rank lists constructed by the project personnel on the words in each sentence of the passages. The computer program was written in WATFIV Fortran language. The computer program printed the Kendall Coefficient of Concordance (W) (Ostle, 1963) for each sentence and printed each sentence at 20 and 40% levels of reduction. The sentences were then typed in paragraph form and punctuation was added by the experimenter.

Each of the six traditional passages was pilot tested in six self-contained sixth grade classes in a public school. The subjects were all in regular classes with each class ranging from 18 to 23 students. Each student read one experimental passage and then responded to a multiple choice comprehension test.

The Kuder-Richardson #20 formula was used to evaluate the test-retest reliability. On the basis of the KR-20 results, the following three passages were selected for use in this experiment: Scientific, "Blue River in the Sea" (KR-20 = .80); News, "Action at the White House" (KR-20 = .71); and Fiction, "Uncle John's Place" (KR-20 = .41).

Procedure

The same procedure for administering the materials was followed by each subject population with slight alterations in accordance with the special necessities of presenting educational materials to the handicapped. Each group received a version of a story, a time recording form, a multiple choice test, and a sheet on which to record test answers. The deaf subjects received their instructions in sign language and were requested to read the story, record their reading time immediately upon completion of their story, and proceed with the test questions. The blind subjects received oral instructions and their reading time was recorded for them immediately upon completion of the story. The passages for the blind were presented in Grade I Braille and braillewriters were provided for recording answers to the multiple choice tests.

The materials for each story were presented in three consecutive sessions one week apart for the 35 blind subjects and three consecutive days for the 195 deaf subjects.

Design and Analyses

The analyses of this study involved three sets of data obtained for each of the three types of stories. No direct statistical comparisons were made among story types because of the differences in reading difficulty.

Measurements of reading performance for the blind and deaf subject populations were obtained independently and analyzed in separate designs. Measures were obtained from each population on the multiple-choice tests; reading time, stated in number of minutes required to read the assigned passage; reading rate, which was computed as the number of words read per minute; and efficiency, defined as comprehension divided by reading time and multiplied by 100.

Blind. The 2 x 2 and 1 x 5 ANOVA designs were performed on each set of data obtained from the responses of the blind subjects on multiple choice comprehension, reading time, reading rate, and efficiency. The main effects of the 2 x 2 ANOVA included a comparison of the reduction methods, frequency and subjective, and deletion levels, 20 and 40%. The Scheffé test of multiple comparisons was utilized to locate the differences among treatment means when indicated by the significant F value.

Deaf. Separate 2 x 2 and 1 x 5 ANOCOV (analysis of covariance) designs were performed on the four dependent variables. The covariates were IQ and reading achievement. Scheffé analyses were performed where appropriate.

Results

Blind Data

Science. A 2 x 2 and 1 x 5 ANOVA was performed on the passages developed from the science article. Means and standard deviations of the treatment conditions for each dependent variable are presented in Table 15.3. No significant differences were found among the science conditions on any of the four dependent variables of reading performance. The precise F values and corresponding probabilities of the ANOVAs are reported in Table 15.4.

News. The treatment passages of the news article were compared in a 2 x 2 and a 1 x 5 ANOVA design. On the variables of comprehension, reading time, and efficiency, no differences were found among the passage conditions, but a significant difference was found among deletion levels in the 2 x 2 ANOVA for reading rate (F (1,21) = 8.84, $p < .01$). Results of the ANOVAs on all dependent variables are reported in Table 15.5. Means and standard deviations of all performance measures for the news passages are found in Table 15.6.

TABLE 15.3

Means and Standard Deviations for the Four Reading Performance Measures on the Science Passage (Blind Subjects)

Dependent Variables	Treatment Conditions				
		Subjective		Frequency	
	Trad	20%	40%	20%	40%
Multiple Choice					
Mean	15.00	14.62	13.17	15.29	13.29
S.D.	6.68	4.37	5.27	5.15	5.44
N =	8	8	6	7	7
Reading Time					
Mean	11.72	9.91	7.79	10.75	10.35
S.D.	4.40	2.22	1.49	4.24	3.51
N =	8	8	6	7	7
Reading Rate					
Mean	59.78	51.75	49.18	53.49	40.75
S.D.	23.34	11.00	9.43	21.18	16.80
N =	8	8	6	7	7
Efficiency					
Mean	154.78	152.63	177.02	171.56	142.41
S.D.	101.11	47.40	77.20	105.83	70.87
N =	8	8	6	7	7

TABLE 15.4

Results of the 2 x 2 and 1 x 5 ANOVAs
on the Science Passage (Blind Subjects)

Dependent Variables	Analysis of Variance	
	2 x 2	1 x 5
Multiple Choice	Deletion Method (M) (F = .04, df = 1,24, p = .83) Deletion Level (L) (F = .82, df = 1,24, p = .39) M x L (F = .02, df = 1,24, p = .88)	F = .23, df = 4,31, p = .92
Reading Time	Deletion Method (M) (F = 2.12, df = 1,24, p = .15) Deletion Level (L) (F = 1.15, df = 1,24, p = .29) M x L (F = .54, df = 1,24, p = .48)	F = 1.29, df = 4,31, p = .30
Reading Rate	Deletion Method (M) (F = .33, df = 1,24, p = .58) Deletion Level (L) (F = 1.72, df = 1,24, p = .20) M x L (F = .76, df = 1,24, p = .40)	F = 1.12, df = 4,31, p = .37
Efficiency	Deletion Method (M) (F = .07, df = 1,24, p = .79) Deletion Level (L) (F = .01, df = 1,24, p = .37) M x L (F = .83, df = 1,24, p = .37)	F = .21, df = 4,31, p = .93

TABLE 15.5

Results of the 2 x 2 and 1 x 5 ANOVAs on the News Passage (Blind Subjects)

Dependent Variables	Analysis of Variance	
	2 x 2	1 x 5
Multiple Choice	Deletion Method (M) (F = 1.67, df = 1,21, p = .21 Deletion Level (L) (F = 1.46, df = 1,21, p = .24) M x L (F = .01, df = 1,21, p = .90)	F = 1.19, df = 4,27, p = .34
Reading Time	Deletion Method (M) (F = .31, df = 1,21, p = .59) Deletion Level (L) (F = .01, df = 1,21, p = .94) M x L (F = .11, df = 1,21, p = .74)	F = 1.51, df = 4,27, p = .23
Reading Rate	Deletion Method (M) (F = 1.50, df = 1,21, p = .23) Deletion Level (L) (F = 8.84, df = 1,21, p = .01) M x L (F = .47, df = 1,21, p = .50)	F = 2.04, df = 4,27, p = .12
Efficiency	Deletion Method (M) (F = 3.43, df = 1,21, p = .08) Deletion Level (L) (F = .84, df = 1,21, p = .37) M x L (F = .25, df = 1,21, p = .62)	F = 1.26, df = 4,27, p = .31

TABLE 15.6

Means and Standard Deviations for the Four Reading Performance Measures on the News Passage (Blind Subjects)

Dependent Variables	Treatment Conditions				
		Subjective		Frequency	
	Trad	20%	40%	20%	40%
Multiple Choice					
Mean	20.57	21.17	18.50	18.33	16.14
S.D.	2.94	4.62	4.59	4.80	5.76
N =	7	6	6	6	7
Reading Time					
Mean	10.61	7.54	7.75	8.25	7.93
S.D.	3.99	2.82	2.29	1.16	1.34
N =	7	6	6	6	7
Reading Rate					
Mean	58.25	59.97	42.63	50.92	40.10
S.D.	20.70	18.17	12.09	8.14	6.04
N =	7	6	6	6	7
Efficiency					
Mean	225.30	320.05	265.63	229.67	213.96
S.D.	101.48	122.15	102.11	62.26	87.60
N =	7	6	6	6	7

Fiction. Analysis of the variables of reading performance for the fiction passages yielded greater differences among means than was found for the news and science passages. Means and standard deviations for all dependent variables are presented in Table 15.7. The F values and corresponding probabilities for all ANOVAs performed on the fiction passage means are found in Table 15.8. No significant differences were found among means on the 2 x 2 and 1 x 5 ANOVAs for multiple choice comprehension. The 2 x 2 ANOVA on reading time was significant between the two reduction methods (F (1,24) = 3.88, $p < .05$). The frequency method required more time than the subjective method.

