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ABSTRACT

It has been assumed that written and spoken language contains many words and word sequences which are unnecessary for the comprehension of a message. The purpose of this research was the development and evaluation of three major telegraphic production schemes. Telegraphic prose refers to an abbreviated writing style similar to that found in telegrams. These reduction schemes were based upon the analysis of word frequencies, grammatical categories, and kernel sentences. Eight experiments were conducted in which different types of educational materials were shortened to form various levels of word deletions of the traditionally written materials. Comprehension, reading rate, reading time, and presentation efficiency measures were obtained from samples of college students. The results showed that some degree of prose reduction was possible without significantly affecting reading performance. Extreme reduction levels in certain grammatical and word frequency categories did adversely affect performance. Results showed that the three telegraphic production schemes do provide a basis for the development of telegraphic materials. Results were interpreted as supporting the assumption that written language contains many words and word sequences which are unnecessary for the comprehension of newspaper style, fiction, and scientific materials. (Author)

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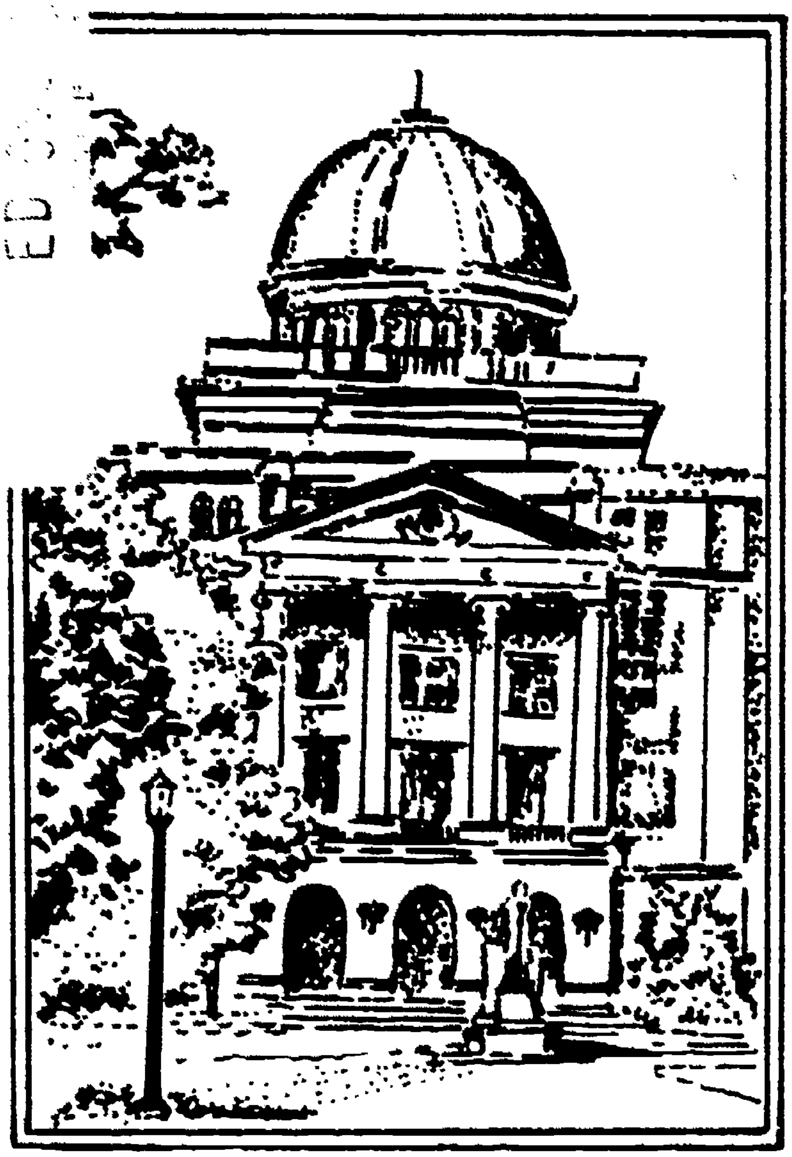

FINAL REPORT

Project No. 10176F
Contract No. OEC-6-71-0527-(509)

May 31, 1974

Clessen J. Martin
Texas A&M Research Foundation
Texas A&M University
College Station, Texas 77843

DEVELOPMENT OF AN ANALYTICAL APPROACH TO TELEGRAPHIC COMMUNICATION

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

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ABSTRACT

This project was based upon the assumption that written and spoken language contains many words and word sequences which are unnecessary for the comprehension of a message. The purpose of this research was the development and evaluation of three major telegraphic production schemes. Telegraphic prose refers to an abbreviated writing style similar to that found in telegrams. These reduction schemes were based upon the analysis of word frequencies, grammatical categories, and kernel sentences. Eight experiments were conducted in which different types of educational materials were shortened to form various levels of word deletions of the traditionally written materials. Comprehension, reading rate, reading time, and presentation efficiency measures were obtained from samples of college students. The results showed that some degree of prose reduction was possible without significantly affecting reading performance. Extreme reduction levels in certain grammatical and word frequency categories did adversely affect performance. Results showed that the three telegraphic production schemes do provide a basis for the development of telegraphic materials. Results were interpreted as supporting the assumption that written language contains many words and word sequences which are unnecessary for the comprehension of newspaper style, fiction, and scientific materials.

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CHAPTER I

INTRODUCTION

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 material. 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.

With the aid of the various information theory measures, it is now possible to estimate the amount of redundancy in some cases. Shannon (1949) has suggested a method by which the redundancy of letter sequences can be measured. His method was to present a series of letters and spaces, and then ask the subjects to guess which letter went in each space. As the subject guessed correctly, the letters were entered in the spaces. When the subject guessed incorrectly, one of two different techniques was used: (1) the experimenter either told the subject what the right response should have been or (2) the experimenter asked the subject to keep guessing until the correct response was made and the number of errors was recorded. Shannon (1949) found that a printed message has 50% letter redundancy; that is, one needs only 50% of the letters available in the message in order to predict the complete message. Thus, it is possible in English prose to eliminate as much as half of the letters without any loss of predictability.

Additional estimates of the redundancy associated with letters in printed English have been provided by Shannon (1951), Newman and Gerstman (1952), and Burton and Licklider (1955). After Shannon (1949) completed his initial study of the redundancy of letters in printed English, he developed another method for estimating letter redundancy. Shannon's (1951) new method was based on a study of the predictability of printed English and was considered to be more sensitive than his previous (1949) method. According to Shannon's (1951) data, a letter is at least 75% determined by what has preceded it; about one-fourth of the letter's information is unique. Burton and Licklider (1955), using Shannon's (1951) experimental model, conducted a study to determine the extent to which estimates of the redundancy of English prose are dependent upon the number of preceding letters known to the subject. Their data indicated that the estimate of relative redundancy increases as knowledge of the preceding sequence is extended from zero to approximately 32 letters, but above 32 letters there is no noticeable rise. They confirmed Shannon's (1951) estimate of 75% redundancy. However, the results of Newman and Gerstman (1952) revealed a lower estimate of redundancy using a 10,000 word extract from the King James version of the Bible. According to Garner (1962), the Newman-Gerstman estimate of redundancy is 52%.

Still working with letters as opposed to words to investigate redundancy, Chapanis (1954) was the first to demonstrate that subjects recognize and use redundancy in printed English. His study was an attempt to discover how well a heterogeneous sample of subjects can reconstruct an English passage when various amounts of the passage have been deleted. Using 13 prose passages differing widely in content and style, Chapanis (1954) made deletions in both regular and random patterns and in six amounts varying from 10 to 67%. Results indicated that with regular 20% deletion,approximately 90% of the missing letters were correctly restored. However, as the percentage of deletion increased, accuracy in restoring missing letters diminished rapidly. When 50% of the text had been deleted, only about 10% of the missing letters could be recovered. Results also indicated that when the amount of deletion was 25% or less, randomly deleted passages were more difficult to reconstruct than passages deleted in a regular pattern. But when 33% or more of the material was deleted, the randomly deleted passages were easier to reconstruct. Chapanis' (1954) results were confirmed in a similar experiment by Miller and Friedman (1957). In their study, five types of mutilations were used, including the type of mutilation that Chapanis (1954) used. They found that by deleting and abbreviating the ten prose passages with an average abbreviation of 48%, their subjects were able to reproduce 93% of the omitted letters. Garner (1962) suggests that Miller and Friedman's (1957) abbreviation technique provides a reasonably efficient method of coding English without destroying comprehensibility.

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 (1965) 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, 1965).

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 (1965) 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.

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. 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 determine the differences among college students in amount of information recalled and in reading rates between telegraphic and traditional materials.

2) To determine whether various levels of prior practice in reading telegraphic materials resulted in a learning-to-learn phenomena.

3) To apply 10, 20, 40, 60, and 80% reduction levels on five grammatical categories: nouns and pronouns; verbs; adjectives and adverbs; prepositions; and articles and conjunctions. This objective pertained to existing textbook-type information which had not been previously condensed.

4) To determine what effects the different reduction techniques developed in objective three have upon the comprehension of materials presented to college students.

5) To develop probability distributions for individual words within a passage in order to develop a reduction technique based upon word frequency. The goal here was to develop frequency categories so that different reduction percentages could be applied to these categories.

6) To determine what effects the reduction programs developed in objective five had upon comprehension and reading rate.

7) To determine the effects which the grammatical and the word frequency reduction procedures had upon the comprehension of three different types of prose materials. This objective involved the selection of prose passages from three different sources (newspapers, general fiction, and scientific writing) in order to determine the effects which the reduction programs had upon the comprehension of these materials.

CHAPTER II

EXPERIMENT I

EFFECTS OF PRACTICE AND MODE OF PRESENTATION UPON THE COMPREHENSION OF TELEGRAPHIC PROSE

Introduction

Martin and Alonso (1967) reported the results of a two-year U.S. Office of Education grant designed to examine the ability of blind children to comprehend braille presented in two telegraphic styles, medium telegraphic (Med-Tel) and highly telegraphic (Hi-Tel). The traditional (Trad) passage was a 1620-word fictional story concerning two warring African nations and was written in full prose. The Med-Tel passage was a condensation of the same story. It was written in traditional sentence and paragraph form, but with a 42% reduction in narrative and background material of the original passage. The Hi-Tel version of the story was written in a format which appeared similar to a telegram. A 72% word reduction was achieved in the Hi-Tel version in comparison to the Trad passage.

The results of the Martin and Alonso (1967) investigation suggested that telegraphic materials may be a more efficient way for braille and sighted readers to learn equivalent content of traditionally written text materials. While there were few significant differences in comprehension among the three versions, there were significant differences among the three versions in the average number of minutes required to read the passages. Braille readers required 53% less time to read the Hi-Tel version than the Trad version, while comprehension was only 12% less.

An explicit assumption involved in the Martin and Alonso (1967) study was that the rate of information input could be increased via telegraphic materials. This presumed that a blind child would maintain the same reading speed with telegraphic materials as with traditional materials. But the data indicated a range of 35 to 50% reduction in the reading rates among children reading the Hi-Tel version. There was no significant difference between the Trad and Med-Tel versions in reading rate, both of which were written in traditional sentence and paragraph style.

Two possible factors may have accounted for the slower reading rates associated with the Hi-Tel passages. First, subjects may have selected reading rates which insured comfortable rates of information input, and they did not voluntarily exceed these rates. It is assumed that telegraphic prose is informationally more compact than traditional prose. Thus, individuals may find decreasing their normal reading rates necessary in order to achieve the same levels of comprehension usually achieved with traditionally written prose text. Second, the fact that the subjects were not accustomed to reading telegraphic materials may have caused a reduction in reading rates. The unique style of the Hi-Tel version, written in outline form, may have accounted for the significantly greater reduction in reading rates in the Hi-Tel version as compared to reading rates in the Med-Tel and Trad versions.

In the present experiment, two hypotheses were formulated to account for the reduction in reading rates. The first hypothesis states that subjects selected reading rates which insured comfortable rates of information input, and they did not voluntarily exceed these rates. The second hypothesis states that the unique style of the telegraphic prose caused the reduction in reading speed.

The first hypothesis is tested in this experiment by presenting the traditional and telegraphic prose in the form of a tape-recorded message. The aural message provides a constant input rate which cannot be changed by subjects. The second hypothesis is tested by providing subjects with varying degrees of familiarization training prior to the criterion task in either an aural condition (tape-recorded presentation) or a written condition (subjects reading the prose selection).

A major problem which arises in the development of telegraphic materials is the measurement of redundancy in meaningful prose. Dawes (1964) has developed a method which provides the basis for defining the essential structure of prose material. Because the method itself is artificial, it is difficult to analyze existing prose material. However, it does provide a basis for operationally defining the essential information in artificially constructed meaningful material. With this method, it is possible to keep the amount of essential information constant among different types of specially constructed prose passages.

The essential feature of Dawes' (1964) model is the definition of the structure of prose material in terms of set relations. With this model it is possible to diagram the structure of a specially designed passage by the use of Venn diagrams.

Dawes (1964) constructed a story about an imaginary island in the middle Atlantic Ocean. The island's people had always been faced with a water shortage. Farming and cattle ranching were the main occupations. However, none of the ranchers engaged in farming, nor did any of the farmers engage in ranching. This information can be diagrammed as two exclusive sets. These two sets are presented in Figure 2.1.

The story indicates that the island is governed by a 10-man senate composed entirely of ranchers. Thus, senators are a sub-set of ranchers. Figure 2.2 presents this relationship. Because senators are a sub-set within the set of all ranchers, this relationship is referred to as a nested relationship.

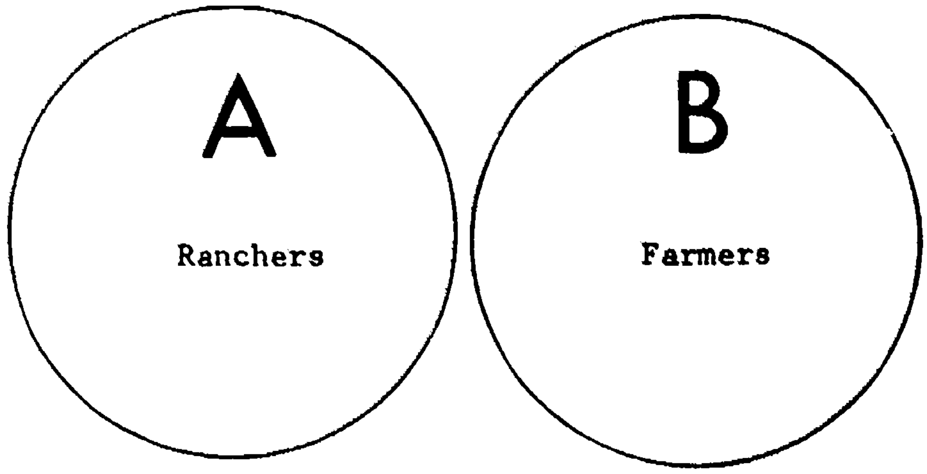

Figure 2.1. Diagram of two exclusive sets.

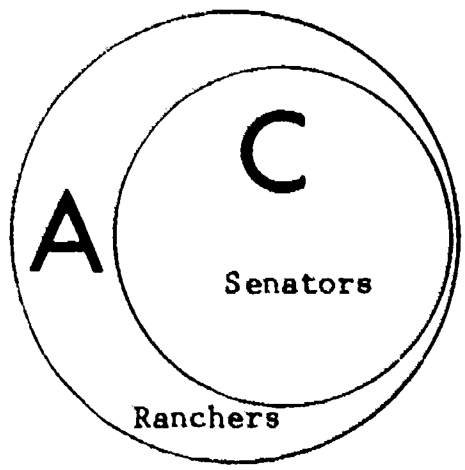

Figure 2.2. Diagram of a nested set.

The story also tells of a pro-canal association which was formed by some of the farmers and a few of the senators. Thus, the pro-canal association is represented by an overlapping set of some senators and some farmers. Figure 2.3 presents this relationship. Sub-set D is referred to as a disjunctive relation because it contains elements which are common to both sets A and B.

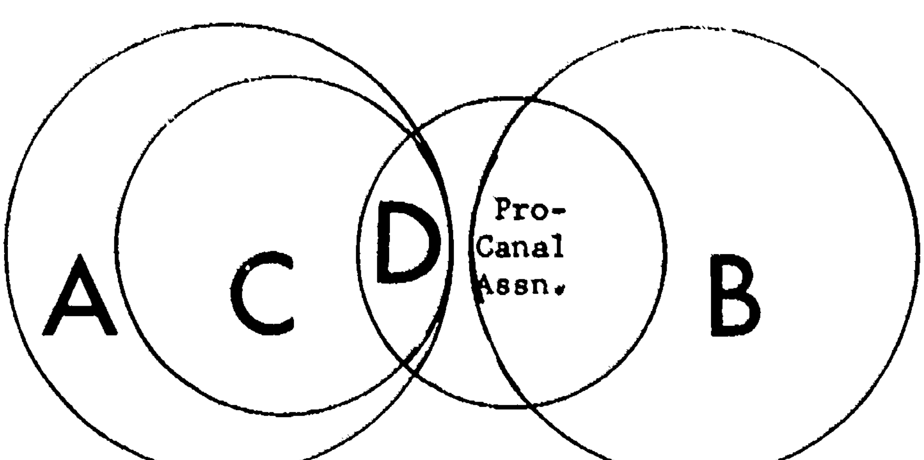

Figure 2.3. Diagram of a disjunctive set.

The final set in the story involved those islanders who voted for the idea of constructing a canal. This set (E) is labeled the pro-voters and consists of all members of the pro-canal association and all farmers. Figure 2.4 represents, in Venn diagram form, the structure of the story.