The results of reading time were reflected in the results on reading rate. Reading rate was significantly slower among subjects who read the frequency reduced passages (F (1,24) = 4.83, $p < .05$). Additionally, reading rate decreased significantly at the 40% level of deletion (F (1,24) = 4.69, $p < .05$). The 1 x 5 ANOVA also demonstrated a significant difference among treatment groups. A Scheffé test was conducted on the 1 x 5 analysis, resulting in a significant decrease for the 40% frequency passage when compared with the traditional or 20% subjective passages (Table 15.9).

The results of the efficiency measure, designed to test the ratio of comprehension and reading time, were not significant. No differences were found among the effects of treatment groups of the 2 x 2 and 1 x 5 ANOVAs performed on this variable.

Deaf Data

Intercorrelation Matrices. Intercorrelation analyses were performed among the reading performance variables and the covariates, IQ and reading achievement. For each type of literature, the reading performance dependent variables were computed for the correlation analysis from all five treatment conditions. The IQ and reading achievement data were obtained from the school records. Intercorrelation matrices were computed for each passage type: science, news, and fiction, and are reported in Tables 15.10, 15.11, and 15.12, respectively.

The results of the intercorrelation analyses of the differing passage types were very similar. IQ had an insignificant effect on reading time, but demonstrated some degree of correlation with presentation efficiency, multiple choice comprehension, and to a lesser extent, reading rate. Reading achievement scores consistently correlated well with presentation efficiency and multiple choice comprehension. With exception of the fiction passages, reading achievement also correlated with reading rate.

The intercorrelations among the variable of reading time and reading rate and efficiency were consistently high for each passage type. The inverse relationship found in the negative correlations between reading time and reading rate and efficiency was expected. Similarly, the high correlation between efficiency and reading rate was also expected since efficiency was measured in terms of reading

TABLE 15.7

Means and Standard Deviations for the Four Reading Performance Measures on the Fiction Passage (Blind Subjects)

Dependent Variables	Treatment Conditions				
		Subjective		Frequency	
	Trad	20%	40%	20%	40%
Multiple Choice					
Mean	16.67	17.83	14.86	15.50	15.71
S.D.	4.72	4.26	5.34	5.63	4.35
N =	6	6	7	8	7
Reading Time					
Mean	9.17	8.50	8.04	10.22	11.14
S.D.	1.27	3.24	2.91	1.47	4.67
N =	6	6	7	8	7
Reading Rate					
Mean	74.54	67.84	54.01	53.83	42.60
S.D.	10.59	17.59	14.71	7.76	19.53
N =	6	6	7	8	7
Efficiency					
Mean	187.16	239.17	206.08	157.10	177.69
S.D.	55.02	94.10	97.06	67.36	119.65
N =	6	6	7	8	7

TABLE 15.8

Results of the 2 x 2 and 1 x 5 ANOVAs
on the Science Passage (Blind Subjects)

Dependent Variables	Analysis of Variance	
	2 x 2	1 x 5
Multiple Choice	Deletion Method (M) (F = .15, df = 1,24, p = .70) Deletion Level (L) (F = .53, df = 1,24, p = .48) M x L (F = .71, df = 1,24, p = .41)	F = .37, df = 4,29, p = .83
Reading Time	Deletion Method (M) (F = 3.88, df = 1,24, p = .05) Deletion Level (L) (F = .04, df = 1,24, p = .85) M x L (F = .32, df = 1,24, p = .58)	F = 1.22 df = 4,29, p = .33
Reading Rate	Deletion Method (M) (F = 4.83, df = 1,24, p .04) Deletion Level (L) (F = 4.69, df = 1,24, p = .04) M x L (F = .05, df = 1,24, p = .82)	F = 5.09, df = 4,29, p = .003
Efficiency	Deletion Method (M) (F = 2.32, df = 1,24, p = .14) Deletion Level (L) (F = .03, df = 1,24, p = .86) M x L (F = .55, df = 1,24, p = .47)	F = .80, df = 4,29, p = .53

TABLE 15.9

Significant Differences Between Treatment Means of Reading Rate for the 1 x 5 ANOVA (Scheffé)* (Blind Subjects)

Treatment Conditions				
T	S20	S40	F20	F40

*Treatment conditions arranged from highest (left) to lowest (right). Treatment conditions underlined by a common line do not differ significantly; treatment conditions not underlined by a common line do differ significantly ($p < .05$).

TABLE 15.10

Intercorrelation Matrix of the Subject Performance Variables From All Five Treatment Conditions of the Science Passage (Deaf Subjects)

Variables	1	2	3	4	5	6
Multiple Choice (1)	1.00	0.02	0.03	0.66	0.08	0.36
Reading Time (2)	0.02	1.00	-0.71	-0.57	0.01	-0.09
Reading Rate (3)	0.03	-0.71	1.00	0.61	0.10	0.20
Efficiency (4)	0.66	-0.57	0.61	1.00	0.12	0.38
IQ (5)	0.08	0.01	0.10	0.12	1.00	0.29
Reading Achievement (6)	0.36	-0.09	0.20	0.38	0.29	1.00

TABLE 15.11

Intercorrelation Matrix of the Subject Performance Variables From All Five Treatment Conditions of the News Passage (Deaf Subjects)

Variables	1	2	3	4	5	6
Multiple Choice (1)	1.00	-0.07	-0.00	0.58	0.11	0.35
Reading Time (2)	-0.07	1.00	-0.68	-0.57	-0.02	-0.18
Reading Rate (3)	-0.00	-0.68	1.00	0.67	0.09	0.19
Efficiency (4)	0.58	-0.57	0.67	1.00	0.15	0.48
IQ (5)	0.11	-0.02	0.09	0.15	1.00	0.28
Reading Achievement (6)	0.35	-0.18	0.19	0.48	0.28	1.00

TABLE 15.12

Intercorrelation Matrix of the Subject Performance Variables From All Five Treatment Conditions of the Fiction Passage (Deaf Subjects)

Variables	1	2	3	4	5	6
Multiple Choice (1)	1.00	0.45	0.01	0.47	0.11	0.31
Reading Time (2)	0.05	1.00	-0.65	-0.61	-0.06	-0.14
Reading Rate (3)	0.01	-0.65	1.00	0.77	0.05	0.07
Efficiency (4)	0.47	-0.61	0.77	1.00	0.11	0.29
IQ (5)	0.11	-0.06	0.05	0.11	1.00	0.30
Reading Achievement (6)	0.31	-0.14	0.07	0.29	0.30	1.00

time. Although the intercorrelations among the reading performance variables were not as important to the subsequent analyses of covariance as were the relationships found for IQ and reading achievement, the degree of interrelationship among these variables substantiates the validity of the performance measures.

It is interesting to note that no correlation was found between multiple choice comprehension and reading rate. If a passage was difficult to comprehend as indicated by the comprehension score, rate of reading was expected to decrease.

Science. The 1 x 5 ANOVA design was performed on IQ and reading achievement in order to determine whether the groups reading the five science treatment passages were equivalent. Means and standard deviations of reading achievement and IQ for subjects assigned the five treatment conditions are reported in Table 15.13. There were no significant differences found among groups on either IQ or reading achievement for the science conditions.

The means of the multiple choice scores were adjusted for IQ and reading achievement and a 2 x 2 and 1 x 5 ANOCOV was performed on the adjusted means presented in Table 15.14. No differences were found among the main effects in the 2 x 2 ANOCOV nor between treatment conditions in the 1 x 5 ANOCOV. The 2 x 2 ANOCOV did yield a significant interaction which is shown in Figure 15.1 (F (1,139) = 6.11, $p < .02$). The type of deletion method was significantly affected by reduction level.

With exception of the deletion level effect, the results of the ANOCOV designs on reading time yielded no significant differences among the treatment groups. The 40% level of deletion required significantly less time to read than the 20% level (F (1,139) = 3.99, $p < .05$). Means and standard deviations for reading time are presented in Table 15.14.

Differences found among means on reading rate were significant for the Deletion Level main effect (F (1,139) = 4.54, $p < .03$). Reading rate was significantly slower at the 40% level. Means and standard deviations of reading rate for subjects assigned the treatment passages are reported in Table 15.14. A significant difference was also found among groups on the 1 x 5 ANOCOV (F (4,174) = 11.71, $p < .001$). Post hoc comparisons between means indicated that the traditional passage was significantly superior to the reduced versions (Table 15.15).

There were no significant differences found among the means on efficiency. Means and standard deviations for the variable of efficiency are found in Table 15.14.

The values from the analyses of variance and covariance performed on the science passages have been summarized in Table 15.16 for all dependent variables.

TABLE 15.13

Means and Standard Deviations of IQ and Reading Achievement for the Treatment Groups Assigned the Five Conditions of the Three Passages (Deaf Subjects)

Variables		Treatment Conditions				
			Subjective		Frequency	
		Trad	20%	40%	20%	40%
Science	IQ					
	Mean	99.56	95.73	97.29	97.26	98.39
	S.D.	19.65	17.56	18.52	14.66	12.40
	N =	36	33	35	38	38
	Reading * Achievement					
	Mean	4.28	4.23	4.19	4.37	4.25
	S.D.	1.83	1.92	1.22	1.32	1.71
	N =	39	35	37	39	38
News	IQ					
	Mean	95.51	101.34	97.32	94.77	99.67
	S.D.	14.16	14.20	18.18	19.14	16.23
	N =	37	35	34	38	36
	Reading * Achievement					
	Mean	3.93	4.12	4.45	4.13	4.48
	S.D.	1.14	1.55	1.89	1.64	1.25
	N =	37	37	36	40	38
Fiction	IQ					
	Mean	98.81	95.95	100.24	96.71	98.35
	S.D.	14.54	18.46	15.91	14.22	14.96
	N =	36	40	38	35	37
	Reading * Achievement					
	Mean	4.19	3.89	4.26	4.18	4.68
	S.D.	1.16	1.28	1.11	1.18	2.38
	N =	36	40	39	37	37

* Reading Achievement = Reading Age

TABLE 15.14

Adjusted Means and Standard Deviations for the Four Reading Performance Measures on the Science Passage (Deaf Subjects)

Dependent Variables	Treatment Conditions				
		Subjective		Frequency	
	Trad	20%	40%	20%	40%
Multiple Choice					
Mean	8.98	9.73	8.14	8.61	9.33
S.D.	2.88	2.89	2.49	2.95	2.79
N =	36	33	35	38	37
Reading Time					
Mean	4.99	5.39	4.82	5.61	4.97
S.D.	1.30	1.67	2.03	1.72	1.83
N =	36	33	35	38	37
Reading Rate					
Mean	128.79	99.43	87.73	95.49	84.73
S.D.	27.01	31.91	33.45	30.00	30.68
N =	36	33	35	38	37
Efficiency					
Mean	193.50	202.26	200.78	170.11	215.34
S.D.	65.66	70.04	94.52	66.02	112.52
N =	36	33	35	38	37

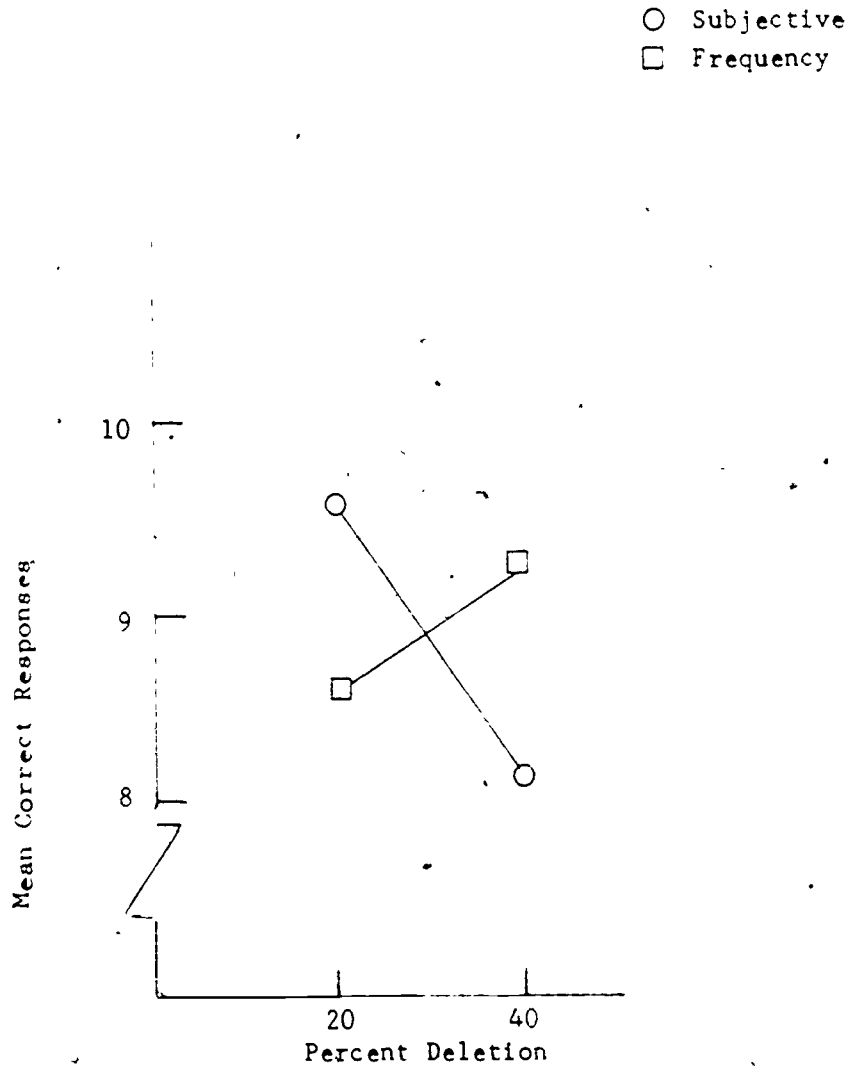


Figure 15.1. Interaction of Deletion Method by Deletion Level for the adjusted means on the multiple choice dependent variable.

TABLE 15.15

Significant Differences Between Treatment Means of Reading Rate for the 1 x 5 ANOCOV (Scheffé)* (Deaf Subjects)

Passage Type	Treatment Conditions				
Science	T	S20	S40	F20	F40
News	T	F20	S20	F40	S40

*Treatment conditions arranged from highest (left) to lowest (right). Treatment conditions underlined by a common line do not differ significantly; treatment conditions not underlined by a common line do differ significantly ($p < .05$).