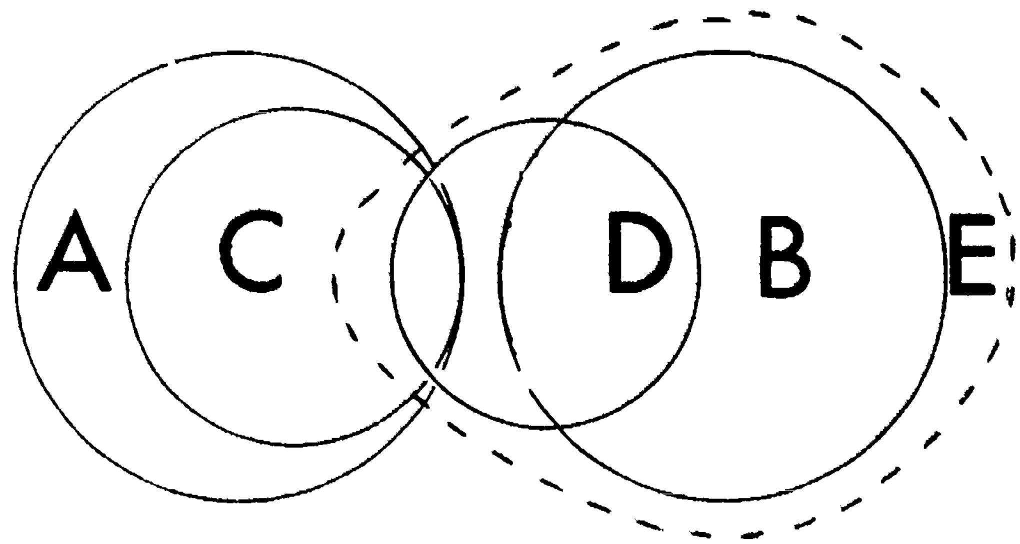

Figure 2.4. Diagrammatic representation of the structure of Dawes' story.

Although most prose material is not amenable to a set relations analysis, the Dawes (1964) model does permit one to construct a passage whose structure is definable in terms of nested and disjunctive relationships. Therefore, it is possible to develop prose materials which contain varying amounts of nonessential information. Essential information is defined as material which describes the set relations. This model also permits one to keep the amount of essential information constant among various prose passages.

A second feature of this model is that it allows one to test the comprehension of some rather complex relationships. Dawes (1964) postulates two types of errors possible in the recall of the set relations. If, in a nested set such as that presented in Figure 2.2, a subject recalls set C as overlapping or disjunctive with sets A and B, the subject has made a pseudo-discrimination error; that is, the subject has made a discrimination when in fact there was none. On the other hand, a subject may fail to recall a discrimination that was present in the passage, as in Figure 2.3. The subject may not recall that some farmers, some ranchers, and some senators belonged to the pro-canal association; or, that some, rather than all or no members, of a set were included in another set. The subject has failed to make a discrimination where one in fact existed. Such an error is termed an overgeneralization error. Thus, the model makes it possible to measure the comprehension of the two types of set relations.

A third and rather interesting aspect of Dawes' (1964) study was the type of errors which were made in recall. As predicted, he found that overgeneralization errors were more common than pseudo-discrimination errors. The explanation which he offered for these findings was one of information overload. Since overgeneralization results in a reduction in the number of categories in the passage (e.g., in Figure 2.3, the subject fails to recall that a portion of sub-set D is contained in sets B, C, and A), it reduces the amount of information contained in the passage. On the other hand, pseudo-discrimination errors produce an increase in amount of information. Because of the limitation in human memory, Dawes (1964) was not surprised that subjects made more overgeneralization than pseudo-discrimination errors.

Dawes' (1964) model not only affords a technique for holding the amount of essential information constant across the three versions, but it also provides a basis for comparing telegraphic and traditional passages on the type of recall errors made. Assuming that overgeneralization errors occur as a result of information overload and since the shorter passages contain less extraneous information, the model may be interpreted as predicting proportionately fewer overgeneralization errors in the telegraphic passages. Although all the passages contain the same set relations material, they differ in the amount of extraneous material. The latter increases the amount of total information in the passage; consequently, it may interfere with the recall of the basic set relations. Thus, analysis of the set relations recall errors may offer the opportunity of determining whether or not telegraphic materials make less imposition upon memory than traditional materials.

While it is interesting to speculate on the type of set relations errors predicted by the model in the recall of traditional and telegraphic materials, this is not the major advantage of the model. The utility of this model is that it makes possible an operational definition of essential information, thereby permitting this information to be held constant across all versions. Furthermore, the model provides a method for directly assessing the comprehension of the complex set relations.

Method

Subjects

The subjects were 306 male and female students enrolled in an undergraduate educational psychology course at Texas A&M University. There were 282 male and 24 female subjects randomly assigned to one of 18 experimental conditions. The course was designed to improve reading skills. Those skills concerned with reading rate, vocabulary improvement, and comprehension of written materials were practiced through the use of lectures, laboratory sessions, and reading machines. Since the nature of the experiment was in line with the course objectives, participation in all sessions was required. Subjects were not informed of the exact nature of the study until after the completion of all tasks.

Materials

Basic structure of the three treatment versions: The construction of the set relations framework. One-half of the subjects read the prose passages and one-half listened to the same passages presented through individual tape recorders. Each subject, regardless of mode of presentation (aural or written), was presented five prose passages and was tested over this material. Within both the aural and written treatments, one-third read a Trad version, one-third read a Med-Tel version, and one-third read a Hi-Tel version. Volume II to this report contains the 15 versions tested in this experiment.

Four passages were written for this experiment in addition to a fifth passage (Mambo and Yam) which had been written for use in an earlier experiment (Martin & Alonso, 1967). Each story was based on the Dawes (1964) model which involved changing relationships among two major identifiable groups. Appendix A illustrates the changing set relations as each story progressed.

The prose passages were written in narrative style and included much extraneous material. As originally written, some of the passages were too long for use in the allotted class time. Stories were rewritten with minor editing so that a relatively slow reader could finish in less than half a class period, leaving the remaining time for test administration. The finished passages were designated the "traditional" versions. Each story is briefly described in the following paragraphs.

> "Mambo and Yam"--"Mambo and Yam" referenced the changing relationships of two warring African nations along the Nile River. Their people's nature and livelihood were vastly different. Warloving Mambos, led by jealous King Koko, planned to raid wealthy Yam. Yam's kind ruler, King Lester, and his citizens, predominately merchants, were not trained warriors. Mambo easily defeated the Yam merchants and traitor Mambo warriors (secretly trained the merchants to defeat Koko). All Yam citizens became slaves; they plotted against Koko. A legend developed: Lester saved by spirits and would return to free his people. Koko's victory was not sweet; he could trust no one.

> "Buena-I and Ralo"--"Buena-I and Ralo" told of difficulties encountered by two colonist groups sent to planet Gardine-X-35 for copper ore. The Bonese lived on the large land mass which had vast quantities of copper, sparse vegetation, and dry arid climate. The Raloans inhabited the smaller land which was rich in soil and water but poor in

copper. A contract was made to provide water for the Bonese and copper for the Raloans. Friction erupted between the two governments. Raloan leader, Chan, was killed by the Bonese. The Bonese took over Ralo; Raloans became slaves. Freedom of slaves was recommendation was rejected by the Bonese government which resulted in annihilation of both groups.

"The Eskimo"--"The Eskimo" was concerned with a primitive tribe of walrus hunters whose young men were unexpectedly employed by an oil company to perform unsilled labor on a drilling rig. Aktu, future chief of the tribe, learned new skills and adapted to a new environment and different ideas. He became a "bridge" between the culture of his people and the modern-day cities' business life. Johnson, the oil company division supervisor, advised Aktu to form a corporation which produced and sold clothing and native carvings obtained from hunting walrus. Because of the corporation demands, Aktu was unable to assume his hereditary role as leader of the tribe on their hunts.

"Vanua Lava Island"--"Vanua Lava Island" recounted the impact the U.S. Navy, during World War II, had on a peaceful island inhabited by Polynesian coconut harvesters. Led by Captain Morrison, the Navy men erected a supply station and employed a few native men from the Keri tribe. As war efforts moved north, the Navy needed the island station less; therefore, it was abandoned. Most of the Keri men returned again to harvesting coconuts to make copra. Some of the proud chiefs, led by Tomana, refused to return to this work. They took up watch on the island's high cliffs, waiting for the Navy's return. They turned again the Christian missionary, Father Beddington, and reverted to a pagan type worship. Tomana ordered an altar built on the highest cliff for the "Great God Navy" and offered prayers in hopes of a return someday.

"San Francisco"--"San Francisco" described the impact of a devastating earthquake on a major urban area. The functioning of the city government, headed by Mayor St. John, and the state government, was terminated with the deaths of most of the younger city councilmen and senators, the mayor and most of the police officers in the disaster. A young surviving councilman, Will Atkins, assumed leadership of the rescue and evacuation work He had established workable rapport with the city's youth and now welcomed their aid in the work. A group of young people from a mountain valley commune, led by a girl named Helda, gradually overcame the previous resentment which existed between the surviving policemen and youth groups. Forming a group known as the Volunteers for Hope, the young people reclaimed their place in modern urban society.

Calculation of Readability Level

The Flesch readability formula (1949) was used in calculating the difficulty level of the four prose passages constructed for use in Experiment I. The formula requires a 100-word sample from each 500 words of text. The first paragraph is usually not used. The number of sentences in each sample is counted and the total number is divided into 100 to obtain the average sentence length. A sentence portion at the end of the sample is not counted. The syllables in each sample are then counted. The total number of syllables in the sample is located on the Flesch formula chart. The same procedure is followed for the sentence length scale, thus, plotting an intersecting line. The Flesch formula chart is presented in Figure 2.5. The reading ease score for each sample is that level on the center column of the chart where the line crosses. Both a numerical score and a general categorical listing are available. Categories bear such labels as "very easy, easy, standard, fairly difficult, very difficult."

The Flesch (1949) formula scores, descriptive categories, and the grade range equivalents are presented in Table 2.1.

TABLE 2.1

Flesch's Reading Ease Categories

Score	Descriptive Category	Grade Range
90-100	Very Easy	5th grade
80- 90	Easy	6th grade
70- 80	Fairly Easy	7th grade
60- 70	Standard	8th & 9th grades
45- 60	Fairly Difficult	10th-12th grades
30- 45	Difficult	College Undergraduates
0- 30	Very Difficult	College Graduates

One story was designed for the "Fairly Difficult" to "Difficult" range. The other three stories were written for the "Standard" range.

In the present study, the prose passage titled "Buena-I and Ralo" scores at the "College Undergraduate" level of difficulty. The length of this selection necessitated taking eight samples which ranged from a score of 61 (Standard) to a score of 1 (Very Difficult). The other three passages scored at easier readability levels. The passage constructed for the Martin and Alonso (1967) experiment had an average score of 74 (Fairly Easy). This is typical of the prose that is encountered at the seventh grade

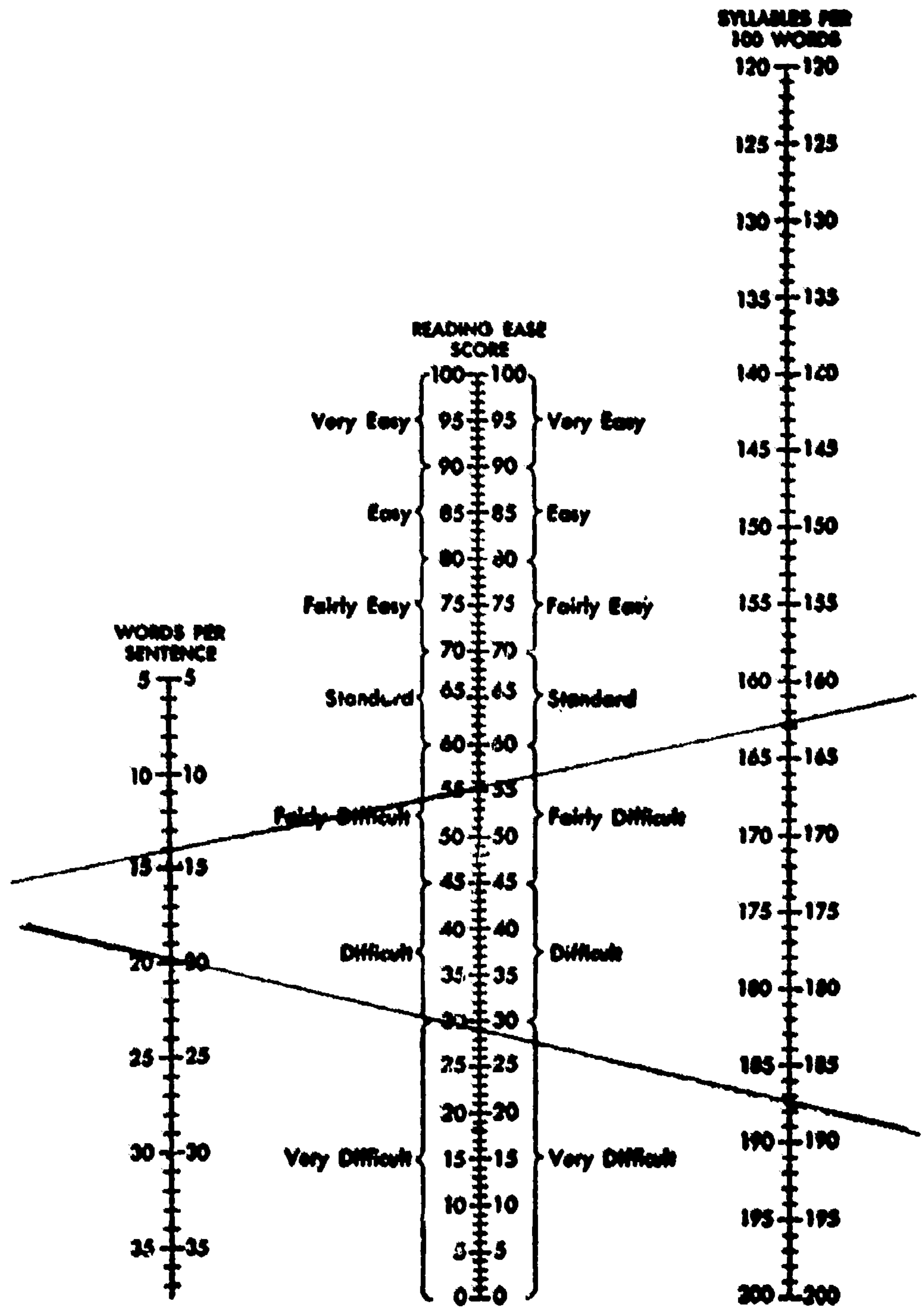

Figure 2.5. Flesch Formula Chart for determining the reading ease score of prose material.

level of difficulty and that appears in most newspapers. Table 2.3 gives the Flesch readability scores for each passage.

The Process of Reducing Prose Length: Style

The first reduction of the original passage was made by the author through the process of eliminating lengthy descriptions, extraneous facts, and redundancies. Words, phrases, sentences, and even paragraphs that did not contribute to the set relations structure were eliminated. The passages written for this experiment were reduced to 50% of their original length. This new version was designated the Med-Tel version.

The Med-Tel versions then underwent a process of deleting all but the most essential information. The result was the Hi-Tel versions which contained approximately 25% of the words found in the Trad versions. Both the Med-Tel and Hi-Tel versions contained the same essential information, with the same sequences of events maintained and the same groups of persons (set relationships) as the Trad versions. The Med-Tel versions maintained a form which were similar to prose found in books, newspapers, and magazines. The Hi-Tel versions, however, were qualitatively different from the Trad and Med-Tel versions. The prose style of the Hi-Tel versions was similar to a telegram.

The Trad, Med-Tel, and Hi-Tel versions for each of the five stories are presented in Volume II of this report. The total number of words present in all five passages is presented in Table 2.2.

TABLE 2.2

Number of Words Contained in the Three Versions for Each Story and Percent Reduction of the Traditional Version

Story	Trad	Med-Tel	% of Trad	Hi-Tel	% of Trad
Mambo and Yam	1601	947	59	455	28
Buena-I and Ralo	3930	1476	38	657	16
The Eskimo	3542	1635	46	527	14
Vanua Lava Island	2568	1214	47	631	24
San Francisco	2692	1341	50	567	21

Preliminary study on two forms of Hi-Tel material. Reduction in reading rates among subjects assigned to a Hi-Tel version was noted in the Martin and Alonso (1967) study. The sentences or sentence fragments in this version were presented in outline form. Sentences were grouped in sets with varying amounts of indentation in the progression down the page.

TABLE 2.3

Flesch Readability Scores for the Five Stories

Sample Number	Word Count in Passage	Sentences Per Sample	Words Per Sentence	Syllables Per Sample	Formula Score
		Mambo and Yam (1601 Words)			
1	73-172	7	14	145	70
2	650-749	7	14	130	82
3	1231-1330	6	16	141	70
				Average	74
					(Fairly Easy)
		Buena-I and Ralo (3930 Words)			
1	98-197	5	20	169	44
2	520-619	5	20	178	37
3	997-1096	5	20	174	40
4	1609-1708	7	14	171	49
5	2056-2155	4	25	176	33
6	2502-2601	2	50	185	1
7	3114-3213	4	20	149	61
8	3595-3694	4	25	154	51
				Average	39
					(Difficult)
		The Eskimo (3542 Words)			
1	145-244	3	33	137	57
2	526-625	3	33	124	67
3	1000-1099	5	20	128	78
4	1483-1582	3	33	139	55
5	2166-2265	4	25	140	62
6	2441-2540	3	33	130	62
7	2917-3016	5	20	167	44
				Average	61
					(Standard)
		Vanua Lava Island (2568 Words)			
1	221-320	5	20	136	73
2	555-654	5	20	152	58
3	1084-1183	5	20	150	60
4	1600-1699	6	16	135	76
5	2133-2232	4	25	146	58
				Average	65
					(Standard)
		San Francisco (2692 Words)			
1	112-211	5	20	151	59
2	553-652	8	12.5	144	72
3	1277-1376	6	16.6	154	60
4	1924-2023	5	20	168	45
5	2205-2304	6	16.6	159	56
				Average	58
					(Fairly Difficult)

The possibility existed that the reduction in reading rate was due to the outline form rather than the density of information. The Hi-Tel version of "San Francisco" was presented to a total of 41 subjects. Twenty subjects read passages printed in paragraph form and 21 subjects read material written in outline style. Subjects were also given two test booklets containing multiple choice and set relation questions; two IBM answer sheets to record the answers; and a time recording form to record the elapsed time spent in reading the passage. Instructions were read aloud to the group.

The test showed no significant differences in the mean word per minute (wpm) reading rate or the mean comprehension score between the two forms.

Sentence structure changes in the reduction process: grammar, punctuation, and indentation. Although the Trad and Med-Tel versions differed in narrative and background material, they were essentially alike in sentence structure. The Hi-Tel version was written in outline form since the preliminary study showed no difference in the comprehension or reading rate among subjects reading the two Hi-Tel versions.