TABLE 15.16

Results of the 2 x 2 and 1 x 5 ANOCOVs on the Science Passage (Deaf Subjects)

Dependent Variables	Analysis of Covariance	
	2 x 2	1 x 5
Multiple Choice	Deletion Method (M) (F = .0, df = 1,139, p = .95) Deletion Level (L) (F = .87, df = 1,139, p = .35) M x L (F = 6.11, df = 1,139, p = .01)	F = 1.73, df = 4,174, p = .15
Reading Time	Deletion Method (M) (F = .36, df = 1,139, p = .56) Deletion Level (L) (F = 3.99, df = 1,139, p = .04) M x L (F = .01, df = 1,139, p = .91)	F = 1.31, df = 4,174, p = .27
Reading Rate	Deletion Method (M) (F = .43, df = 1,139, p = .52) Deletion Level (L) (F = 4.54, df = 1,139, p = .03) M x L (F = .01, df = 1,139, p = .93)	F = 11.71, df = 4,174, p = .001
Efficiency	Deletion Method (M) (F = .35, df = 1,139, p = .56) Deletion Level (L) (F = 2.16, df = 1,139, p = .14) M x L (F = 2.47, df = 1,139, p = .11)	F = 1.39 df = 4,174, p = .24

News. Analysis of variance performed on the treatment means of IQ and reading achievement yielded no significant differences among the groups who read the news passages. Means and standard deviations of the IQ and reading achievement scores are reported in Table 15.13.

Some significant differences were found in the 2 x 2 and 1 x 5 ANOCOV designs performed on the dependent variables of reading performance. Means and standard deviations of the performance on all dependent variables of the news passage are presented in Table 15.17. The variables of multiple choice comprehension and reading time yielded no significant differences among means on either the 2 x 2 or 1 x 5 ANOCOV designs, but a significant difference was found among deletion levels for reading rate (F (1,139) = 5.08, $p < .03$), and efficiency (F (1,139) = 4.41, $p < .04$). Reading rate was significantly slower at the 40% level, however, the 40% level was more efficient than the 20% level. Further differences were found among treatment means in the 1 x 5 ANOCOV on reading rate (F (4,175) = 4.08, $p < .01$). Illustrated in Table 15.15, both the frequency and subjective 40% level passages were read significantly slower than the traditional passage.

The values attained from the ANOVAs and ANOCOVs performed on the news passages are summarized for each dependent variable in Table 15.18.

Fiction. A comparison among treatment groups on IQ and reading achievement by analysis of variance resulted in no differences for the fiction passage study. Means and standard deviations of these two variables are reported in Table 15.13.

Among the ANOCOVs performed for the fiction passages, no differences were found among the treatment conditions on the variables of multiple choice comprehension, reading time, or efficiency. A significant difference was found between deletion levels in the 2 x 2 ANOCOV on reading rate (F (1,146) = 4.80, $p < .03$). Reading rate decreased significantly at the 40% level. No differences were found between individual treatment means in the 1 x 5 ANOCOV on reading rate.

The means and standard deviations of the dependent variables for the fiction treatments are presented in Table 15.19, and a summary of the ANOVA and ANOCOV values computed for the fiction treatment conditions are found in Table 15.20.

Discussion and Conclusions

Blind Experiment

This study was conducted in three parts. Each passage type was analyzed separately, thus each type represents an independent experiment and is a sort of replication of the independent variables.

TABLE 15.17

Adjusted Means and Standard Deviations for the Four Reading Performance Measures on the News Passage (Deaf Subjects)

Dependent Variables	Treatment Conditions				
		Subjective		Frequency	
	Trad	20%	40%	20%	40%
Multiple Choice					
Mean	11.20	10.55	11.88	10.72	11.42
S.D.	3.96	4.62	4.43	4.10	2.89
N =	37	35	34	38	36
Reading Time					
Mean	4.08	4.18	3.89	4.15	3.67
S.D.	1.57	1.35	1.29	1.49	1.31
N =	37	35	34	38	36
Reading Rate					
Mean	151.19	111.26	88.57	119.76	97.82
S.D.	107.13	61.07	42.31	77.17	47.71
N =	37	35	34	38	36
Efficiency					
Mean	412.67	272.30	393.58	324.68	369.70
S.D.	409.75	128.80	367.21	181.25	210.12
N =	37	35	34	38	36

TABLE 15.18

Results of the 2 x 2 and 1 x 5 ANOCOVs on the News Passage (Deaf Subjects)

Dependent Variables	Analysis of Covariance	
	2 x 2	1 x 5
Multiple Choice	Deletion Method (M) (F = .04, df = 1,139, p = .83) Deletion Level (L) (F = 2.24, df = 1,139, p = .13) M x L (F = .21, df = 1,139, p = .65)	F = .64, df = 4,175, p = .64
Reading Time	Deletion Method (M) (F = .29, df = 1,139, p = .60) Deletion Level (L) (F = 2.84, df = 1,139, p = .09) M x L (F = .16, df = 1,139, p = .69)	F = .82, df = 4,175, p = .51
Reading Rate	Deletion Method (M) (F = .80, df = 1,139, p = .38) Deletion Level (L) (F = 5.08, df = 1,139, p = .02) M x L (F = .0, df = 1,139, p = .97)	F = 4.08, df = 4,175, p = .004
Efficiency	Deletion Method (M) (F = .13, df = 1,139, p = .72) Deletion Level (L) (F = 4.41, df = 1,139, p = .04) M x L (F = .93, df = 1,139, p = .34)	F = 1.46, df = 4,175, p = .22

TABLE 15.19

Adjusted Means and Standard Deviations for the Four Reading Performance Measures on the Fiction Passage (Deaf Subjects)

Dependent Variables	Treatment Conditions				
		Subjective		Frequency	
	Trad	20%	40%	20%	40%
Multiple Choice					
Mean	9.16	8.33	8.52	8.97	9.44
S.D.	3.77	3.13	3.27	2.86	3.35
N =	35	40	38	35	37
Reading Time					
Mean	4.56	4.17	3.97	4.36	3.78
S.D.	1.44	2.04	1.76	1.52	1.75
N =	35	40	38	35	37
Reading Rate					
Mean	171.22	164.96	113.53	155.47	135.25
S.D.	105.16	115.53	40.95	138.35	79.34
N =	35	40	38	35	37
Efficiency					
Mean	235.53	279.84	240.50	245.48	324.42
S.D.	157.26	262.38	122.66	144.30	210.41
N =	35	40	38	35	37

TABLE 15.20

Results of the 2 x 2 and 1 x 5 ANOCOVs
on the Fiction Passage (Deaf Subjects)

Dependent Variables	Analyses of Covariance	
	2 x 2	1 x 5
Multiple Choice	Deletion Method (M) (F = 2.24, df = 1,146, p = .13) Deletion Level (L) (F = .41, df = 1,146, p = .53) M x L (F = .07, df = 1,146, p = .78)	F = .70, df = 4,180 p = .59
Reading Time	Deletion Method (M) (F = .0, df = 1,146, p = .98) Deletion Level (L) (F = 1.81, df = 1,146, p = .18) M x L (F = .42, df = 1,146, p = .53)	F = 1.18, df = 4,180, p = .32
Reading Rate	Deletion Method (M) (F = .14, df = 1,146, p = .71) Deletion Level (L) (F = 4.80, df = 1,146, p = .03) M x L (F = .91, df = 1,146, p = .34)	F = 2.02, df = 4,180, p = .09
Efficiency	Deletion Method (M) (F = .61, df = 1,146, p = .44) Deletion Level (L) (F = .39, df = 1,146, p = .54) M x L (F = 3.45, df = 1,146, p = .06)	F = 1.46, df = 4,180, p = .22

The results of the fiction, science, and news articles had some important similarities. Reduction as great as 40% by either reduction method had no effect on comprehension, reading time, or efficiency. The sole exception was a reduction in time found for the frequency method among the fiction passages. The effect of prose reduction on comprehension was very favorable, but it was expected that reading time would decrease and subsequently the efficiency of the reduced versions would improve.

The greatest difference among groups was found for reading rate when the fiction and news passages were administered. Rate of reading significantly decreased when 40% of the words were omitted. Although reduced passages were generally more difficult for normal subjects to read, reading rate was not expected to decrease significantly among braille readers (Experiment VII). Results from Experiment VII showed that reading rate of blind subjects was not reduced in the telegraphic passages.

The results on reading rate and reading time of both the fiction and news passages tend to contradict the results from Experiment VII. Further research with braille readers may resolve the differences found between the studies on reading rate performance and the practical application of the telegraphic concept to braille materials.

Deaf Experiment

Since it was not possible to control for IQ and reading achievement, the effect of these variables on the group means was controlled by analysis of covariance. The intercorrelation analysis demonstrated that both IQ and reading achievement correlated positively with multiple choice comprehension, efficiency, and reading rate. However, due in part to the random assignment of the subjects to the treatment conditions, no significant differences were found among treatment groups on either IQ or reading achievement for each literature analysis.

The effect of reducing science, news, or fiction material by either a subjective or frequency reduction method to a level of 40% had no effect on the ability of the deaf subjects to comprehend at the same level as those who read the traditional passage. The deletion level effect had a consistent and adverse effect on reading rate. Among the science passages none of the reduced versions compared favorable with the traditional and among the news passages only the 20% level was comparable to the traditional passage. Among the fiction passages, deletion level also yielded a significant difference on reading rate at the 40% level. The adverse effect of reduced prose on reading rate indicated that redundant words have an important effect on rate of information processing, but as was reported above, redundant words had no effect on comprehension. The results of redundancy reduction on the reading performance of deaf subjects were nearly identical to the performance of the blind subjects. Rate of reading decreased significantly as a function of redundancy reduction in English prose but little effect upon comprehension was observed.

CHAPTER XVI

SUMMARY AND CONCLUSIONS

This chapter is organized on the basis of the two major areas of investigation encompassed by this project, the associative strategy research and the telegraphic prose research. In both phases of this research it has been customary to compare some new treatment condition with a traditional or customary learning approach. For example, in the telegraphic research it has been customary to compare the various types of telegraphic materials to the traditional or unaltered version. Many of the conclusions were based upon whether deleted versions did or did not differ significantly from the traditional version. When, for example, certain deletion levels did not differ significantly on a particular dependent variable, then it was concluded that there was no difference or no effects due to the manipulation of this variable. Caution must be exercised in the interpretation of this type of conclusion. Statistically, it is not possible to prove the null hypothesis. The decision one makes is either to reject or fail to reject the null hypothesis. It was not possible to prove that no differences existed when in actuality there were always some differences among the different treatment passages. The test of the null hypothesis was used on pragmatic grounds in order to provide some basis for the evaluation of the effects produced by the treatment conditions. Alpha levels of .05 and .01 were used only because these are the generally accepted levels. It is realized that the conclusions are very much related to these significance levels. Had less stringent levels been used, some of the conclusions would have been different. This is not a particular shortcoming of this research but applies to all research involving tests of the null hypothesis. Suffice it to say, that conclusions regarding the feasibility of telegraphic prose and the efficacy of associative strategy training in applied settings is related to this general issue.

Associative Strategy Phase

This research has been based on the assumption that the inferior performance of retarded children in memory tasks is due to their preponderant use of inefficient associative learning strategies. Another assumption involved in the conduct of this research has postulated a basic similarity between paired-associate learning and word recognition learning. It has been assumed that in order to make a correct response in the word recognition task, the printed word must elicit the correct oral response. Experiment I attempted to show the beneficial effects of the Syntactical and Word Formation conditions when compared to the Repetition and Control conditions. One aspect of this

experiment was the development of a computer program designed to search a large number of criterion words and identify all cue words contained in them. Statistically, there were no significant differences existing among the four groups either during the cue word training, criterion task, or the retention task. However, the learning curves showed the subjects' performance in the Control condition to be inferior to the performance of the other three conditions on all five test trials. The performance of the Syntactical and Word Formation groups was similar during the criterion and retention tasks. The results of this experiment prompted a closer study of the structure of the experimenter-supplied strategies, instructions to associate cue words to the criterion words, and different procedures for presenting strategies to the subjects. These latter two areas were of primary interest in Experiment II.

Experiment II consisted of a pilot test, slide projection phase, and a reinforcement study. Because of the negative results from the pilot phase, attention was focused toward more explicit aspects of reinforcement. This experiment was the first study in which learning strategies were presented by the use of a slide projector rather than by manual presentation of the material. It was also the first experiment in which the instructions were pre-recorded on cassette tapes. This study was discontinued after testing eight subjects. The procedure was too mechanical and impersonal for the retarded subjects. They became bored and easily distracted. Testing was continued with the remaining subjects in an interview-type fashion. Subjects were asked to comment on the effects of slides, recorded instructions, and the concept of an association, i.e., cue word and its relation to the criterion word. The subjects' typical comments were that there were too many words in the lists and the recorded instructions were difficult to understand. Many subjects requested pictures of the cue-criterion word combinations (this area was investigated further in Experiment III). Administering verbal reinforcement during this session produced favorable results. The data obtained in the pilot tests prompted further investigation into the effect of reinforcement upon learning strategies with educable retarded subjects. Forty EMRs were randomly assigned to two experimental conditions, Reinforced and Nonreinforced. Each subject in the Reinforced group received an M&M candy each time a correct response was given in the cue word recognition task. The subjects in the Nonreinforced group did not receive any reinforcement for correct responses. The experimenter presented the 80 cue words on 5 x 8 inch cards to both groups without the aid of a slide projector or tape recorder. The results of the 1 x 2 ANOVA indicated that the Reinforced group produced significantly more correct responses than did the Nonreinforced group. These results indicated that the use of a slide projector and tape recorded instructions was too impersonal and complicated for the educable retarded child. However, the impersonality of the experimental session was overcome by the experimenter's interaction with the subjects and the administration of reinforcements. Tangible reinforcers and less mechanized modes of presentation were used in the following experiments.

On the basis of Experiment II, it was hypothesized that pictures of the cue and criterion words would aid in the association process. Experiment III was designed to test the effectiveness of visual mediators in word recognition learning. An Imagery and a Nonimagery condition were devised. Both conditions involved cue word training and presentation of syntactical strategies, but the Imagery condition involved presentation of the pictures of the criterion words. During the learning of the criterion words, the Nonimagery group required 20% more trials than did the Imagery group, however, the difference was not significant. Also, the Imagery group made 22% more correct responses during the retention task than did the Nonimagery group but again, this difference was not significant. A generalization effect was observed on the transfer task. A second set of cue-criterion word combinations and syntactical strategies was administered in Phase II of this study. The results obtained in Phase II were similar to those in Phase I. Although nonsignificance was obtained in Phases I and II, the overall trend of the criterion and retention tasks indicated that the Imagery condition was more facilitative than the Nonimagery condition. The T values approached significance in both cases, particularly for the retention task.

The preceding experiments involved the presentation of associative strategies which were contrived by the experimenter without the use of any data from the retarded population. Based upon the limited success of these studies to facilitate memory of the criterion words, it was decided to conduct a rather extensive experiment designed to examine the effect of associative strategies generated by retarded children as compared to strategies generated by nonretarded persons. In addition, Experiment IV focused upon the effect of experimenter- and subject-generated strategies as applied to the Syntactical and Word Formation conditions. Also involved in the experiment was a Control condition which received no strategy instructions. The methodology involved in the Syntactical and Word Formation conditions was identical to that used in Experiments I and III. The experimenter-supplied Control condition was the same as the previous Repetition conditions and the subject-generated Control condition received no instructions. As expected, the EMR subjects receiving subject-generated mediators performed significantly better on acquisition and retention. There were no overall significant differences between the Syntactical, Word Formation, and Control conditions. However, the learning curves indicated that the Syntactical and Word Formation conditions performed better than the Control conditions. The results of this study demonstrate that retarded subjects can learn faster and retain more information when supplied with mediators that have been constructed by other retarded individuals. Additional research is necessary in order to identify the structural aspects of learning strategies generated by children at different intellectual levels.