Pilot test of questions constructed for prose passages. Twenty, two-choice set relation questions for each of the four new passages were constructed to test comprehension of nested and disjunctive relations. Sixty-five, four choice multiple choice questions were prepared for the longer "Buena-I and Ralo" prose selection and 60 each for the three other new passages. The passage taken from an earlier experiment, "Mambo and Yam," originally had 39 multiple choice questions constructed for it. Eleven new questions were added to create a 50-item multiple choice test. All questions were based on factual material available in the Hi-Tel version of each prose passage. No detail was tested that was not clearly mentioned in all three versions. After the questions were constructed, they were checked against the Trad and Med-Tel versions to be certain that no conflicting detail was present which might cause confusion due to the greater amount of descriptive material.

The pilot test of the questions was administered to four undergraduate psychology classes at Texas A&M University. These classes consisted of both male and female students. Time sheets were used to record the length of time each subject required to read the Trad passage. Subjects answered all questions on IBM answer sheets.

The answer sheets were machine scored. Kuder-Richardson #20 correlations, point-biserial correlations, and item discrimination values were computed for each question. The original intent of the pilot test had been to reduce the total number of multiple choice questions. However, retention of all the multiple choice items was decided in view of the relatively high Kuder-Richardson #20 correlations. Table 2.4 presents the test item statistics for the set relations and multiple choice tests.

TABLE 2.4

Summary Statistics of the Two Tests Developed for Each of the Four Prose Passages

Passage and Statistics	Multiple Choice Questions	Set Relation Questions
Buena-I and Ralo		
Number	32	33
K-R #20	0.93	0.60
Mean Point-Biserial	0.41	0.32
Mean Item Discrimination	0.38	0.32
Mean Item Difficulty	0.71	0.72
The Eskimo		
Number	22	22
K-R #20	0.84	0.37
Mean Point-Biserial	0.28	0.21
Mean Item Discrimination	0.21	0.19
Mean Item Difficulty	0.87	0.81
Vanua Lava Island		
Number	50	51
K-R #20	0.87	0.30
Mean Point-Biserial	0.35	0.26
Mean Item Discrimination	0.30	0.22
Mean Item Difficulty	0.78	0.76
San Francisco		
Number	49	53
K-R #20	0.88	0.45
Mean Point-Biserial	0.34	0.27
Mean Item Discrimination	0.27	0.28
Mean Item Difficulty	0.83	0.70

Recording of Passages for Aural Presentation

A college speech instructor recorded the prose passages. A sample recording was made on which a trial portion of one passage was recorded in three styles. The first style was a dramatic reading with a great amount of variation in volume and interpretation of words and phrases. In a second reading, the narrator gave the passage a carefully timed and unemotional setting. A third reading was presented at a very rapid rate in a flat manner of speech. The second style was chosen for this experiment. The narrator recorded the five prose passages in each of the three versions after scoring the printed copies to insure proper word emphasis, pronunciation, and pauses to indicate sentence endings and paragraph completions. These recordings were made on Scotch brand, type 140 magnetic tape, using a Sony reel-to-reel machine for monaural microphone pickup. The reel tape was then re-recorded onto Norelco C-60 cassettes. Three copies were made of each version of each prose passage. Table 2.5 presents the average word per minute recording rate calculated for each of the three versions for all five stories.

TABLE 2.5

Recorded WPM Rates for the Aural Presentations

Story	Trad	Med-Tel	Hi-Tel
Buena-I and Ralo	135.51	139.51	94.94
The Eskimo	145.58	130.80	103.74
San Francisco	145.77	138.68	106.38
Vanua Lava Island	148.18	140.02	132.84
Mambo and Yam	132.53	132.26	118.80
Mean wpm rate	141.51	136.25	111.34

Selection of the Criterion Passage

Selection of the criterion passage was based upon the following criteria: (1) the questions testing the subjects' comprehension of the prose passage should have high reliability; (2) the passage should be of sufficient interest to college undergraduate students; (3) the reading level of the prose passage should be difficult enough to challenge college undergraduate subjects; and (4) the length of the passage plus the number of test questions should not be too great so that all questions can be completed in the allotted testing time.

Examination of K-R #20 values indicated "Buena-I and Ralo" to be the best selection with values of 0.60 for the set relation questions and 0.93 for the multiple choice questions. The second selection was "San Francisco" with set relations and multiple choice scores of 0.45 and 0.88, respectively.

The four new passages were intended to have high interest value to an undergraduate college population. The "Buena-I and Ralo" passage seemed a good choice in considering this criterion because of its science fiction format. Importance was also attached to the reader's ability to identify with the fictional characters of the passages as a means of promoting interest. Using this criterion, both "San Francisco" and "The Eskimo" were good choices. Each was concerned with the contributions of youth in society. They were judged the best in meeting the interest criterion.

The passage, "Buena-I and Ralo," was the best choice with respect to the difficulty criterion. Flesch (1949) formula calculations revealed an average score of 39 (Difficult) for the eight samples. The "San Francisco" passage was second best with an average readability score of 58 (Fairly Difficult). The other two passages were within the "Standard" range with average scores ranging from 61 to 65. The "Mambo and Yam" passage, developed for use among young blind children in an earlier experiment, had an average score of 74 (Fairly Easy).

The fourth criterion was concerned with the length of each class session, which became the deciding factor. Since the length of the "Buena-I and Ralo" passage was greater than the other passages and the multiple choice test was longer, this passage was rejected as the criterion passage. The "San Francisco" passage was finally selected as the criterion passage because it met all criteria fairly well. The Flesch (1949) readability values for this passage are presented in Table 2.6.

TABLE 2.6

Flesch Readability Scores for the San Francisco Criterion Passage

Passage	Total Words	Average Readability Score	Difficulty Level
Trad	2692	58	Fairly Difficult, 10th-12th grades
Med-Tel	1341	66	Standard, 8th & 9th grades
Hi-Tel	564	44	Difficult, College Undergraduate

The percentage of total number of words in each of the eight grammatical categories for the three versions of "San Francisco" revealed little change in the distribution of these percentages for the Trad and Med-Tel versions. However, the Hi-Tel version showed marked changes in percentages among certain grammatical categories. Table 2.7 presents the percentage of words within each grammatical category for the three versions of the passage.

Sentences in the Hi-Tel version were shorter than those in the Trad and Med-Tel versions. There were 17.81 words per sentence for the Trad passage compared to 17.13 and 9.26 for Med-Tel and Hi-Tel, respectively. A sample selection from each of the three versions of the "San Francisco" criterion passage is presented in Table 2.8.

TABLE 2.7

Percentage of Total Words in Eight Grammatical Categories for the Three Versions of the San Francisco Passage

Grammatical Category	Versions		
	Trad	Med-Tel	Hi-Tel
Nouns	24.04	27.89	43.35
Verbs	19.77	20.09	16.99
Articles	10.38	10.64	0.18
Pronouns	7.42	6.45	2.12
Adjectives	12.02	11.39	17.36
Adverbs	8.61	6.67	3.19
Conjunctions	4.82	3.75	1.24
Prepositions	12.94	13.12	15.57

TABLE 2.8

Sample Passages from the Three Versions of the San Francisco Story

Version	Passage
Traditional	On the seal of the city of San Francisco which existed between the years 1860 and 1974, there was pictured the Phoenix, the Egyptian symbol of immortality. The bird rises from ashes on the seal, commemorating the disastrous fires of the early 1850's. No one then foresaw the destruction by earthquake and fire, followed by rebuilding, followed by repeated destruction by earthquake, sinking of land and tidal wave. The Phoenix was eventually made the symbol of the Volunteers for Hope. Out of the ashes of the generation gap had arisen a reborn life: a new respect, understanding, acceptance, and love of old for young and young for old.
Med-Tel	On the San Francisco city seal there was pictured the Phoenix, the Egyptian symbol of immortality. The bird rises from ashes, commemorating the disastrous fires of the 1850's. The Phoenix eventually became the symbol of the Volunteers for Hope. Out of the ashes of the generation gap had arisen a new respect, understanding, acceptance, and love of old for young and young for old.
Hi-Tel	San Francisco city seal had Phoenix, Egyptian symbol of immortality, pictured. Volunteers for Hope adopted Phoenix as their symbol. Out of ashes of generation gap had arisen new respect, understanding, acceptance.

Procedure and Design

The study employed a 3 x 3 x 2 factorial design. The independent variables were the number of Practice Sessions prior to reading the criterion passage (0, 2, 4); Material Format (Trad, Med-Tel, Hi-Tel); and Mode of Presentation (aural or written). Assignment of subjects to one of the 18 treatment conditions was based on the following procedure. Class rosters were secured for all subjects participating in the experiment. Numbers were randomly assigned to all subjects in order to eliminate alphabetization effects. Subjects were first assigned to one of the two modes of presentation; and then they were randomly assigned to one of the three material format conditions. Each subject was then assigned, at random, to one of the three practice conditions.

To control for any possible effect which might arise as a result of reading the practice passages in a particular order, a listing was made of the 24 possible presentation orders. From these 24 different orders, 15 presentation orders were chosen at random. Thus, even though the criterion passage was used only on sessions 1, 3, and 5 (practice sessions 0, 2, and 4), the additional four stories were counterbalanced, with respect to the order of presentation, before and after the criterion passage. The orders of the stories are shown in Appendix B.

All subjects received the same instructions and followed the same testing procedure. Recall of the set relations and multiple choice tests was measured immediately after reading or hearing the assigned version. The actual testing was conducted during the last two weeks of the semester.

Attenuation of Subjects

Of the 354 students enrolled in the classes, 48 were eliminated because of improperly marked answer sheets, failure to enter correct reading times, or because they did not read all five stories within the two weeks allotted for the experiment.

Comprehension: Set Relations

This recall condition was specifically designed to measure subjects' retention and distortion of the set relations. The test consisted of 10 nested items and 10 disjunctive items. Each item required subjects to choose between two statements. The set relations test for each of the five stories is presented in Volume II.

Comprehension: Multiple Choice

The length of each criterion passage determined the length of each multiple choice test. Each test consisted of 50 to 65, four-alternative multiple choice items based on the important events, settings, and people in the story. The primary purpose of this test was to test retention of factual type information. As with the set relations test, the multiple choice test was the same for all subjects. Multiple choice tests for the five stories are presented in Volume II.

Scoring of Dependent Variables

Comprehension of set relations was measured by: (1) total number of correct items and (2) a simplication score (S-score) which was defined as the number of nested items correct minus the number of disjunctive items correct plus 10. Comprehension of the multiple choice test was based on the total number of correct responses.

Instructions to Subjects

Instructions were presented aurally to all subjects each time they read or listened to a story. An identical set of instructions was typed and taped on the desk in front of each subject at all times. The aural and written presentation instructions are presented in Appendix C.

Class size ranged from 19 to 27 students, with approximately half of the students listening to passages and half reading passages during each session. Subjects in the aural condition were seated at 15 listening stations located at the sides and back of the classroom with their backs to subjects reading the passages. Subjects in the written condition sat in regular classroom desks in the center of the room facing the front.

Since participation in the experiment was required, subjects were allowed to make up missed sessions at any of the regularly scheduled testing times. In addition, after the experiment, one day was reserved in order to allow subjects to complete all five stories.

Results and Discussion

Test Item Statistics

Table 2.9 presents the results of the item analysis for the criterion passage on the 20-item set relations test and the 60-item multiple choice test for both the written and aural conditions.

Each of the test statistics presented in Table 2.9 is based on 153 subjects. Considering the relatively large number of subjects on which these values are based, the test statistics should be rather stable.

TABLE 2.9

Results of the Item Analyses for the Two Comprehension Tests in the Written and Aural Conditions

Item Statistics	Written		Aural	
	MC	SR	MC	SR
Mean Number Correct	48.10	13.69	43.09	12.84
Standard Deviation	8.55	2.59	9.03	2.40
Kuder-Richardson #20	0.90	0.53	0.88	0.40
Mean Point-Biserial	0.38	0.31	0.36	0.28
Mean Item Discrimination	0.32	0.31	0.35	0.29
Mean Item Difficulty	0.80	0.72	0.71	0.64
Standard Error of Measurement	2.76	1.78	3.09	1.86

Ebel (1954) recommends that items be in the mid-range of difficulty (40-70%). With the exception of the multiple choice items in the written condition, the other values are near the upper limit of this recommended range. Ebel also recommends that the items be above .30 in discrimination. All mean item discrimination values were above this minimal value except the set relation questions in the aural condition, which was .29.

The mean point-biserial correlation measures the relationship between performance (pass/fail) on the items and total test score. The resulting T value for all four tests was significant beyond the .001 level. The Kuder-Richardson #20 values are certainly acceptable for the multiple choice test in both the written and aural conditions. The lower correlation coefficients for the set relations test are undoubtedly due to the relatively smaller number of items in this test in comparison to the multiple choice test.

Analysis of Multiple Choice Comprehension Test

The total number of correct responses on the multiple choice test was analyzed by the use of a 3 x 3 x 2 ANOVA. The independent variables were: Material Format (Trad, Med-Tel, Hi-Tel); number of Practice Sessions prior to reading or listening to the criterion passage (0, 2, 4); and Mode of Presentation (aural or written). Table 2.10 presents the mean number of correct responses and the standard deviations for the cell means in the 3 x 3 x 2 ANOVA.

The results indicated a significant effect for the Material Format main effect ($\underline{F}(2,228) = 9.50$, $\underline{p}<.001$). The Scheffé test (Winer, 1962) indicated significant differences ($\underline{p}<.05$) between Med-Tel and Hi-Tel versions. The ANOVA also

TABLE 2.10

Cell Means and Standard Deviations for the Number of Correct Responses on the Multiple Choice Test in the 3 x 3 x 2 ANOVA

Item		Correct Responses		
Practice Sessions		0	2	4
	Mean S.D.	45.50 8.44	46.12 8.49	45.17 10.41
Material Format		Trad	Med-Tel	Hi-Tel
	Mean S.D.	46.62 8.99	47.57 8.06	42.60 9.59
Mode of Presentation		Written	Aural	
	Mean S.D.	48.10 8.55	43.09 9.03	
Practice x Format		Practice Sessions		
		0	2	4
Trad	Mean S.D.	46.62 9.03	47.47 7.93	42.41 7.64
Med-Tel	Mean S.D.	48.32 7.28	47.03 7.44	43.00 9.83
Hi-Tel	Mean S.D.	44.91 10.34	48.20 8.95	42.38 11.23
Practice x Mode Interaction		Practice Sessions		
		0	2	4
Written	Mean S.D.	48.29 7.10	48.73 7.65	47.28 10.61
Aural	Mean S.D.	42.71 8.80	43.51 8.56	43.06 9.85

TABLE 2.10

(Continued)

Item		Correct Responses		
Material Format x Mode Interaction		Mode of Presentation		
		Written	Aural	
Trad	Mean	49.69	43.55	
	S.D.	8.05	8.90	
Med-Tel	Mean	49.47	45.67	
	S.D.	6.02	9.37	
Hi-Tel	Mean	45.14	40.09	
	S.D.	10.38	8.04	
Practice x Material Format		Practice Sessions (Written)		
		0	2	4
Trad	Mean	49.76	48.84	46.29
	S.D.	7.52	6.60	7.12
Med-Tel	Mean	51.18	48.71	46.29
	S.D.	6.48	5.61	9.83
Hi-Tel	Mean	48.18	50.88	42.82
	S.D.	9.96	5.93	13.45
Practice x Material Format		Practice Sessions (Aural)		
		0	2	4
Trad	Mean	43.47	46.12	38.53
	S.D.	9.51	9.07	6.15
Med-Tel	Mean	45.47	45.35	39.71
	S.D.	7.06	8.75	8.92
Hi-Tel	Mean	41.71	45.53	41.94
	S.D.	9.99	10.72	8.86

indicated a significant difference ($F(1,288) = 25.64$, $p<.001$) between the written and aural presentation conditions. The Scheffé test indicated that there was 10% less comprehension in the aural condition in comparison to the written condition. None of the interactions approached significance at the .05 level. The expectation was that practice would have some effect upon comprehension, especially for the Hi-Tel condition. However, neither the Practice Sessions main effect nor the Practice by Material Format interaction were significant.

Set Relations Analysis

The total number of correct responses on the set relations test was also analyzed by the use of a 3 x 3 x 2 ANOVA. Again, the independent variables were: Material Format (Trad, Med-Tel, Hi-Tel); number of Practice Sessions prior to reading or listening to the criterion passage (0, 2, 4); and Mode of Presentation (aural or written). Table 2.11 presents the mean number of correct responses and the standard deviations for the cell means in this analysis.

The results of the set relations comprehension test paralleled the results of the multiple choice test. There was a significant effect for the Material Format main effect ($F(2,288) = 5.59$, $p<.01$) and the Mode of Presentation main effect ($F(1,288) = 9.20$, $p<.01$). In addition, the two-way interaction of Material Format by Mode of Presentation main effects was significant ($F(2,288) = 3.61$, $p<.01$). Figure 2.6 shows a rather marked decrement in comprehension for the Trad passage presented in the aural mode. There was some decrease in comprehension of the Hi-Tel material in the aural mode compared to comprehension of the Hi-Tel material in the written mode. The mean number of correct responses is very similar for the three format conditions in the aural mode; however, there are rather large differences among the format conditions in the written mode.

These results are somewhat surprising in view of the relatively constant input rate under the aural mode for the three material format conditions. If it can be assumed that telegraphic messages are more informationally compact than Trad messages, then one would expect to find greater decrements in comprehension for the telegraphic format in the aural mode.