Two major considerations guided the direction of the associative strategy research during this phase of the project. The results of Experiment IV were very encouraging especially in view of the rather

disappointing results obtained in the first three experiments. First, there was strong evidence from Experiment IV that subject-generated strategies did facilitate learning among retarded individuals. Thus, the concept of an associative strategy as a facilitator of word recognition learning was tenable. Second, the plan was to use 16mm animated film in order to dramatize the pictorial and syntactical aspects of the associative strategy concept. Before the animated films were developed, it was thought necessary to determine the drawing style preferences of retarded individuals. This information might have an important bearing on the type of pictorial stimuli used in the animated films. Experiment V was designed to assess EMRs preferences for seven aspects of some possible parameters which could be manipulated in a series of animated film studies. Drawings were presented to a sample of EMRs and they were asked to select the drawing which they would most like to read or hear a story about. The following variables were examined: age, media richness, realism, background, mood, personality, and type of animal. The results showed reliable preferences among the subjects. They favored stimuli which were young, realistically drawn, and portrayed cute and cocky aspects of character.

Experiment VI was designed on the assumption that the same associative strategy process which is operating to facilitate learning in paired-associate tasks can also be induced by the use of animation to facilitate word recognition learning among retarded children and adults. By using animation, it was possible to focus attention upon the cue word and to visually depict the associative strategy. The three most basic strategy conditions were selected for this study: Repetition, Word Formation, and Mediation. The Repetition condition involved the presentation of the criterion word several times. Nothing was done to focus attention on the cue element in the criterion word. The Word Formation condition involved focusing attention on the cue word but no strategy nor mediating phrase or visual representation was provided. The Mediation condition involved the presentation of a verbal and a pictorial mediating link. It was hypothesized that the Mediation subjects would perform better than the Word Formation subjects and the Word Formation subjects would perform better than the Repetition subjects. The results of the criterion learning task indicated a significant difference between the three strategy conditions. The Repetition group required more trials to learn the criterion word than did the other two conditions. Analyses of both criterion word sentence discrimination tasks were significant. In both tasks the Repetition condition was inferior to the other two conditions. Analysis of the retention data showed that all subjects responded correctly to the criterion word. Both the Mediation and Word Formation strategy conditions were superior to the Repetition condition throughout the experiment, thus confirming the first hypothesis. However, the Mediation and Word Formation conditions resulted in similar overall performance. The hypothesis concerning the superiority of the Mediation condition over the Word Formation condition was not supported.

Table 16.1 presents in summary fashion the results and conclusions of the six associative strategy experiments. It is concluded from these results that learning and retention in word recognition tasks can be facilitated by the use of associative learning strategies. Although the results from the initial studies were not encouraging, the last two experiments dealing with subject-generated strategies and strategy animation did produce optimistic findings. However, the precise mechanism responsible for the facilitation has not been identified. Figure 7.1 attempts to depict the locus of facilitation in the more complex strategy conditions. The assumption has been that the associative strategy presented in the Syntactical condition permits the learner to bridge the associative gap between the printed S-term and the oral R-term. However, the results from the animation experiment (Experiment VI) revealed no differences between the Word Formation and the Syntactical conditions. The Word Formation treatment does not offer a strategy technique designed to mediate the S- and R-terms. A possible explanation for the facilitation observed in this treatment is the emphasis placed upon the cue word and its associated criterion word. By pointing out the presence of the cue word in the criterion word, the effective meaningfulness of the criterion word may be increased. The verbal learning literature related to meaningfulness shows this variable to be a potent one. If the meaningfulness of the criterion word was increased in Experiment VI, then the implications are great. For it shows that meaningfulness can be experimentally induced by the use of animation and such techniques then would have important implications for the design and development of instructional materials for retarded learners.

The implications of this research are broader than just memory facilitation in the mentally retarded learner. Basic research regarding the parameters in learning from film and television formats is lacking. Experiment VI might well serve as a prototype experiment in a scientific approach to the study of media. The approach used in the final experiment makes it possible to isolate and manipulate molecular aspects of complex media parameters. Also, studies similar to Experiment V are needed in order to investigate some of the affective variables influencing attention and learning. This type of research is necessary before any type of scientific foundation can be provided for the design and development of materials used in the film and television industries. A scientific analysis of the molecular elements involved in any type of presentation condition and the effects resulting from the combination of these elements ought to be as possible as the isolation and investigation of chemical combinations. A molecular science of media is possible and probably desirable. The results of such a science would surely dictate the conditions which would facilitate learning from various media formats.

TABLE 16.1

Summary of the Six Associative Strategy Experiments

Experiment	Problem	Type of Subjects	Modes of Presentation	Results	Conclusions
I	evaluation of 4 strategy groups	59 EMRs, CA range, 10-21; IQ range, 45-75	slide projector with oral instructions by experimenter	no significant differences among 4 groups	Syntactical & Word Formation conditions were no more effective in word recognition learning than Repetition & Control conditions
II	evaluation of automated testing procedure	a total of 104 EMRs with mean IQ of 53 & mean CA of 11	same as Exp. 1 with instructions automated. Reinforcement condition added.	automated procedure was not effective. Significant effects associated with administration of candy reinforcement.	completely mechanical automation of task was not conducive to learning. Reinforcement effect upon word recognition learning.
III	evaluation of visual mediators	43 EMRs with mean IQ of approximately 61 and age range of 10-17	manual presentation of picture foldouts, oral instructions	no significant learning effect but significantly better retention for imagery over nonimagery	presentation of pictured cue-criterion words more effective than words only

TABLE 16.1

(continued)

Experiment	Problem	Type of Subjects	Modes of Presentation	Results	Conclusions
IV	evaluation of subject-generated strategies	96 TMRs & EMRs with mean IQ of 53 & mean CA of approx. 24	color slides & oral instructions	better learning & retention for subject-generated strategies. No differences among Syntactical, Word Formation & Control conditions	retarded learners profit more from strategies developed by retarded children than from experimenter-supplied strategies
V	determine drawing style preferences of retarded children	12 EMRs with age range of 7-15 with mean IQ of approx. 50	pictures presented manually	significant preference on 7 of 9 picture sets	EMRs preferred characters who were young, happy, & portrayed cute & cocky aspects of personality
VI	evaluation of semi-animated word learning film	59 TMRs & EMRs with mean IQ of 50 & mean CA of 29.	animated & non-animated word recognition films completely automated	significantly faster learning rates for Syntactical & Word Formation conditions than for Repetition condition	semi-animated word recognition tasks facilitated among TMRs & EMRs, animation may induce effective memory processes for the retarded

Telegraphic Prose Phase

The purpose of Experiment VII was to determine the effects on reading performance when subjectively reduced prose passages were read by blind and sighted subjects. Two sets of data were used in the study (a) data from sighted subjects and (b) data from blind subjects. Three telegraphic versions (10, 30, and 50%) and the traditional version were compared with respect to comprehension, reading rate, reading time, and efficiency for each set of data and in a comparison of the two subject samples. Reading rates of blind subjects were not reduced in the telegraphic passages; comprehension was not affected; and reading times were considerably shortened for blind subjects assigned the 50% reduced version in comparison to the reading times of blind subjects assigned the traditional passage. Comprehension as well as reading rates were decreased for sighted subjects assigned the 50% reduced passage. However, at the 30% deletion level, comprehension for sighted subjects was not affected and reading times were decreased. The results of this experiment are very encouraging and show that considerable efficiency is achieved by blind subjects reading telegraphic versions reduced to 50% of the traditional passage.