Although a meaningful interpretation of the Mode of Presentation main effect is not possible due to the interaction effect, inspection of Figure 2.6 reveals the source of the Mode of Presentation main effect. The superiority of the written mode is due primarily to the relatively high comprehension associated with the Trad passage. The other treatment means differ by less than one correct response. Again, the expectation was that aural practice on telegraphic materials

TABLE 2.11

Mean Number of Correct Responses and Standard Deviations on the Set Relations Test in the 3 x 3 x 2 ANOVA

Item		Correct Responses		
Practice Sessions		0	2	4
	Mean S.D.	13.26 2.47	13.40 2.44	13.12 2.68
Material Format		Trad	Med-Tel	Hi-Tel
	Mean S.D.	13.92 2.78	12.88 2.17	12.98 2.49
Mode of Presentation		Written	Aural	
	Mean S.D.	13.69 2.59	12.84 2.40	
Practice x Material Format		Practice Sessions		
		0	2	4
Trad	Mean S.D.	13.65 2.67	14.35 2.62	13.76 3.06
Med-Tel	Mean S.D.	13.38 2.12	12.56 2.26	12.71 2.27
Hi-Tel	Mean S.D.	12.76 2.57	13.29 2.15	12.88 2.56
Practice x Mode		Practice Sessions		
		0	2	4
Writ-ten	Mean S.D.	13.45 2.69	13.88 2.43	13.73 2.67
Aural	Mean S.D.	13.08 2.23	12.92 2.38	12.51 2.58

TABLE 2.11

(Continued)

Item		Correct Responses		
Material Format x Mode of Presentation		Written	Aural	
Trad	Mean S.D.	14.80 2.69	13.04 2.60	
Med-Tel	Mean S.D.	12.84 1.82	12.92 2.50	
Hi-Tel	Mean S.D.	13.41 2.79	12.55 2.09	
Practice x Material Format		Practice Sessions (Written)		
		0	2	4
Trad	Mean S.D.	14.71 2.73	15.24 2.49	14.47 2.94
Med-Tel	Mean S.D.	12.76 2.11	12.65 1.77	13.11 1.62
Hi-Tel	Mean S.D.	12.88 2.87	13.76 2.36	13.59 3.16
Practice x Material Format		Practice Sessions (Aural)		
		0	2	4
Trad	Mean S.D.	12.59 2.21	13.47 2.50	13.06 3.09
Med-Tel	Mean S.D.	14.00 2.00	12.47 2.72	12.29 2.49
Hi-Tel	Mean S.D.	12.65 2.32	12.82 1.88	12.18 2.13

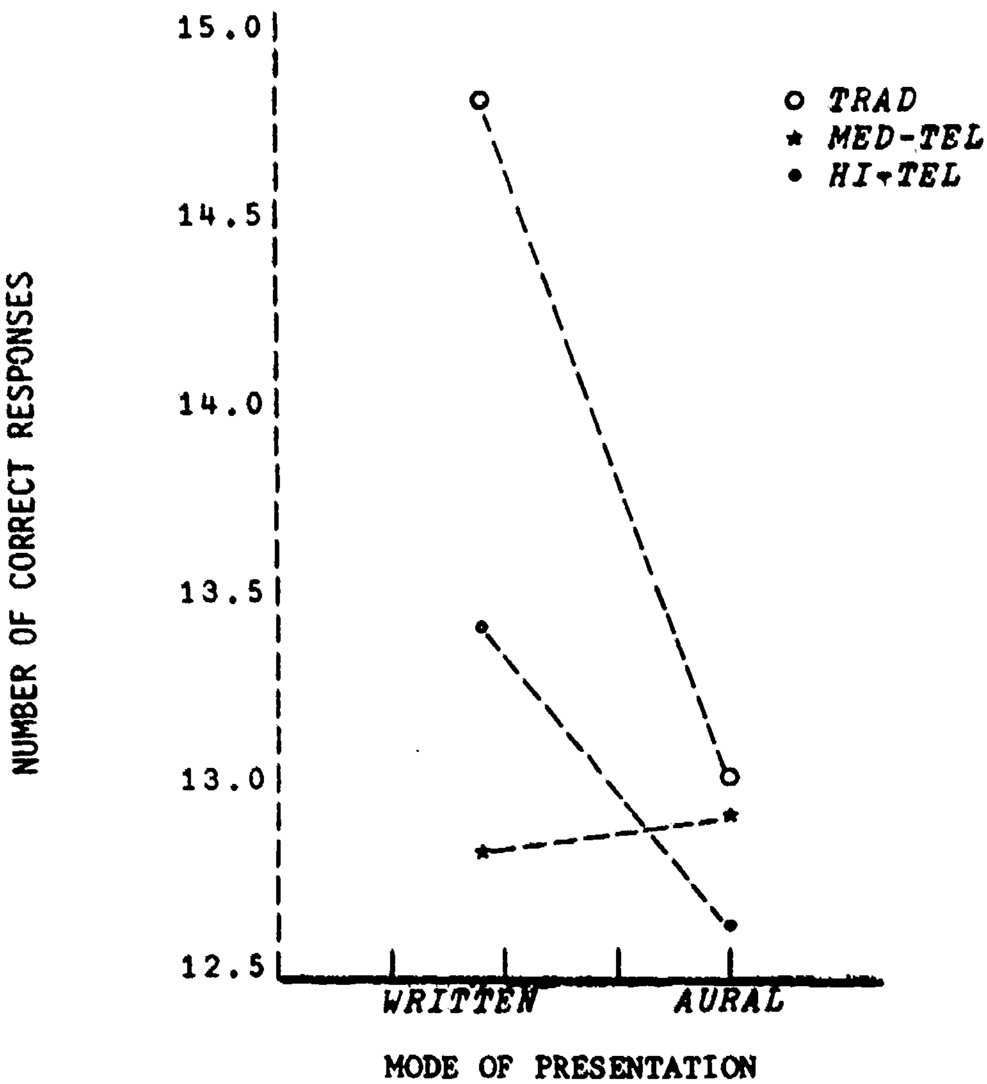

Figure 2.6. Interaction effect of Material Format x Mode of Presentation on the set relations test.

would enhance comprehension of messages presented in the telegraphic format. The lack of a significant practice effect fails to support this expectation.

Analysis of Reading Time

All subjects in the written condition recorded the total time they required to read the entire passage. Table 2.12 presents the means and standard deviations for reading time. A 3 x 3 ANOVA was used to determine whether any differences existed among the material format conditions and among practice sessions.

The only effect which was significant was the Material Format main effect ($F(2,152) = 77.36$, $p<.001$). The Scheffé analysis indicated a significant difference ($p<.001$) between Trad and Med-Tel, Trad and Hi-Tel, but no difference between Med-Tel and Hi-Tel. Again, neither the Practice Sessions main effect nor the Practice by Material Format interaction were significant. Thus, these results show that significantly less time was spent reading the telegraphic versions in comparison to the Trad version; but practice had no effect in decreasing the amount of reading time required for the Hi-Tel versions. The Med-Tel version required 41% less reading time in comparison to the Trad version, while 55% less time was spent reading the Hi-Tel version in comparison to the Trad version.

Analysis of Reading Rate

The number of words read per minute (wpm) was computed for each subject. The means and standard deviations of the reading rates are presented in Table 2.13. A 3 x 3 ANOVA was used to determine whether any differences existed among the three practice levels and the three material format conditions.

The only effect which was significant was the Material Format main effect ($F(2,152) = 14.81$, $p<.001$). Scheffé's method of multiple comparisons indicated a significant difference ($p<.001$) between the means of the Trad and Hi-Tel versions and between the means of the Med-Tel and Hi-Tel versions. Again, as in the Martin and Alonso (1967) investigation, there was a significant decrement in reading rate for subjects reading the Hi-Tel prose. Two or four practice sessions were not effective in increasing reading rates comparable to the rates exhibited by subjects reading the Trad prose. The 37% reduction in reading rates among subjects reading the Hi-Tel version in comparison to the Trad version seems to indicate that the Hi-Tel version was more informationally compact than the Trad version.

Analysis of Nested and Disjunctive Relationships

A feature of the Dawes (1964) model is that it allows one to test the comprehension of some rather complex relationships. Dawes postulates two types of possible errors in the recall of

TABLE 2.12

Mean Number of Minutes and Standard Deviations
Required to Read the Criterion Passage

Item		Reading Time		
Practice Sessions		0	2	4
	Mean S.D.	9.82 5.79	9.26 5.05	8.80 4.65
Material Format		Trad	Med-Tel	Hi-Tel
	Mean S.D.	14.36 3.50	7.58 2.09	5.94 4.88
Practice x Material Format		Practice Sessions		
		0	2	4
Trad	Mean S.D.	14.11 3.41	15.11 3.42	13.86 3.75
Med-Tel	Mean S.D.	7.37 1.77	8.04 2.19	7.32 2.33
Hi-Tel	Mean S.D.	7.97 7.76	4.62 1.59	5.22 2.22

TABLE 2.13

Mean Number of Words Per Minute and Standard Deviations for the 3 x 3 ANOVA

Item		Words Per Minute		
Practice Sessions		0	2	4
	Mean S.D.	165.92 63.30	175.83 85.74	180.77 102.90
Material Format		Trad	Med-Tel	Hi-Tel
	Mean S.D.	200.21 67.91	196.10 85.52	126.23 81.30
Practice x Material Format		Practice Sessions		
		0	2	4
Trad	Mean S.D.	201.11 54.44	193.18 63.64	206.33 85.46
Med-Tel	Mean S.D.	191.65 42.44	179.62 50.75	217.02 133.07
Hi-Tel	Mean S.D.	105.01 42.36	154.70 124.64	118.97 43.95

the set relations. If in the recall of a nested set the subject reca s that it overlapped with some other set, then a pseudo-discrimination error has occurred. The subject has made a discrimination when, in fact, there was none. On the other hand, failure to recall a discrimination that was present in the passage is termed an overgeneralization error (i.e., some of X belongs in Y, but the subject recalls all X is Y or no X is Y). The model makes it possible to measure the comprehension of these two types of set relations. Another interesting aspect of Dawes' (1964) study was the type of errors made in recall. As predicted, he found that over-generalization errors were more common than pseudo-discrimination errors. The explanation he offered for these results was in terms of information overload. Since overgeneralization results in a reduction in the number of categories in the passage, it reduces the amount of information contained in the passage. Pseudo-discrimination errors, on the other hand, produce an increase in the amount of information. It was not surprising that Dawes' subjects made overgeneralization rather than pseudo-discrimination errors.

Dawes' analysis of the two types of errors leads one to predict that more nested items will be correct than disjunctive items. Furthermore, if it can be assumed that there is less total information in the telegraphic versions, then one would expect to find more disjunctive items correct in telegraphic messages than in Trad messages. This analysis would lead one to predict an interaction effect between Material Format and the Type of Question (nested and disjunctive). In order to test this hypothesis, a Lindquist Type III ANOVA was computed. In this analysis, the three main effects were Material Format, Practice Sessions, and Type of Question. Table 2.14 presents the means and standard deviations on the number of correct responses for the nested and disjunctive scores in the written mode.

The results of the Lindquist Type III ANOVA indicated significance ($F(2,144) = 8.40$, $p<.001$) for the Material Format main effect. This result was not surprising since format has previously been shown to be a significant variable. Type of question produced a significant F value ($F(1,144) = 168.48$, $p<.001$). Contrary to Dawes' findings, the results of this study have shown the disjunctive items to be easier than the nested ones. Also, the predicted interaction between Type of Question and Material Format did not approach significance.

A second Lindquist Type III design was used to test the same effects for the aural condition. Table 2.15 presents a summary of the means and standard deviations on the number of correct responses for the nested and disjunctive scores in the aural mode. This analysis revealed no significant differences among the material format conditions. However, there was a significant difference ($F(1,144) = 175.51$, $p<.001$) for the Type of Question main effect which shows the disjunctive items

TABLE 2.14

Mean Number of Correct Responses and Standard Deviations for the Written Nested and Disjunctive Scores

Item		Correct Responses		
Practice Sessions (Nested)		0	2	4
	Mean S.D.	5.63 1.89	5.55 1.72	5.76 1.85
Material Format (Nested)		Trad	Med-Tel	Hi-Tel
	Mean S.D.	6.33 1.74	5.02 1.57	5.59 1.90
Practice Sessions (Disjunctive)		0	2	4
	Mean S.D.	7.78 1.69	8.33 1.57	7.96 2.12
Material Format (Disjunctive)		Trad	Med-Tel	Hi-Tel
	Mean S.D.	8.47 1.39	7.78 2.14	7.82 1.73
Practice x Material Format		Practice Sessions (Nested)		
		0	2	4
Trad	Mean S.D.	6.24 1.76	6.47 1.61	6.29 1.84
Med-Tel	Mean S.D.	5.18 1.83	4.71 1.56	5.18 1.04
Hi-Tel	Mean S.D.	5.47 1.85	5.47 1.58	5.82 2.26

TABLE 2.14

(Continued)

Item		Correct Responses		
Practice x Material Format		Practice Sessions (Disjunctive)		
		0	2	4
Trad	Mean	8.47	8.76	8.18
	S.D.	1.19	1.31	1.58
Med-Tel	Mean	7.47	7.94	7.94
	S.D.	1.50	1.86	1.39
Hi-Tel	Mean	7.41	8.29	7.76
	S.D.	2.06	1.36	1.59

TABLE 2.15

Mean Number of Correct Responses and Standard Deviations for the Aural Nested and Disjunctive Scores

Item		Correct Responses		
Practice Sessions (Nested)		0	2	4
	Mean S.D.	5.22 1.72	5.24 1.60	4.94 1.80
Material Format (Nested)		Trad	Med-Tel	Hi-Tel
	Mean S.D.	5.16 1.62	5.16 1.83	5.08 1.68
Practice Sessions (Disjunctive)		0	2	4
	Mean S.D.	7.80 1.71	7.78 1.67	7.57 1.61
Material Format (Disjunctive)		Trad	Med-Tel	Hi-Tel
	Mean S.D.	7.88 1.80	7.80 1.64	7.47 1.51
Practice x Material Format		Practice Sessions (Nested)		
		0	2	4
Trad	Mean S.D.	4.94 1.35	5.53 1.19	5.00 2.11
Med-Tel	Mean S.D.	5.71 1.73	5.00 1.91	4.76 1.70
Hi-Tel	Mean S.D.	5.00 1.91	5.18 1.58	5.05 1.51

TABLE 2.15

(Continued)

Item		Correct Responses		
Practice x Material Format		Practice Sessions (Disjunctive)		
		0	2	4
Trad	Mean	7.47	8.12	8.06
	S.D.	2.12	1.53	1.62
Med-Tel	Mean	8.29	7.58	7.53
	S.D.	0.96	1.94	1.75
Hi-Tel	Mean	7.65	7.65	7.12
	S.D.	1.71	1.45	1.28

to be easier than the nested ones. Contrary to expectation, there was no interaction between Type of Question and Material Format.

Conclusions

The results of this investigation are contradictory to Dawes' (1964) results. In this study, disjunctive items were consistently easier than nested items. It appears that the relative ease of disjunctive items as opposed to nested items makes it impossible to test for information density in telegraphic passages. The analysis of the wpm rates suggests that telegraphic messages produced greater information overload than did traditional passages. Yet, in none of the analyses was there any interaction between Material Format and Type of Question.

The first hypothesis tested in this experiment assumed that the reduction in wpm rate associated with telegraphic prose in the Martin and Alonso (1967) study was due to the relative compactness of the information in telegraphic prose as compared to the distribution of information in traditional prose. Thus, when subjects read telegraphic materials, it was necessary to compensate for the compactness of the information by reducing their reading speed.

The second hypothesis tested assumed that the reduction in the wpm rate was due to the unique style of telegraphic prose and that practice by telegraphic material would increase reading speed. The results of this experiment provided no support for the second hypothesis. In none of the analyses was the Practice Sessions main effect significant.

There tends to be more support for the first hypothesis. First, there was a significant main effect due to Material Format in the analysis of both the set relations test and the multiple choice test. Comprehension of the Hi-Tel version was lower than comprehension of the Trad version. Second, the wpm rate for the Hi-Tel version was lower than that for the Med-Tel or Trad versions. However, significantly lower comprehension scores were associated with the aural mode in spite of the relatively slower wpm presentation rate. In addition, no differential reduction in comprehension was associated with the Hi-Tel passage presented in the aural mode.

An interesting aspect of the results of this experiment is related to the overall efficiency of telegraphic prose. Although the Hi-Tel versions averaged 8% less comprehension, there was approximately 70% less time devoted to either listening or reading the Hi-Tel version.

In summary, the results suggest that when information is compactly presented in a Hi-Tel format, subjects' rate of information input is voluntarily reduced. However, when the relatively small reduction in the Hi-Tel messages is considered in relation to the total message time, telegraphic prose is much more efficient than traditional prose.

CHAPTER III

EXPERIMENT II

EFFECTS OF A GRAMMATICAL DELETION SCHEME IN THE GENERATION OF TELEGRAPHIC PROSE

Introduction

Brown and Bellugi (1966), 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. Brown and Fraser (1963) have stated that a young child's sentences are limited in length by the child's ability to plan them. Consequently, young children are compelled to omit some words from the longer sentences they hear from adults. In spite of the telegraphic nature of 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.

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, 1965).

Another aspect of the more redundant structural elements concerns their effects 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 bits of 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 (1965) indicated that the structural elements are primarily for encoding. He further stated 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 subject's own spontaneous distribution of function words than to those functors presented in the original passages. The opposite effect was found for the lexical elements.

In defense of the existence of structural redundancy which can be identified by the functional parts of speech, Fillenbaum, Jones, and Rapaport (1963) reported evidence for redundancy as a function of the dependencies of grammatical categories.

Using the cloze procedure, Fillenbaum, Jones, and Rapaport (1963) deleted words from a prose passage at varying rates of deletion. Every second, third, fourth, fifth, and sixth word was deleted systematically creating five passages of cloze material. The subjects, who were asked to guess the missing words, were measured on form class predictability, e.g., the extent to which they could supply a word of the same grammatical class as the original word, and on verbatim predictability, or the extent to which the exact word was supplied.

There were few distinctive differences found among the grammatical classes on form class predictability, although the greatest success was found for nouns, pronouns, conjunctions, and prepositions. Specific verbatim identification of nouns, main verbs, and adverbs was considerably lower than for the function words (pronouns, articles, auxiliary verbs, prepositions, and conjunctions). Thus, members of a grammatical class of fewer items, such as function words, were better identified verbatim than those members in classes of larger numbers. Significantly, the general success of the form class completion, even when every second word was omitted, indicated strong evidence for a redundant syntactic organization in the language.

The existence and effect of grammatical structure in the language has been further investigated by the use of a variety of methods, with similar results.

Coleman and Miller (1968) developed a measure of efficiency by which a passage transmits information. The measure, called information gain, is based upon Shannon's (1951) "guessing game technique." Coleman and Miller measured the amount of information gain contributed by the grammatical word classes. Nouns resulted in the highest amount of information gain followed by adjectives, verbs, adverbs, conjunctions, pronouns, articles, and finally prepositions. The results of this study tend to support the findings by Fillenbaum, Jones, and Rapaport (1963).

The importance of the various grammatical categories on comprehension was further investigated by Sheffield (1972). Sheffield asked subjects to rank the words in each of several sentences according to their importance for the meaning of the sentence. An analysis of the word rankings by grammatical category indicated that the following categories were ranked in order of their importance for sentence understanding: nouns, verbs, adjectives, prepositions, pronouns, conjunctions, adverbs, and articles. Although the results of the Coleman and Miller (1968) study indicate a slight modification in the order of the unimportant categories, the results of the Sheffield investigation generally supports a structural and lexical word dichotomy.

By using the cloze technique, Coleman and Blumenfeld (1963) measured the importance of several grammatical categories on the basis of their predictability. The cloze technique was applied to two types of passages. One contained nominalized sentences; the other contained active verb sentences. Several cloze test forms were developed for each passage so that every word could be scored. Although there was no significant difference in the mean number of function words filled in correctly between the two passages, mean content words filled in correctly for the nominalized sentences was significantly less than for the active verb sentences. Percentage of correct responses over both passage types indicates an inverse relationship with the importance of the grammatical parts of speech. In order of predictability, 47% function words, 34% pronouns, 11% adverbs, 10% adjectives, 10% nouns, and 7% verbs could be correctly replaced. In this study, the relative importance of verbs supersedes that of nouns. It is suggested that the difficulty of the passages, which were of a technical nature, as well as the combination of two types of writing may have affected this outcome.

The present study was 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. The five grammatical categories were: nouns and pronouns, verbs, adjectives and adverbs, prepositions, and 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, 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.

Method

Subjects

A total of 468 subjects were tested in this experiment. All subjects were enrolled in either introductory or sophomore level psychology courses at Sam Houston State University. A total of 18 subjects were randomly assigned to each of the 26 experimental passages.

Materials

The original form of "San Francisco" from Experiment I was chosen as the traditional (Trad) passage for this study. Twenty-five 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 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 Trad 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 each of the five categories. Only one category of words was deleted at a specified level of reduction so that there were five versions of the passage at each deletion level.

The Trad passage contained the following number of words in each grammatical category: 644 nouns, 200 pronouns, 533 verbs, 324 adjectives, 232 adverbs, 349 prepositions, 280 articles, and 130 conjunctions. The percentage of each grammatical category to the total number of words in the passage was as follows: 24.04% nouns, 7.42% pronouns, 19.77% verbs, 12.02% adjectives, 8.61% adverbs, 12.94% prepositions, 10.38% articles, and 4.82% conjunctions.

Reading time was recorded by each subject. The timing device was a large classroom clock which was placed in view of all subjects. When the subjects began reading the passages, the clock was set at exactly 12:00. All subjects were instructed to record the elapsed reading time when they finished reading the passage.

When the subjects completed the reading passage, they were administered a 60-item multiple choice test and a 20-item set relations test which was developed and used in Experiment I. Experiment I described the construction of the two tests.

The telegraphic versions of the passage were typed from the computer printouts. The original sentence and paragraph formats were maintained in the telegraphic passages. If the first word or words of the sentence were deleted, the first remaining word was capitalized. The total number of words in each version is presented in Table 3.1. The mean sentence length for each passage is presented in Table 3.2. The percentage of words remaining in each deleted version as compared to the Trad passage is presented in Table 3.3.

TABLE 3.1

Total Number of Words in Each of the 25 Experimental Prose Passages

Grammatical Category	Percentage Deletion				
	10%	20%	40%	60%	80%
Nouns & Pronouns	2612	2527	2357	2188	2018
Verbs	2643	2590	2483	2377	2270
Adjectives & Adverbs	2641	2586	2475	2363	2252
Prepositions	2662	2627	2557	2487	2417
Conjunctions & Articles	2655	2614	2532	2450	2368
Traditional	2692				

Procedure and Design

The 26 versions of the passage were randomly distributed among the subjects in their regular classrooms. The test packet for each subject consisted of a cover page, an instruction sheet, a prose selection, a time recording form, the test questions, and an IBM answer sheet. As the subjects received their packets, they were instructed to put their names on the answer sheet and the time sheet. The instructions were then read aloud by the experimenter as the subjects read from their instruction sheets. When instructed to begin, the subjects read the story, immediately recorded the elapsed reading time, and then answered the test items.

Four dependent variables were examined in this study: reading rate, reading time, number of correct items on the multiple choice test, and number of correct items on the set relations test. A 1 x 26 ANOVA was used to examine differences across the 26 treatment conditions for each of the

TABLE 3.2

Mean Sentence Length for the 25 Computer Generated Versions of San Francisco Story

Grammatical Category	Deletion Level 10%	20%	40%	60%	80%
Nouns & Pronouns	17.30	16.74	15.61	14.49	13.36
Verbs	17.50	17.15	16.44	15.74	15.03
Adjectives & Adverbs	17.49	17.12	16.38	15.65	14.91
Prepositions	17.63	17.40	16.93	16.47	16.01
Conjunctions & Articles	17.58	17.31	16.77	16.23	15.68

Traditional = 17.85

TABLE 3.3

Percentage of Total Number of Words in the 25 Experimental Passages Compared to the Number of Words in the Traditional Passage

Grammatical Category	Deletion Level 10%	20%	40%	60%	80%
Nouns & Pronouns	96.88	93.73	87.42	81.15	74.85
Verbs	98.03	96.07	92.10	86.17	84.20
Adjectives & Adverbs	97.96	95.88	91.77	87.65	83.53
Prepositions	98.74	97.44	94.84	92.25	98.65
Conjunctions & Articles	98.48	96.96	93.92	90.88	87.83

dependent variables. A 5 x 5 ANOVA was used to determine whether interaction effects were present between deletion level and grammatical category for each of the dependent variables. In addition, a 1 x 6 ANOVA was used to examine each level within the two main effects, Grammatical Category and Deletion Level, of the 5 x 5 ANOVA in relation to the Trad passage.

Results and Discussion

Multiple Choice Test

Table 3.4 presents the mean number of correct responses and the standard deviations for the 5 x 5 ANOVA performed on the multiple choice test. A significant F-ratio ($F(4,425) = 12.96$, $p<.001$) was obtained for the Grammatical Category main effect as well as for the Deletion Level main effect ($F(4,425) = 17.72$, $p<.001$). A significant interaction effect was also found ($F(16,425) = 2.08$, $p<.01$). Figure 3.1 presents the mean number of correct responses for the 26 conditions. Instead of analyzing the simple effects as a result of the significant interaction, each level within the two main effects of the 5 x 5 ANOVA was analyzed in relation to the Trad passage.

The 1 x 6 ANOVAs performed for each level within the Grammatical Category main effect indicated significant differences in all of the grammatical categories except prepositions. In order to determine the exact location of the differences among the six deletion levels, the Scheffé test of multiple comparisons (Winer, 1962) was performed within each grammatical category. Results of the 1 x 6 ANOVA performed on nouns and pronouns indicated a significant difference ($F(5,102) = 17.09$, $p<.001$). The Scheffé analysis revealed significant differences between the Trad version and the 60 and 80% reduced versions. The 10% reduced version also differed significantly ($p<.01$) from the 60 and 80% reduced versions. Both the 20 and 40% reduced versions differed significantly from the 80% reduced version. No differences in comprehension were found between the Trad passage and the passages in which 10, 20, or 40% of the nouns and pronouns were deleted. Thus, up to 40% deletion of nouns and pronouns caused no significant decrease in comprehension in comparison to the Trad passage.

The 1 x 6 ANOVA performed on the verb category indicated a significant difference ($F(5,102) = 4.56$, $p<.01$). Due to the conservative nature of the Scheffé test, the exact location of the differences could not be determined from the post hoc analyses. However, it was possible to infer the location of the differences responsible for the significant difference in the ANOVA design by examining the exact p-values. As compared to the 80% reduced passage, the Trad, 10, and 20% reduced

TABLE 3.4

Means and Standard Deviations for the Number of Correct Responses on the Multiple Choice Test for the 26 Prose Selections and for the 5 x 5 ANOVA

Item	Correct Responses				
Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Prepositions	Conjunctions & Articles
Mean S.D.	38.94 9.96	44.79 9.06	44.22 8.44	46.56 8.01	46.19 8.40
Deletion Level	10	20	40	60	80
Mean S.D.	47.64 7.85	46.74 7.30	45.48 8.52	41.57 9.13	39.27 10.11
Nouns & Pronouns	Deletion Level				
	10	20	40	60	80
Mean S.D.	46.22 7.74	42.50 7.41	42.28 8.77	34.67 7.55	29.06 8.13
Verbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	48.94 7.04	49.22 6.41	43.94 10.04	41.33 10.00	40.50 8.11
Adjectives & Adverbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	48.28 8.46	44.44 7.73	46.33 8.68	40.11 6.42	41.94 8.88
Prepositions	Deletion Level				
	10	20	40	60	80
Mean S.D.	45.39 9.49	47.44 6.64	48.83 8.03	46.56 8.38	44.56 7.39
Conjunctions & Articles	Deletion Level				
	10	20	40	60	80
Mean S.D.	49.39 6.17	50.11 5.94	46.00 5.99	45.17 8.66	40.28 10.95

Traditional Mean = 49.06 S.D. = 6.03

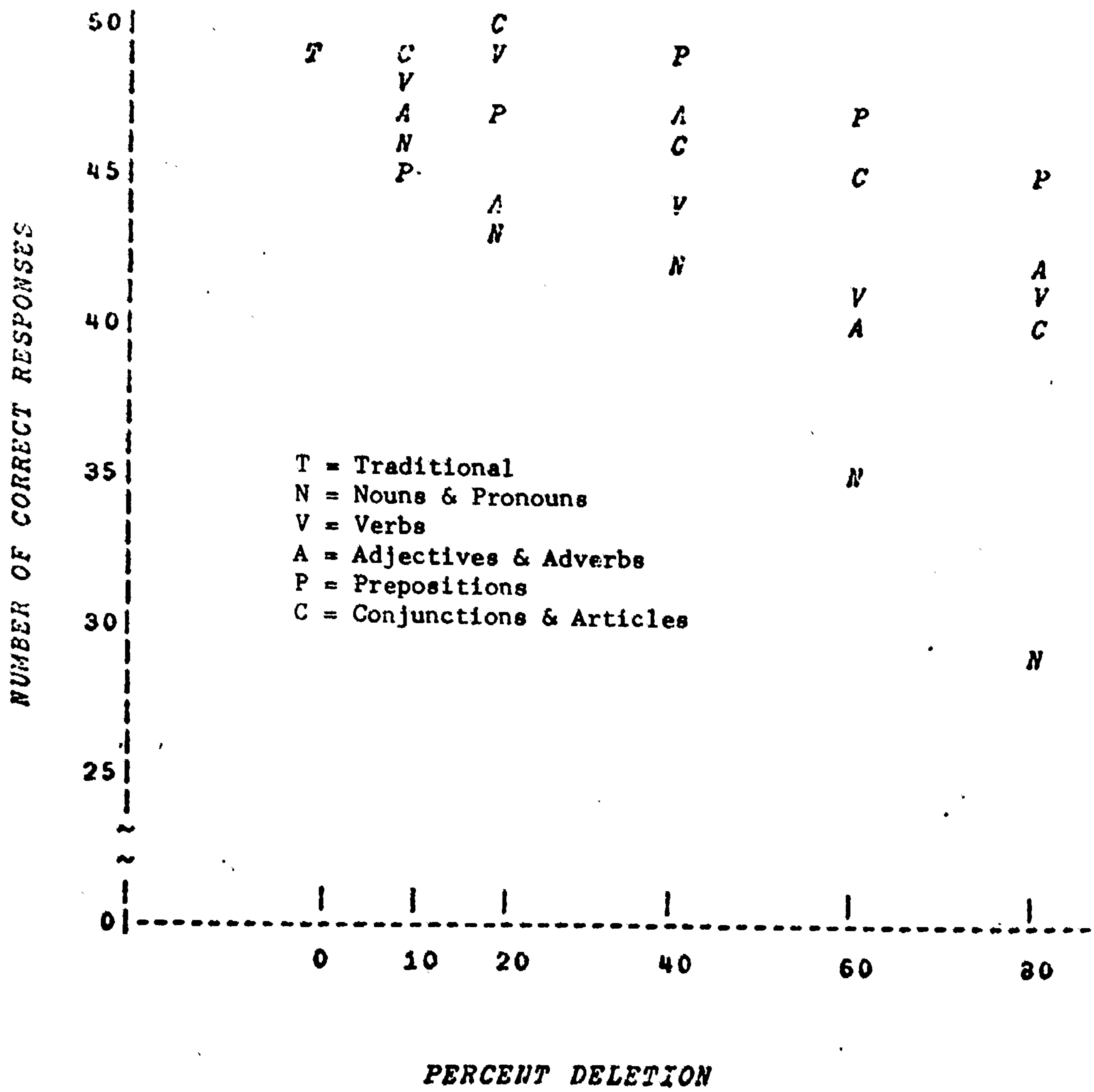

Figure 3.1. Mean number of correct responses on the multiple choice test for each of the 26 prose selections.

passages approached significance. The differences between the 80% reduced passage and the Trad, 10, and 20% reduced passages were the largest based on the exact p-values ($p<.08$, $p<.09$, $p<.07$, respectively).

A significant difference in the effects of deleting increasing percentages of adjectives and adverbs was also found ($F(5,102) = 3.71$, $p<.01$). The Scheffé analysis, however, did not reveal where the differences were. Examination of the exact p-values indicated that the difference between multiple choice scores made by subjects assigned the Trad passage and the 60% reduced passage approached significance ($p<.058$).

Comprehension was not significantly affected by the deletion of prepositions. No significant differences were found in the number of multiple choice items correct when up to 80% of the prepositions were deleted from the passage.

A significant difference ($F(5,102) = 4.35$, $p<.01$) in multiple choice scores was obtained for articles and conjunctions. The Scheffé test revealed a significant difference between the 20 and 80% reduced versions ($p<.05$). Inspection of Table 3.4 indicates that subjects assigned the 20% reduced passage answered the most multiple choice test items correctly ($\bar{X} = 50.11$), while subjects assigned the 80% reduced passage answered the fewest multiple choice items correctly ($\bar{X} = 40.28$). There was no significant difference when the 80% condition was compared to the Trad passage. On the basis of this comparison, it appears that rather large deletion levels can be tolerated among articles and conjunctions.

In order to examine the effects of deleting different amounts from the five grammatical categories, five 1 x 6 ANOVAs were performed on the number of correct responses on the multiple choice test for each percentage deletion level. It should be pointed out that the validity of these analyses is questionable. This is because a fixed deletion level among the five grammatical categories results in different total percentages of words deleted among the categories. Table 3.3 presents the percentage of the total number of words in the deleted passages compared to the Trad passage. Reference to this table is essential in a discussion of the following results.

No significant differences in multiple choice items correct were found across grammatical categories for the 10 and 40% deletion levels. No differences were observed between the Trad passage and any of the five experimental passages. These results indicate that there is no decrement in comprehension when either 10 or 40% of the words within each of the grammatical categories is eliminated in comparison to the Trad passage.

There is some inconsistency in the results of the 1 x 6 ANOVAs performed by deletion level in that there was a significant *F*-value associated with the 20% deletion level ($F(5,102) = 3.64$, $p<.01$). Because of the conservative nature of the Scheffé test, none of the individual comparisons were significant. However, inspection of the exact probability levels indicates that the difference in multiple choice scores for subjects assigned the passage with 20% of the nouns and pronouns deleted ($\bar{X} = 42.5$) compared to subjects assigned the passage with 20% of the articles and conjunctions deleted ($\bar{X} = 50.11$) was responsible for the significant *F*-value in the 1 x 6 ANOVA design. Although the associated *p*-value ($p<.17$) did not approach significance, it was the smallest *p*-value resulting from the pairwise comparisons. This result is not surprising. At the 20% deletion level, the greatest percentage of words omitted was in the noun and pronoun category while the least omitted was in the article and conjunction category.

A significant difference was found at the 60% deletion level across grammatical categories ($F(5,102) = 7.64$, $p<.001$) between the Trad passage and the passage in which 60% of the nouns and pronouns were eliminated. The passage in which 60% of the nouns and pronouns were eliminated differed significantly from the passage in which 60% of the prepositions were eliminated ($p<.01$) as well as from the passage in which 60% of the articles and conjunctions were deleted ($p<.05$). Again, these results are due to the relatively larger percentage of words omitted from the noun and pronoun category.

A significant difference was found across grammatical categories at the 80% deletion level ($F(5,102) = 11.36$, $p<.001$). The post hoc comparisons indicated that the passage in which 80% of the nouns and pronouns were eliminated differed significantly from the Trad passage ($p<.001$) and from each of the three passages in which 80% of the verbs ($p<.01$), 80% of the prepositions ($p<.001$), and 80% of the articles and conjunctions ($p<.01$) were eliminated.

A 1 x 26 ANOVA was used to compare all of the experimental versions of the passage with the Trad version so that it could be determined exactly how much can be deleted in each grammatical category without affecting comprehension. A significant difference ($F(25,467) = 6.61$, $p<.001$) was found among the 26 versions of the passage. The passage in which 80% of the nouns and pronouns had been deleted was found to differ significantly from the Trad passage and the following experimental passages: 10% deletion of nouns and pronouns; 10 and 20% deletion of verbs; 10 and 40% deletion of adjectives and adverbs; 20, 40, and 60% deletion of prepositions; and 10, 20, and 40% deletion of articles and conjunctions. The only passage in the 1 x 26 ANOVA which differed significantly from the Trad version was the version in which 80% of the nouns and pronouns had been deleted.

Table 3.5 presents the number of multiple choice questions unanswerable in the 25 experimental passages. The criterion for determining whether a question was answerable from the material in a particular passage was based upon the presence of key words in that passage. Even though it was felt in some instances that the answer could be inferred from the context of the passage, if any key word was deleted, the question was assessed to be unanswerable.