Experiment VIII determined the effects of the subjective method of producing telegraphic passages on the reading behavior of visually handicapped large print readers. Further analyses were conducted to compare reading performance on telegraphic passages with braille and sighted readers from Experiment VII. Three reduced passages at 10, 30, and 50% deletion levels were developed from a 947 word prose story. With inclusion of the traditional, four passage conditions were typed in 16-point primary type and administered to large print readers. Eight dependent variables of reading performance were analyzed: total comprehension score; multiple choice score; set relations score; nested score; disjunctive score; reading rate; reading time; and efficiency. A 1 × 4 ANOVA design was used to compare the means of the large print readers within the four treatment groups on each dependent variable. No differences were found among the treatment conditions for any measure used to assess comprehension. Reading rate tended to decrease at the 50% level, however, reading time for the reduced passages did not decrease when compared with the traditional. The results of the analyses designed to compare the large print, braille, and sighted readers indicated that the large print readers scored significantly lower on comprehension. Concerning reading rate, large print readers and braille readers read at a significantly slower rate than sighted subjects. Similarly, the braille readers required more time to read the passages than the large print readers, and both groups required significantly more reading time than the sighted readers.

Experiment IX was designed to explore the feasibility of the use of a telegraphic concept in the education of the deaf. A traditional story was reduced by a subjective deletion scheme at 10, 30, and 50%. The traditional passage and three telegraphic versions

were compared with respect to measures of comprehension, reading rate, reading time, and reading efficiency. No significant differences were found on comprehension between the traditional version and the telegraphic passages at 10 and 30% deletions. Reading rate decreased with each increase in percentage deletion, but the study failed to show a saving in time for groups reading the telegraphic versions as compared to the groups reading the traditional passage. Although these results showed no decrease in comprehension as reduction level increased, the overall efficiency of the telegraphic materials was no greater than traditional materials due to the decreased reading rate. On the basis of this experiment, it appears that telegraphic materials are not as facilitative for deaf students as they are for blind ones.

A grammatical deletion scheme was used in Experiment X in order to generate telegraphic prose for deaf and hard-of-hearing students. A 2696 word fiction passage was reduced at 20 and 80% of its nouns and pronouns, verbs, adjectives and adverbs, and articles and conjunctions, generating eight reduced versions. A 2 x 4 and 1 x 9 ANOVA were performed for each of the following dependent variables: multiple choice test score, set relation test score, reading time, reading rate, and efficiency. The results of the performance of deaf and hard-of-hearing subjects demonstrated that elimination of 80% of the noun/pronoun category caused a significant decrease in comprehension when compared to the traditional. All passages reduced of the verbs or adjectives and adverbs produced no distinguishable effect upon any of the reading performance variables. The passage reduced of 80% of the articles and conjunctions was superior to all other passages with respect to comprehension. No differences were found among the passages when reading rate or reading time were considered. As was expected, the performance of normal subjects was superior to the deaf and hard-of-hearing subjects on the variables of comprehension and reading time. There was no difference among the three groups on reading rate, although a significant interaction effect indicated that normal subjects are affected more by an 80% reduction level. These results have demonstrated that it is possible to eliminate rather large percentages of certain grammatical categories without seriously affecting the comprehension of hearing impaired individuals.

The applicability of a telegraphic captioning scheme for the deaf was tested in Experiment XI. Two film formats were used, one in which the prose was presented by a manual communicator using signs, the other in which captions of the prose were superimposed across the lower one-third of the screen and presented simultaneously as the words were signed. The prose selections presented in both film formats were telegraphically reduced by a subjective reduction procedure at 10, 30, and 50% deletion levels. Thus, each version, 10, 30, 50%, and traditional, were presented to deaf students in each of the two film formats. A 2 x 4 and 1 x 4 ANOCOV design was performed on the variable of comprehension. The hypothesis that the combination of signing and captions in a single film would be superior to a sign-only presentation was confirmed. The former

condition was significantly superior to the latter condition. As many as 30% of the words could be deleted and presented in the sign and caption format while still maintaining a satisfactory level of comprehension. Across both formats, comprehension decreased significantly at the 50% level as compared to the 10% level. These results show that telegraphic captioning is feasible with deaf students and as much as 30% of the words can be eliminated in a traditional captioning format.

The purpose of Experiment XII was to examine separately a grammatical and a word frequency reduction scheme among deaf and hard-of-hearing students. The prose passage reduced by the word frequency scheme was based upon the identification of its high, medium, and low frequently occurring words and from these three word categories, 10, 30, and 50% of the words were deleted. A 3 x 3 ANOCOV design was performed on the reduced passages. Also included was the traditional and a test-only condition making it possible to use a 1 x 10 and a 1 x 11 ANOCOV design. The passage selected for the grammatical reduction procedure was reduced by each of four grammatical categories: nouns and pronouns, verbs, adjectives and adverbs, and articles and conjunctions at 20 and 80%. A 2 x 4 ANOCOV design was performed among the grammatical categories and deletion levels and a 1 x 9 ANOCOV was performed with inclusion of the traditional. All passages were administered to deaf and hard-of-hearing subjects. Surprisingly, there were no differences found among the frequency reduced passages on any variable of reading performance. The results of the grammatical reduction procedure supported the hypothesis that reduction of the more important grammatical categories, such as nouns and pronouns, and verbs, would produce an adverse effect on measures of comprehension.

Experiment XIII was designed to examine the effects of reducing three types of English prose by two deletion methods on the reading behavior of blind and deaf students. Three passages were selected from among materials on a seventh grade reading level, which were representative of science, news, and fiction style prose. The passages were reduced at 20 and 40% by subjective and frequency deletion methods and administered to deaf and blind high school subjects. Performance of the subjects was assessed for multiple choice comprehension, reading time, reading rate, and efficiency. Separate analyses were completed on the data from the two types of subject populations. Among the blind subjects, no differences were found on the dependent variables among the science passages, but a difference was found among deletion levels on the news and fiction passages. The 40% level was associated with significantly slower reading rate. Concerning the deletion methods, the subjective method was superior to the frequency method only with respect to required reading time and rate of reading on the fiction passage. The performance of the deaf subjects on the same passages was remarkably similar to the blind subjects' performance. No differences were found among deletion methods, but once again reading rate consistently decreased at the 40% level among passages of all literature types.

The results indicate that both blind and deaf subjects respond to reduced prose as do normal subjects who have read similarly reduced materials. Redundancy reduction had an insignificant effect on comprehension, but rate of information processing was affected significantly at high levels of deletion.

Table 16.2 presents in abbreviated form the summaries of the seven telegraphic experiments. In general, these results show that telegraphic prose is a viable alternative to traditional educational materials for the blind. Between 30 and 50% of the verbage in traditionally written material may be eliminated without seriously affecting the reading performance of braille readers. The results were not quite as favorable with respect to the use of telegraphic materials for deaf students. While deletion levels of 30% were possible without decreasing comprehension, reading rate was decreased resulting in no increased efficiency for telegraphic materials. However, telegraphic captioning was shown to be feasible for the deaf and reduction levels up to 30% were possible. These conclusions were generally applicable to fiction, scientific, and newspaper style prose.