TABLE 3.5

Number of Multiple Choice Questions Not Answerable in the 25 Deleted Versions

Grammatical Category	Deletion Level				
	10%	20%	40%	60%	80%
Pronouns & Nouns	2	11	20	28	48
Verbs	1	4	5	9	13
Adjectives & Adverbs	1	5	8	17	21
Prepositions	0	0	0	0	0
Conjunctions & Articles	0	0	0	0	0

The Pearson product-moment correlation coefficient was used to determine the relationship between the number of multiple choice questions answerable to the passages and the number of questions answered correctly by the subjects. A significant positive correlation ($\underline{r}(24) = .83$, $\underline{p}<.01$) was found. That is, as the number of questions answerable in the passage decreased, the number of questions answered correctly also decreased.

A significant positive correlation ($\underline{r}(24) = .85$, $\underline{p}<.01$) was found between the number of words in the experimental passages and the number of multiple choice questions that were answerable from the material contained in the passages. In addition, a significant positive correlation ($\underline{r}(24) = .87$, $\underline{p}<.01$) was found between the number of words in the passage and the number of multiple choice items answered correctly.

Set Relations Test

The means and standard deviations for the number of correct responses within the 5 x 5 ANOVA on the set relations test are presented in Table 3.6. Figure 3.2 presents the

TABLE 3.6

Means and Standard Deviations for the Number of Correct Responses on the Set Relations Test for the 26 Prose Selections and for the 5 x 5 ANOVA

Item	Correct Responses				
Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Prepositions	Conjunctions & Articles
Mean S.D.	12.84 2.69	13.82 3.22	13.28 3.02	13.71 2.83	13.31 2.56
Deletion Level	10	20	40	60	80
Mean S.D.	13.89 2.99	13.61 2.74	14.01 2.70	13.07 2.78	12.39 2.94
Nouns & Pronouns	Deletion Level				
	10	20	40	60	80
Mean S.D.	13.83 3.00	13.61 2.38	12.94 3.10	12.61 2.28	11.22 1.99
Verbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	14.67 3.40	13.50 2.90	14.67 2.68	13.39 3.43	12.89 3.55
Adjectives & Adverbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	14.33 3.22	13.11 3.14	14.00 2.70	12.28 2.49	12.67 3.29
Prepositions	Deletion Level				
	10	20	40	60	80
Mean S.D.	12.89 2.81	14.06 3.08	14.67 2.63	13.44 2.97	13.50 2.64
Conjunctions & Articles	Deletion Level				
	10	20	40	60	80
Mean S.D.	13.72 2.47	13.78 2.34	13.78 2.21	13.61 2.66	11.67 2.68

Traditional Mean = 14.17 S.D. = 1.89

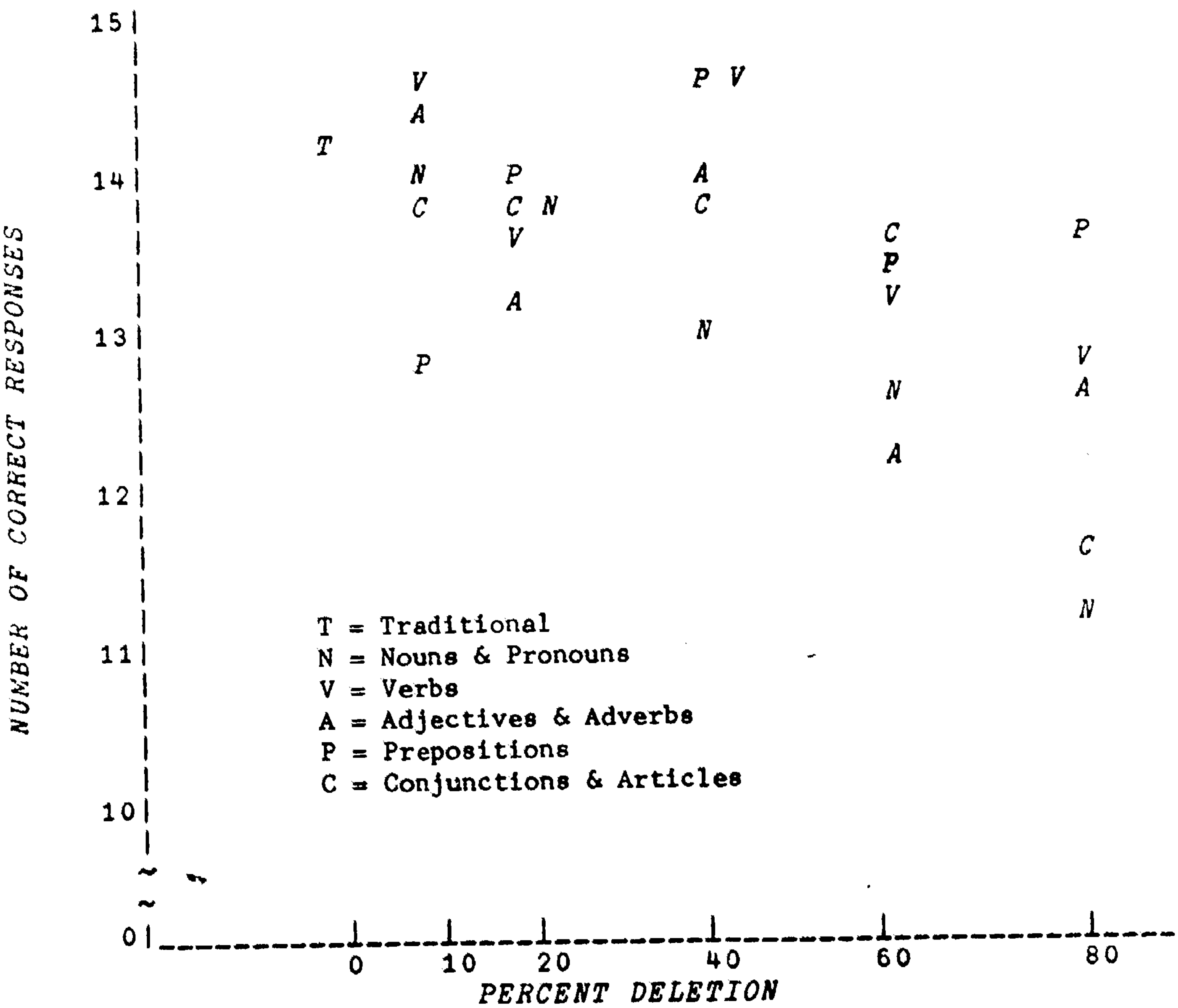

Figure 3.2. Mean number of correct responses on the set relations test for each of the 26 prose selections.

mean number of correct responses on the set relations test for the 26 passages. While no significant differences were found for the Grammatical Category main effect, a significant difference was found for the Deletion Level main effect ($F(4,425) = 5.0385$, $p<.001$). The interaction effect was not significant.

The 1 x 6 ANOVA design was again used to compare each level within the two main effects of the 5 x 5 ANOVA with the Trad passage. No significant differences were found in any of the grammatical categories except the category containing nouns and pronouns ($F(5,102) = 3.35$, $p<.01$). The Scheffé analysis performed on nouns and pronouns revealed no significant differences. However, examination of the exact p-values indicated that the significant difference found in the 1 x 6 ANOVA for nouns and pronouns can be attributed to the difference in number of set relation items correct between subjects assigned the Trad passage and subjects assigned the passage with 80% of the nouns and pronouns eliminated. Although the p-value for the comparison of the Trad passage with the passage in which 80% of the nouns and pronouns were eliminated was not significant ($p<.01$), it was the lowest value resulting from the Scheffé analysis.

The results of the five 1 x 6 ANOVAs performed for each deletion level revealed no significant differences across grammatical categories within any of the five deletion levels. Thus, it can be concluded that the number of set relation items answered correctly was not affected either by any of the deletion levels or by any of the grammatical categories. Subjects assigned the 80% reduced passages did as well when nouns and pronouns were deleted as when articles and conjunctions were deleted.

Table 3.7 presents the number of set relation questions unanswerable in the 25 experimental passages. As with the multiple choice items, the presence of key words in a passage was used as the criterion for designating answerable set relation questions.

The Pearson product-moment correlation coefficient was significant ($r(24) = .60$, $p<.01$) between the number of set relation questions unaswerable in the passages and the number of set relation questions answered correctly.

A significant positive correlation ($r(24) = .83$, $p<.01$) was found between the number of words in the experimental passages and the number of answerable set relation items within the passage. The number of words in the passage also correlated significantly ($r(24) = .72$, $p<.01$) with the number of set relation items answered correctly. Again, as the number of words in the experimental passages decreased, the number of answerable set relation items as well as the number of set relation items answered correctly by the subjects also decreased.

TABLE 3.7

Number of Set Relation Questions Not Answerable on the 25 Deleted Versions

Grammatical Category	Deletion Levels 10	20	40	60	80
Pronouns & Nouns	2	4	11	17	20
Verbs	0	0	1	2	5
Adjectives & Adverbs	0	0	2	5	9
Prepositions	0	0	0	0	0
Conjunctions & Articles	0	0	0	0	0

Reading Rates

Table 3.8 presents the means and standard deviations for the 5 x 5 ANOVA on reading rates. The mean reading rate for subjects assigned each of the experimental passages is illustrated in Figure 3.3. A significant difference was found for the Grammatical Category main effect ($F(4,425) = 7.73$, $p<.001$) as well as the Deletion Level main effect ($F(4,425) = 4.17$, $p<.01$). The interaction effect was not significant.

The five 1 x 6 ANOVAs performed within each grammatical category indicated no significant differences except for the category in which articles and conjunctions were deleted ($F(5,102) = 4.05$, $p<.01$). The Scheffé analysis indicated a significant difference between the Trad passage and the passage in which 40% of the conjunctions and articles had been eliminated ($p<.01$). No other significant differences were found.

The five 1 x 6 ANOVAs performed at each deletion level indicated a significant difference across grammatical categories at the 40% level of reduction. None of the other 1 x 6 ANOVAs were significant. The Scheffé analysis did not reveal where the differences were. However, subjects assigned the passage in which 40% of the articles and conjunctions had been eliminated read at a 23% slower rate than subjects assigned the Trad passage. Although the p-value for the comparison of the Trad passage with the passage in which 40% of the articles and conjunctions were eliminated was not significant ($p<.08$), it was the smallest p-value obtained in the pairwise comparisons.

TABLE 3.8

Means and Standard Deviations for the
5 x 5 ANOVA of Reading Rates

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Prepositions	Conjunctions & Articles
Mean S.D.	211.74 46.57	211.75 55.60	201.84 43.12	194.24 50.28	178.62 42.51
Deletion Level	10	20	40	60	80
Mean S.D.	190.09 52.39	192.42 54.98	194.45 40.82	211.86 38.21	209.38 48.71
Nouns & Pronouns	Deletion Level				
	10	20	40	60	80
Mean S.D.	209.40 49.68	199.48 42.91	211.46 64.65	224.36 38.92	214.00 53.67
Verbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	182.03 37.41	214.59 81.99	199.97 35.65	227.75 56.80	234.40 69.88
Adjectives & Adverbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	190.89 49.46	188.51 35.07	210.00 35.02	213.42 36.18	206.39 54.72
Prepositions	Deletion Level				
	10	20	40	60	80
Mean S.D.	192.33 43.58	179.27 57.25	188.06 41.81	207.33 32.05	204.24 50.30
Conjunctions & Articles	Deletion Level				
	10	20	40	60	80
Mean S.D.	175.78 42.68	180.23 35.80	162.75 18.51	186.46 36.86	187.86 33.06

Traditional Mean = 221.80 S.D. = 67.68

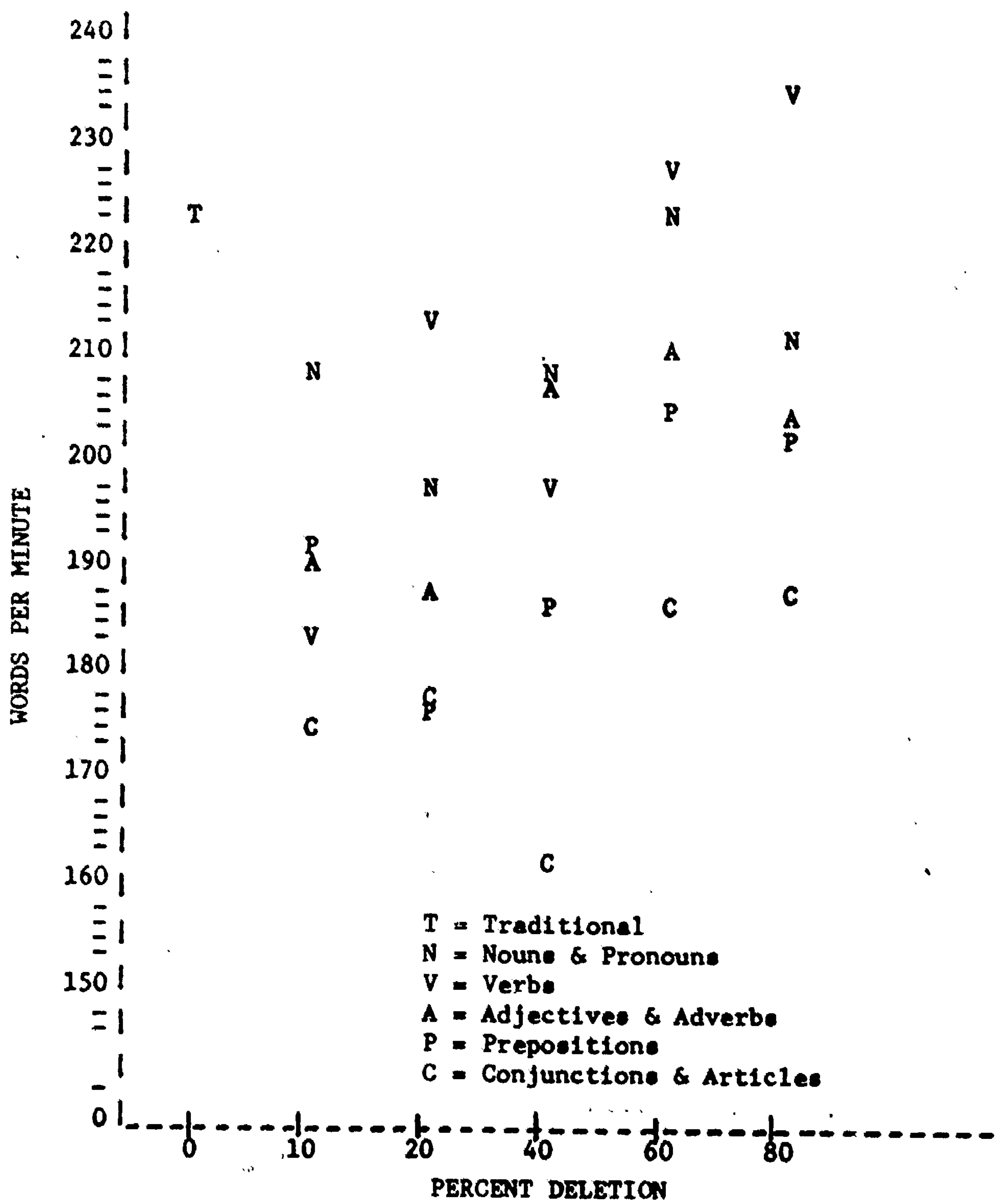

Figure 3.3. Mean reading rate for each of the 26 prose selections.

Reading Times

The means and standard deviations for reading times are presented in Table 3.9. The 5 x 5 ANOVA performed on reading times indicated no significant differences across grammatical categories or across deletion levels.

The ten 1 x 6 ANOVAs comparing the Trad passage with the experimental passages across deletion levels and across grammatical categories again indicated no significant differences in mean reading times.

No significant differences were found in the 1 x 26 ANOVA which was used to compare the Trad version with the 25 experimental passages. Consequently, the time required to read the story was not affected by the deletion of any of the five grammatical categories at any of the five deletion levels.

Conclusions

The hypotheses were only partially confirmed. First, an interaction effect between the Grammatical Category and the Deletion Level main effects was predicted for both comprehension tests. Deletion levels above 40% in the noun/pronoun and verb categories were expected to produce decrements in comprehension. For the multiple choice test, this expectation was confirmed for the noun and pronoun category in which no differences were found between the Trad 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 Trad 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 Trad, 10, 20, 40, and 80% versions when adjectives and adverbs were eliminated. However, the 60% version did differ significantly from the Trad version.

The set relations test was less sensitive to the elimination techniques than the multiple choice test. No interaction effect was obtained for the set relations test. Elimination of 80% of the nouns and pronouns did tend to produce a decrement in comprehension in comparison to the Trad passage ($p<.09$). In general, performance on the set relations test was not affected by the amount of deletion or by the grammatical category when compared to the Trad passage.

TABLE 3.9

Means and Standard Deviations for the
5 x 5 ANOVA of Reading Times

Grammatical Category	Nouns & Pronouns	Verbs	Adjectives & Adverbs	Prepositions	Conjunctions & Articles
Mean S.D.	13.15 3.05	13.11 3.41	12.85 2.80	12.92 3.26	13.11 2.43
Deletion Level	10	20	40	60	80
Mean S.D.	12.98 3.25	13.73 3.57	13.18 2.49	12.48 2.34	12.78 3.09
Nouns & Pronouns	Deletion Level				
	10	20	40	60	80
Mean S.D.	13.30 3.86	13.81 2.84	13.37 3.29	12.22 2.24	13.06 2.92
Verbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	14.52 3.47	13.60 4.63	13.35 2.52	12.18 2.82	11.92 2.84
Adjectives & Adverbs	Deletion Level				
	10	20	40	60	80
Mean S.D.	13.04 2.92	13.59 2.38	12.08 1.92	12.34 2.28	13.20 4.05
Prepositions	Deletion Level				
	10	20	40	60	80
Mean S.D.	11.88 2.43	14.66 4.95	13.12 2.68	12.24 1.72	12.72 3.22
Conjunctions & Articles	Deletion Level				
	10	20	40	60	80
Mean S.D.	12.14 3.05	13.02 2.34	14.00 1.52	13.43 2.52	12.99 2.53

Traditional Mean = 13.35 S.D. = 4.15

Performance on the two 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.

Apart from actual performance measures, analysis of the number of items answerable on the multiple choice and set relations tests is rather revealing. Inspection of Tables 3.5 and 3.7 show that medium to high deletion levels in the noun and pronoun category resulted in rather large numbers of items which could not be answered from the deleted passages. An informal analysis of the criterion tests indicated that by and large the names of persons, places, or things were asked for in the specific items.

Reading rates were not greatly affected. No explanation can be given for the dramatic reduction in reading rate associated with the 40% passage in which articles and conjunctions were eliminated. It may be that this result was a Type I error especially in view of the increased rates at the 60 and 80% levels.

Reading times were not affected at all. This is somewhat surprising in that the 80% reduction level for the noun and pronoun category resulted in approximately 25% fewer words in this passage in comparison to the Trad passage. An average of 13.06 minutes were required to read the 80% noun and pronoun deleted passage compared to 13.35 minutes for the Trad passage.

In conclusion, the reduction of nouns and pronouns resulted in the greatest effect upon comprehension, whereas reduction of prepositions resulted in the least effect. Deletions within the verb category and in the articles and conjunctions category produced no differences in comprehension between the Trad passage and all passages up to and including the 60% deletion level. Little effect upon reading rate and reading time was observed.

CHAPTER IV
EXPERIMENT III
EFFECTS OF A FREQUENCY DELETION SCHEME IN THE GENERATION OF TELEGRAPHIC PROSE

Introduction

A major assumption in this research is that language is not particularly efficient in that there is a great deal of sequential dependency or redundancy. It is believed 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 can be predicted from context.

Frequency has been an important variable in the study of language. Because of the ease with which it can be manipulated, it has been an obvious variable in many different types of psychological investigations. Solomon and Howes (1951) and Howes and Solomon (1951) have shown that the speed with which an individual word is recognized in a tachistoscopic presentation is influenced by the frequency of its occurrence in language. Another area of investigation has shown that there is an inverse relationship between word length and frequency. Miller, Newman, and Friedman (1958) have shown that the most frequently occurring words contain two, three, and four letters.

Miller (1951) has shown that there is a relationship between simple frequency of occurrence and the various parts of speech. Using the data obtained by French, Carter, and Koenig (1930) from recorded telephone conversations, Miller (1951) computed type-token ratios for seven different grammatical categories. This ratio is a measure of word novelty. If the ratio is high, then few words are repeated. If the ratio is low, then a small number of words were used frequently. The type-token ratios for the seven grammatical categories, in descending order, are as follows: .086 nouns; .064 adjectives and adverbs; .036 verbs; .0039 auxiliary verbs; .0029 prepositions and conjunctions; .0025 pronouns; and .00054 articles. In regard to these data, Miller (1951) has noted, "The articles, prepositions, conjunctions, pronouns and auxiliary verbs determine the general form of our statements, while the nouns, adjectives and adverbs contribute to the context. The different forms repeat themselves more often than do the different contexts, and so the minor parts of speech compose the major part of our utterances."

It is clear that language users are aware of, and use, the frequency properties of words. This experiment was designed to determine what effects different deletion levels would have on different word frequency categories. The major hypothesis was that higher deletion levels from high word frequency categories would have less detrimental effects upon comprehension than comparable deletion levels from low word frequency categories.

Method

Subjects

A total of 412 undergraduate students enrolled in introductory psychology courses at Texas A&M University participated in the study. Each of the 22 treatment conditions contained from 19 to 22 subjects.

Materials

The traditional prose passages selected for analyzing the word frequency deletion scheme were "San Francisco" and "Buena-I and Ralo."

The analysis of the frequency of each word within the two passages was performed on an IBM 360/65 computer with a computer program written in FORTRAN IV-G computer language. The resulting printouts for each passage listed the word types (each different word in the passage) 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 frequently occurring word had a rank of one. the second most frequent word had a rank of two, etc. In addition, 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 two passages was also stored on a computer disk for use in the telegraphic materials' generation program. Figures 4.1 and 4.2 present the frequency curves of the words as a function of their ranks from "San Francisco" and "Buena-I and Ralo," respectively. The graphs show the points at which the tokens were divided into thirds to designate the high, medium, and low frequency word categories which formed the three levels of the word frequency independent variable in this experiment. Table 4.1 presents the rank, frequency range, number of tokens, and percent of corpus for each frequency category for each passage. Since there is no empirical basis for dividing types within frequency categories, the frequency categories were divided at points where frequencies appeared to change dramatically so that the number of tokens in each frequency category was only approximately equal to one-third of the total number of tokens in the passage.

The generation of the telegraphic materials was performed by a computer program designed to delete specified percentages

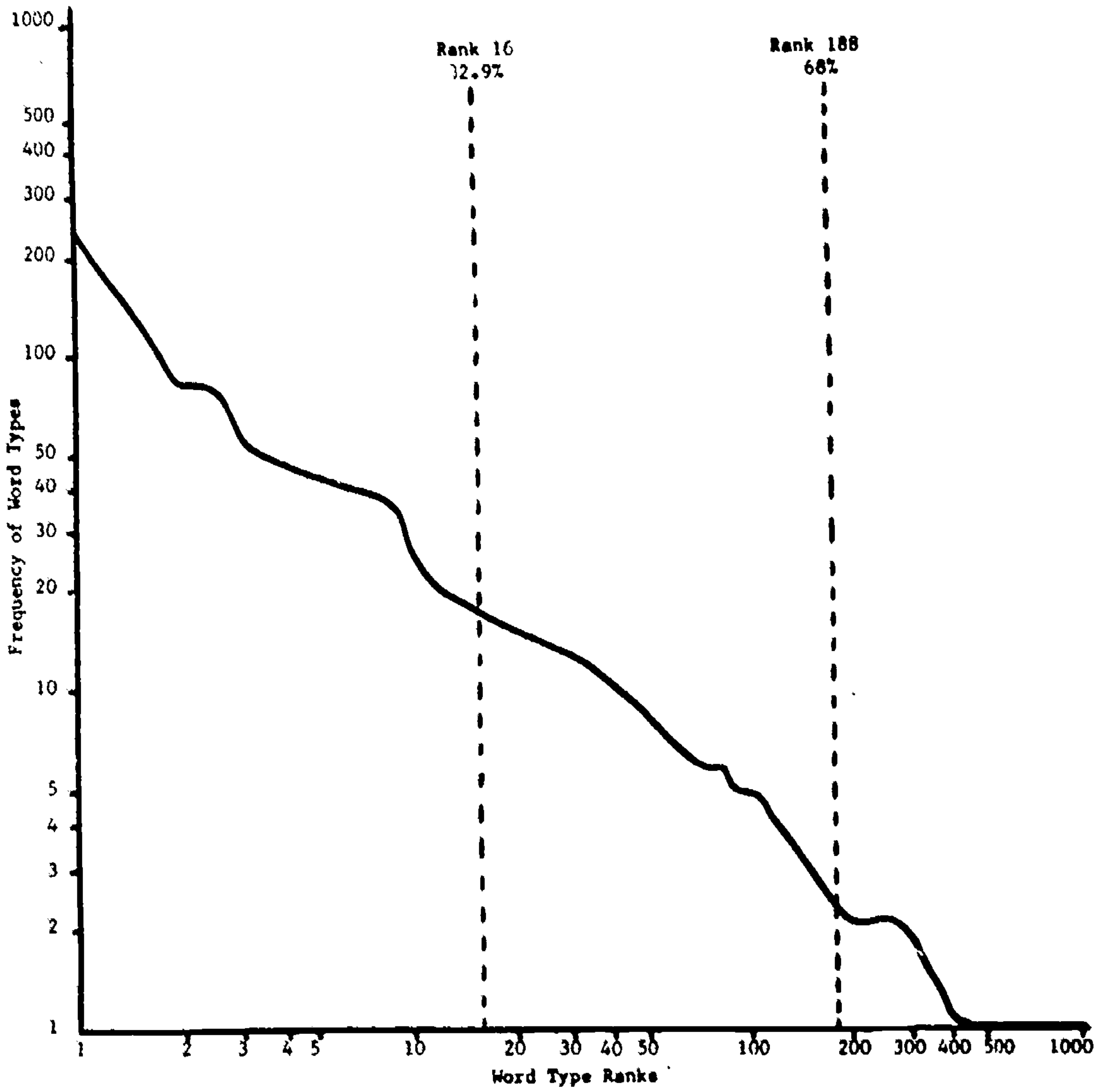

Figure 4.1. Frequency curve of the words from San Francisco.

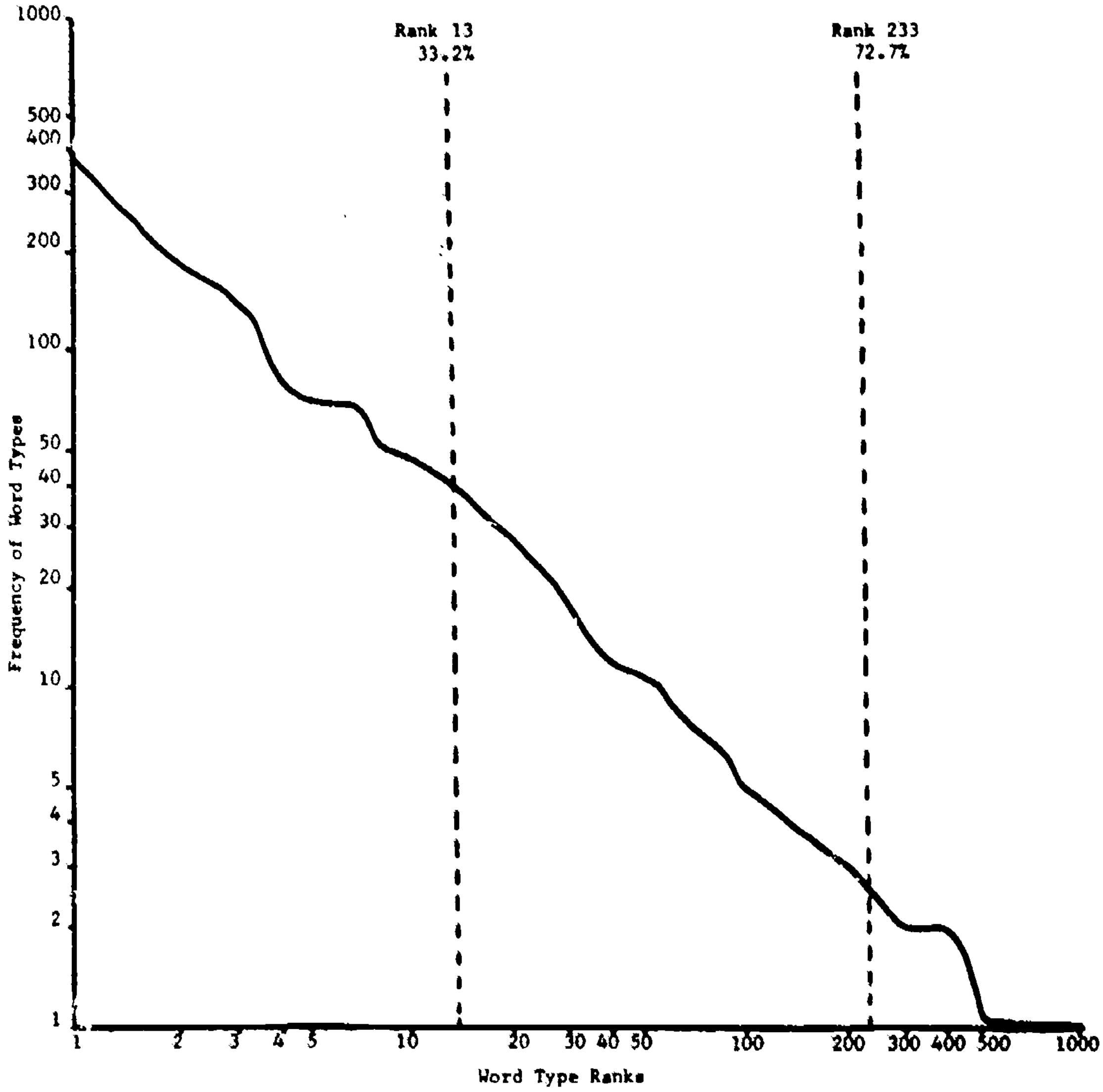

Figure 4.2. Frequency curve of the words from Buena-I and Ralo.

TABLE 4.1

Classification of Frequency
Category by Frequency Range

Frequency Category	Rank	Frequency Range	# of Tokens	% of Corpus
San Francisco				
High	1-20	233-16	891	32.9
Medium	21-188	17-3	952	35.3
Low	189-905	2-1	860	31.8
Type/Token Ratio = .33				
Buena-I and Ralo				
High	1-13	398-37	1312	33.2
Medium	14-233	36-3	1560	39.5
Low	234-1138	2-1	1079	27.3
Type/Token Ratio = .29				

of tokens within one of the three frequency categories. In the preliminary stages, the design specified percentages of each type to be deleted within one of the three frequency categories. 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 greatly 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. Thirty different experimental passages were developed at deletion levels ranging from 10 to 100% in intervals of 10% for each of the three frequency categories.

The telegraphic materials generated for each passage were the 10, 30, and 50% reductions within each of the three word frequency categories. The Trad and reduced versions of the passages were typed double spaced on 8-1/2 x 11 inch paper. The original sentence and paragraph formats were maintained in each reduced version of the passages. The reduced versions of "San Francisco" and "Buena-I and Ralo" are presented in Volume II of this report.

The "San Francisco" passage was thoroughly examined to determine the percent of answerable questions on the multiple choice and set relations tests. The results are presented in Table 4.2. Comprehension of the passages was assessed on the basis of a multiple choice test and set relations test. Subjects assigned "San Francisco" were given a 60-item multiple choice test and a 20-item set relations test. Subjects assigned "Buena-I and Ralo" were given a 65-item multiple choice test and a 20-item set relations test. The construction and development of these tests were discussed in Experiment I

Time recording forms, electronic timer, and IBM answer sheets were also used by subjects participating in the experiment. A digital elapsed time display placed at the front of the room was the timing device. The timer was set to change at ten second intervals. The elapsed reading time was recorded on a time recording form when each subject finished reading an assigned passage. The recorded times were used to compute reading rates and reading times. IBM answer sheets were used to record test answers.

Procedure

A test package consisting of a randomly assigned version of a passage, a time recording form, a multiple choice test, a set relations test, and an IBM answer sheet was assembled for each subject. The subjects were instructed to read the passage at a comfortable rate without re-reading any portion of the passage, record the time taken to read the passage, and answer the two comprehension tests.

TABLE 4.2

Percentage of Questions Which Could Not be Answered in the Multiple Choice Test as a Function of Deletion Level and Frequency Category

Percentage Deletion	Word Frequency Category		
	High	Medium	Low
10%	23%	35%	27%
20%	23%	38%	35%
30%	23%	52%	50%
40%	22%	40%	41%
50%	22%	35%	52%
60%	27%	52%	53%
70%	23%	57%	58%
80%	25%	57%	73%
90%	23%	61%	67%
100%	23%	67%	81%
Mean	23%	49%	54%

Design and Analysis

The two passages were analyzed separately. The nine telegraphic versions of each passage plus the Trad passage were compared on eight dependent variables. The set relations test and the multiple choice test were analyzed in order to assess comprehension. Individual analyses were conducted on the nested and disjunctive scores as well as the total set relations test score. A total test score, the combined number of correct responses on the set relation and multiple choice items, was also used as a measure of comprehension. In addition, reading rate (wpm) and reading time were analyzed separately. A measure of presentation efficiency (E_t) was computed for each subject by dividing the total comprehension (C) score by the reading time (R_t), thus $E_t = \frac{C \times 100}{R_t}$. The independent variables were Frequency Level (high, medium, low) and Deletion Level (10, 30, 50%).

A 3 x 3 ANOVA was used to compare the means of each dependent variable for the two stories. In addition, a 1 x 10 ANOVA was used to compare each of the nine experimental passages with the Trad passage. In order to determine whether the test scores were above chance level, a 1 x 11 ANOVA was used for the comprehension measures to compare the nine experimental versions of the passage, the Trad passage, and a condition in which subjects took the test without reading a passage. The Scheffé test was used to determine the precise nature of the differences among treatment means for each of the three designs.

Results

Analyses of the "Buena-I and Ralo" Passage

The means and standard deviations for each of the eight dependent variables are presented in Table 4.3.

The 3 x 3 ANOVA performed on the reading times indicated no significant differences across frequency levels or across deletion levels. In addition, reading rates were not found to differ significantly across the two independent variables.