Future of Telegraphic Prose

Future reduction schemes need to give greater consideration to the sentence. The sentence is the natural unit which provides the basis for the expression of a self-contained idea or thought. The grammatical and word frequency reduction schemes ignored the sentence as such. Although these word categories did provide the basis for some degree of word reduction, the subjective reduction scheme (SHORT) developed in Experiment VII proved to be the most effective. The SHORT method was based upon subjects' ability to extract the kernel idea of the sentence. In all the experiments involving this method, subjects have been in remarkable agreement concerning the rank order of specific words with respect to their importance in communicating the intended meaning of the sentence. Thus far, all research using the SHORT method has applied the same reduction level across all sentences in a given reduced passage. It is intuitively obvious that the optimal reduction levels for different sentences vary. Application of this method in future investigations must take this into consideration.

Although the time data from Experiment XIII showed the SHORT method to be more effective than the frequency method, this method did fair rather well considering its objective character. The frequency reduction scheme was completely machine based. The reduction algorithm was based upon a simple word count and deletions within a frequency category were random. Likewise, deletions within grammatical categories were random. Both the grammatical and word frequency reduction schemes certainly can be improved to the extent that deletions are made on some other basis than a random one. It would appear that both of these deletion schemes could be improved upon by incorporating an editorial phase in which judgments are made at the sentence and paragraph levels

TABLE 16.2

Summary of the Seven Telegraphic Prose Experiments

Experiment	Type of Subjects	Independent Variables & ANOVAs	Multiple Choice	Reading Time	Reading Rate	Conclusions
VII	blind & sighted	T, 10, 30, 50% SHORT method 1x4 & 2x4	blind N.S. sighted--T,10,30>50	blind T>50 sighted T,10>30,50	blind N.S. sighted T,10 30>50	50% deletion possible for braille readers, 30% for sighted readers
VIII	LPR, braille sighted	T, 10, 30, 50% SHORT method 1x4 & 3x4 LPR	LPR N.S. LPR< braille & sighted	LPR N.S. braille>LPR> sighted	LPR T,10,30 >50; LPR, braille< sighted	50% deletion possible for LPR (Large Print Reader)
IX	deaf	T, 10, 30, 50% SHORT method 1x4	T, 10, 30 >50	N.S.	T>10>30>50	30% deletion possible but does not improve efficiency
X	deaf, hard of hearing, & normals (D, HH, & N)	T, 20, 80% grammatical NP, V, AA, AC 2x4, 1x9, 2x2x4	80NP<T 20V,20AA, 80V,80AA N.S.;80AC superior N>D&HH	N.S. N<D&HH	N.S. N&D&HH N.S. interaction at 80% level had greater effect on N	80% elimination of nouns decreases comprehension for D. Little effect related to elimination of other grammatical categories
XI	deaf A. B.	2 film format sign only sign & caption T, 10, 30, 50% SHORT method 2x4, 1x4 ANOCOV	A<B 10>50 good up to 30% with B			30% telegraphic captioning feasible for the deaf

TABLE 16.2

(continued)

Experiment	Type of Subjects	Independent Variables & ANOVAs	Multiple Choice	Reading Time	Reading Rate	Conclusions
XLI	deaf & hard of hearing	frequency T & high, medium, low, 10, 30, 50% grammatical T, 20 & 80% NP, V, AA, AC 3x3, 1x10, 1x11 ANOCOV (freq); 2x4 1x9 ANOCOV (gram)	grammatical NP & V adverse effect frequency N.S.	frequency N.S.	frequency N.S.	elimination of 80% nouns & pronouns has adverse effect. Reading affected by frequency scheme.
XIII	deaf & blind	T, 20 & 40% SHORT method & frequency 1x5, 2x2 ANOCOV (deaf) 1x5, 2x2 ANOVA (blind) 3 literature types	blind N.S all 3 literatures deaf N.S. news & fiction interaction science 2x2	science: blind N.S. deaf 20>40 news: blind N.S. deaf N.S. fiction: blind S<F deaf N.S.	science: blind N.S. deaf 20<40 news: blind 20<40 deaf 20<40 fiction: blind 20<40 & S<F deaf 20<40	elimination of 40% of the material had no significant effect on comprehension but reading rate was decreased for both deaf and blind students.

T - Traditional; LPR - Large Print Reader; N.S. - Not Significant; NP - Noun/Pronoun; V - Verb; AA - Adjective/Adverb; AC - Article/Conjunction; D - Deaf; HH - Hard of Hearing; N - Normal

regarding the acceptability of a given deletion output. Given the present limited status of knowledge about the relationship between the semantic and syntactic aspects of language, a human editor is required to at least make judgments about the acceptability of a given telegraphic production. It may be that telegraphic research will lead to the creation of a new type of professional role within the field of journalism. Telegraphic editors may well be charged with the responsibility of assisting in the development of new types of educational and professional literature.

The evaluation strategy used in telegraphic research needs to be broadened in future studies. One component should take into consideration the tendency for the reader to select telegraphic materials when they are available along with traditional materials. Another aspect should involve analysis of the telegraphic passage to determine which comprehension test items are answerable. This type of analysis eliminates the memory component in the comprehension variable and may be a more direct test of the passage's utility. The definition and measurement of comprehension needs to be seriously examined. In this project, conclusions regarding the effectiveness of telegraphic research have been based upon comprehension measures such as the recall of multiple choice, cloze, and set relation items. While there are certain types of statistical data which aid in the selection of items for the test of comprehension, there is no guiding rationale governing the content of an item. The identification of main ideas, remembering surface detail and facts, understanding implications, and making inferences are all aspects of the concept of comprehension. Yet, seldom is there any systematic framework which permits definition of these aspects operationally. Furthermore, there is little a priori basis for the selection of the content area being tested in the item. One of the attractive features of the Dawes model, which provided the basis for the construction of several passages, is that there is a logical basis for the construction of a set relations item. However, the model is not appropriate to already existing prose materials.

Another approach to the problem of prose reduction which has not been explored is to make greater use of the comprehension test as a basis for determining the deleted materials. The general procedure followed in this series of experiments involved construction of the comprehension test prior to passage reduction. This approach was followed in order to avoid any bias in favor of the telegraphic passages in the test construction phase. The effect of this procedure was to increase the number of items which could not be answered on the comprehension test as the deletion level increased. In those educational and professional situations where comprehensive criterion instruments already exist for the purpose of assessing learning, such tests may provide the basis for an operational definition of important information. Thus, content analysis of these instruments would provide a basis for determining deletion and/or retention strategies for the related

prose material. Frequency and grammatical analysis of the words and phrases in the criterion instrument could then provide an important basis for the application of these deletion schemes to the reference passage. Where criterion-referenced tests do not exist, the comprehension test could still be used as a basis for deletion decisions.

In conclusion, there is little question regarding the need to develop more efficient ways of communicating written information. The volume of information which is published each year is steadily increasing. In order to keep abreast of current research and developments in most any area, increasing amounts of time are required. In spite of all this, the methods of presenting written information have remained the same for hundreds of years and possibly are unchanged from the earliest recorded sentence. In this respect, the concept of telegraphic prose runs counter to universally accepted writing styles. Seldom if ever does one read printed sentences which contain flagrant violations of syntax. This is especially true when considering educational materials that are used for didactic purposes.

The two assumptions upon which this research was based have received support from the seven experiments presented in this report. First, it was assumed that written and spoken language contains many words and word sequences which are unnecessary for the comprehension of a message. Related to this assumption is the fact that persons engaged in reading and listening activities have knowledge of certain natural language statistics which permit them to anticipate with varying degrees of accuracy material which has not yet been presented but which is obvious from the message context. The second assumption, which formed the basis of this research, is that the concept of a well formed sentence or paragraph is not necessary for the comprehension of a written message. Regardless of the particular deletion scheme used, all seven experiments have demonstrated that some amount of material could be deleted without seriously affecting either comprehension or reading rate.

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