The 3 x 3 ANOVA revealed significant differences in total comprehension scores across the Frequency Level main effect ($F(2,180) = 7.53$, $p<.01$), across the Deletion Level main effect ($F(2,180) = 24.12$, $p<.001$), and a significant interaction effect was found ($F(4,180) = 3.14$, $p<.05$). Figure 4.3 presents the interaction effect. The Scheffé analysis performed within the Frequency Level main effect indicated significant differences between subjects assigned the passages in which the high frequency words were deleted

TABLE 4.3

Means and Standard Deviations for Each of
11 Treatment Conditions (Buena-I and Ralo)

Variables	High Frequency			Medium Frequency			Low Frequency			Traditional Passage	Test Only
	10%	30%	50%	10%	30%	50%	10%	30%	50%		
Reading Time (minutes)											
Mean	17.73	17.58	17.44	18.90	17.58	15.92	17.33	16.87	17.37	16.09	
S.D.	6.17	4.51	3.18	4.42	4.36	4.25	2.99	3.01	3.51	3.95	
Reading Rate (wpm)											
Mean	229.96	213.33	193.28	210.27	208.20	212.35	227.09	222.60	204.12	260.90	
S.D.	51.05	52.41	32.60	49.49	50.35	60.58	40.90	54.73	48.60	74.46	
Total Comprehension											
Mean	68.67	67.81	63.18	71.29	55.52	47.10	69.25	59.38	49.62	69.24	31.42
S.D.	11.96	8.26	15.89	6.99	17.59	12.09	12.41	15.90	14.47	11.63	8.75
Multiple Choice											
Mean	52.90	52.48	47.86	54.48	41.86	34.62	53.95	44.90	36.38	53.29	20.05
S.D.	9.91	6.23	12.73	6.00	14.73	10.25	9.74	12.72	12.58	9.71	6.15

TABLE 4.3

(Continued)

Variables	High Frequency 10%	High Frequency 30%	High Frequency 50%	Medium Frequency 10%	Medium Frequency 30%	Medium Frequency 50%	Low Frequency 10%	Low Frequency 30%	Low Frequency 50%	Traditional Passage	Test Only
Set Relations											
Mean	15.76	15.33	15.32	16.81	13.67	12.48	15.30	14.48	13.24	15.95	11.37
S.D.	3.19	2.63	3.90	1.75	4.20	2.56	3.42	3.91	2.43	3.06	3.89
Nested											
Mean	7.33	7.05	6.68	7.67	6.33	5.24	6.80	6.29	5.95	6.95	5.63
S.D.	2.15	1.66	2.71	1.46	1.93	1.95	2.21	2.28	1.77	2.04	2.22
Disjunctive											
Mean	8.43	8.29	8.64	9.14	7.33	7.24	8.50	8.19	7.29	9.00	5.74
S.D.	1.78	1.38	1.53	0.96	2.71	1.81	1.61	2.25	2.12	1.58	2.33
$E_t \quad \frac{C \times 100}{R_t}$											
Mean	4.17	4.10	3.70	3.98	3.33	3.26	4.11	3.59	3.07	4.65	
S.D.	1.23	1.18	1.09	1.09	1.28	1.43	1.02	1.02	1.38	1.75	

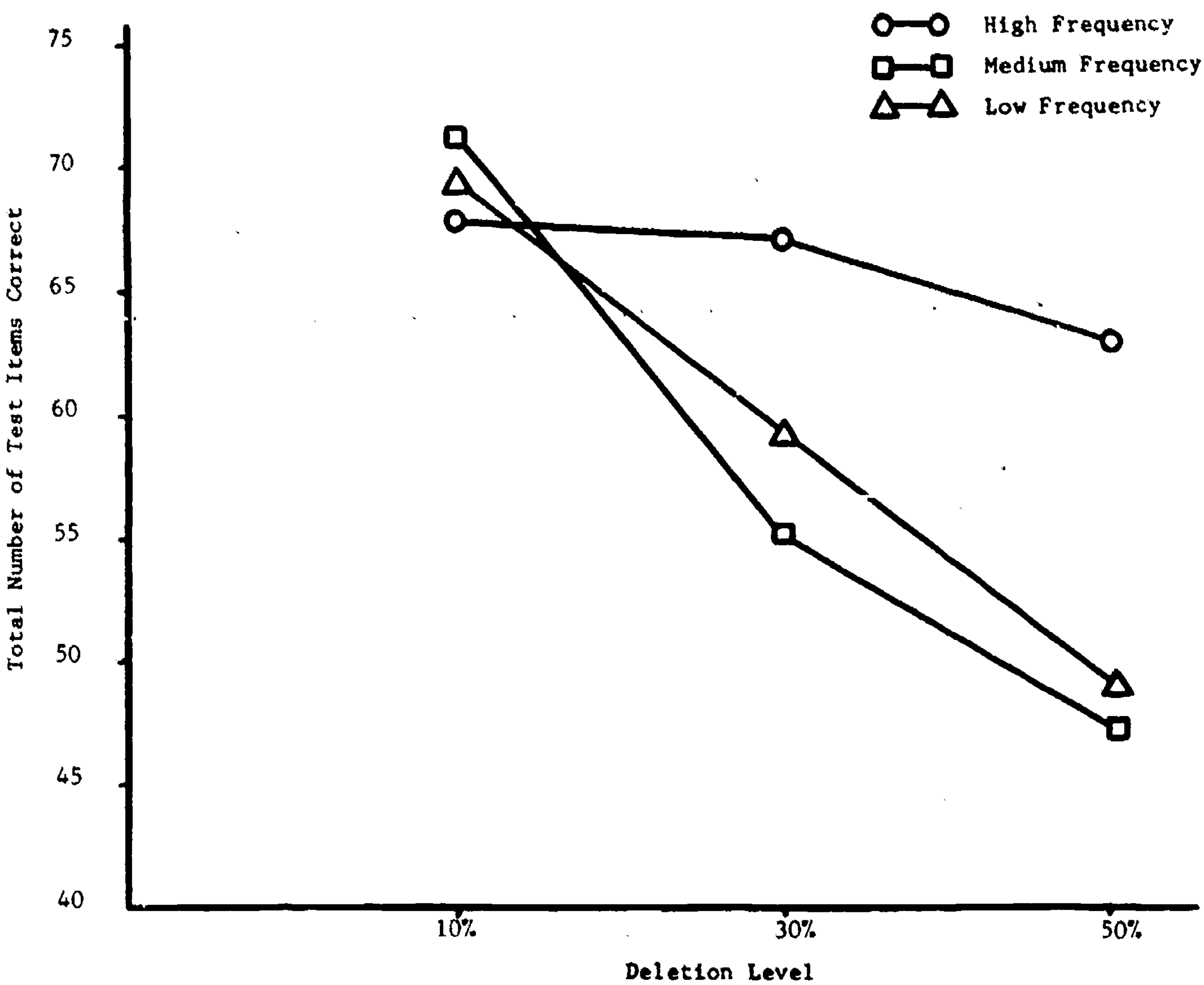

Figure 4.3. Interaction of Deletion Level and Frequency Level on the total comprehension scores. (Buena-I and Ralo)

and subjects assigned the passages in which the medium or low frequency words were deleted. Subjects assigned the high frequency word deletion passages answered 15 and 12% more items correctly than subjects assigned the medium frequency and low frequency word deletion passages, respectively. Within the Deletion Level main effect, the Scheffé analysis indicated that each deletion level differed significantly from the other two deletion levels. Subjects assigned the 10% reduced passages answered 15 and 31% more items correctly than subjects assigned the 30 and 50% reduced passages, respectively. Subjects assigned the 30% reduced passages answered 14% more items correctly than those assigned the 50% reduced passages. The Scheffé analysis indicated that while the three 10% reduced passages differed significantly from the 50% reduced version of the medium or low frequency word passages, the three 10% reduced passages did not differ significantly from the passage in which 50% of the high frequency words had been deleted.

The 3 x 3 ANOVA performed on the number of multiple choice items answered correctly indicated significant differences across the Frequency Level main effect ($F(2,180) = 8.20$, $p<.001$), across the Deletion Level main effect ($F(2,180) = 26.42$, $p<.001$), and a significant interaction effect was again found ($F(4,180) = 3.13$, $p<.05$). Figure 4.4 presents the interaction between Frequency Level and Deletion Level. The Scheffé analysis indicated that the passages which deleted the high frequency words differed significantly from the passages which deleted the medium or low frequency words. Subjects assigned the high frequency word deletion passages answered 17% more items correctly than those assigned the medium frequency word deletion passages, and 13% more items correctly than subjects assigned the low frequency word deletion passages. As with the total comprehension scores, the number of multiple choice items answered correctly at each deletion level differed significantly from the other two deletion levels. Subjects assigned the 10% reduced passages answered 16% more items correctly than those assigned the 30% reduced passages, and 36% more items correctly than subjects assigned the 50% reduced passages. Subjects reading the 30% reduced passages answered 17% more items correctly than those reading the 50% reduced passages. The same differences were found in the Scheffé analysis performed on the means within the interaction effect for multiple choice scores as were found for the total comprehension scores. Again, the three 10% reduced passages differed significantly from the 50% medium and low word frequency deletion passages but did not differ significantly from the 50% high frequency word deletion passage.

A significant difference ($F(2,180) = 8.17$, $p<.001$) was found for the Deletion Level main effect in the 3 x 3 ANOVA performed on the number of set relation test items answered

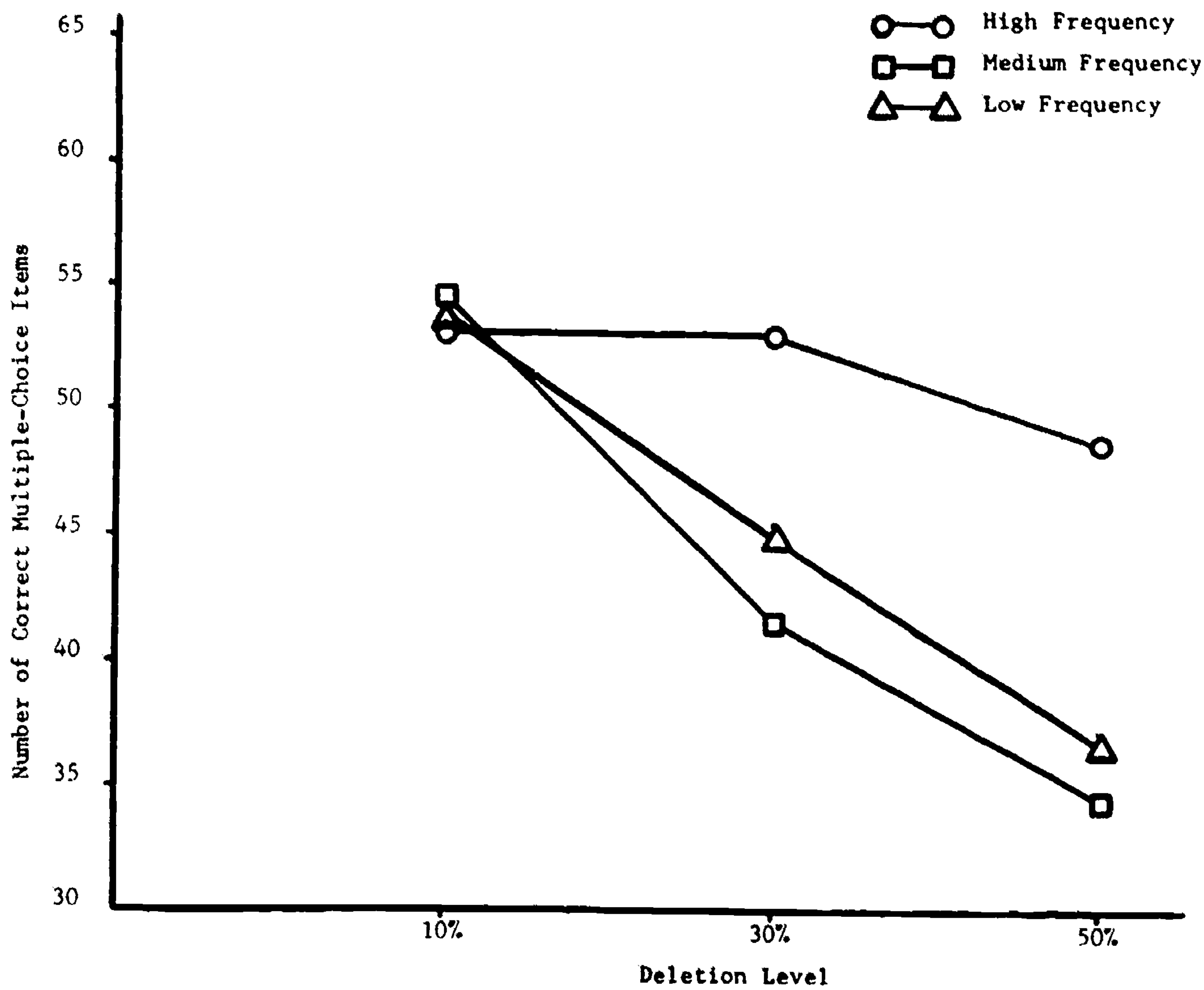

Figure 4.4. Interaction of Deletion Level and Frequency Level on the multiple choice test scores. (Buena-I and Ralo)

correctly. The Scheffé analysis revealed that the 10% reduced passages differed significantly from both the 30 and 50% reduced passages. Subjects assigned the 10% reduced passages answered 10% more set relation items correctly than subjects assigned the 30% reduced passages, and 17% more items correctly than those assigned the 50% reduced passages.

The 3 x 3 ANOVA performed on the nested test items again indicated a significant difference in the Deletion Level main effect ($F(2,180) = 6.44$, $p<.01$). The Scheffé analysis revealed that the 10% reduced passages differed significantly from the 50% reduced passages. Subjects assigned the 10% reduced passages answered 22% more items correctly than those assigned the 50% reduced passages.

A significant difference ($F(2,180) = 4.75$, $p<.01$) was found in the Deletion Level main effect for the 3 x 3 ANOVA performed on the number of disjunctive test items. A significant interaction effect was also found ($F(4,180) = 2.44$, $p<.05$). The Scheffé analysis performed on the means within the Deletion Level main effect indicated that the 10% reduced passages differed significantly from the 50% reduced passages. Subjects reading the 10% reduced passages answered 22% more items correctly than those reading the 50% reduced passages. Figure 4.5 presents the interaction between Frequency Level and Deletion Level. No significant differences were found in the Scheffé analysis performed to determine the location of the differences responsible for the significant interaction effect. However, the smallest p-value resulting from the pairwise comparisons was in the comparison of the passage in which 10% of the medium frequency words were deleted and the passage in which 50% of the medium frequency words were deleted ($p<.21$).

The 3 x 3 ANOVA performed on the efficiency measure revealed a significant difference ($F(2,180) = 6.09$, $p<.01$) within the Deletion Level main effect. The Scheffé analysis revealed that the 10% reduced passages differed significantly from the 50% reduced passages. According to the efficiency ratio used in this study, the 10% reduced passages were 22% more efficient than the 50% reduced passages.

The 1 x 10 ANOVA performed to compare each of the nine experimental passages with the Trad passage indicated no significant differences for reading time. Reading rates, however, were found to be significant ($F(9,200) = 2.64$, $p<.01$). The only significant difference found in the Scheffé analysis was in the comparison of the passage in which 50% of the high frequency words had been deleted and the Trad passage. Subjects reading the 50% high frequency word deletion passage read at a 26% slower rate than subjects reading the Trad passage. The reading rates are presented graphically in Figure 4.6.

In order to determine whether the scores on the comprehension measures were above chance level, an additional condition

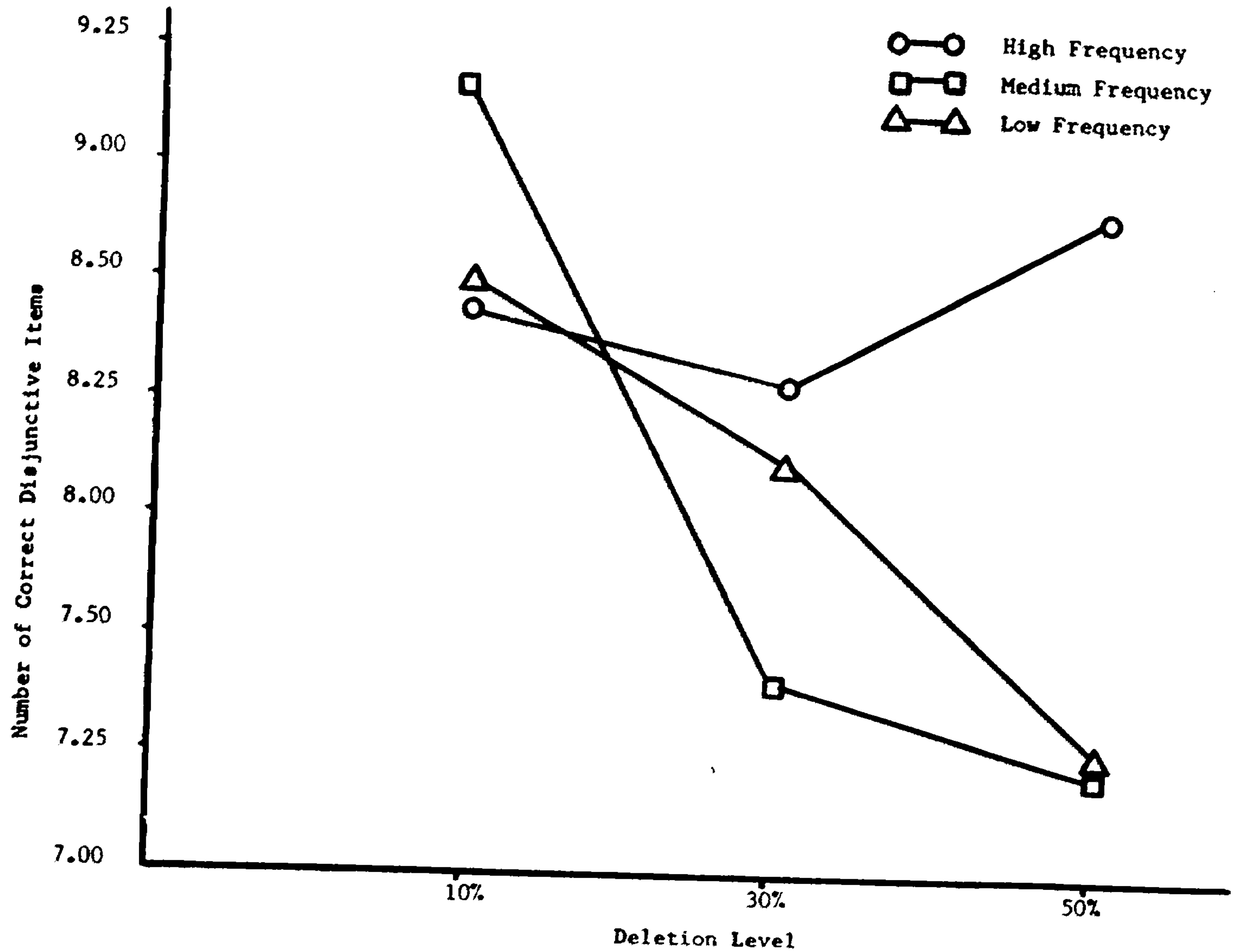

Figure 4.5. Interaction of Deletion Level and Frequency Level on the disjunctive test scores. (Buena-I and Ralo)

in which the scores of subjects who did not read a passage but took the test was added to the analyses. The 1 x 11 performed on the total comprehension scores yielded an F of 18.79, df = 10,218, p<.001. The Scheffé analysis indicated that all of the subjects who were assigned the experimental passages scored significantly higher than those who took the test only with the exception of subjects assigned the passage in which 50% of the medium frequency words were deleted. Subjects assigned the passage in which 50% of the low frequency words were deleted scored significantly lower than subjects assigned the Trad passage. The Scheffé analysis also indicated that the scores for each of the three 10% reduced passages were significantly higher than the scores for the 50% medium frequency and low frequency word deletion passages. In addition, the scores for the 30% high frequency word deletion passages were significantly higher than the scores for the 50% medium frequency and low frequency word deletion passages.

The 1 x 11 performed on the number of multiple choice items answered correctly indicated a significant difference (F(10,218) = 21.24, p<.001) across treatment conditions. The Scheffé analysis revealed the same significant differences as were found in the Scheffé analysis performed on the total comprehension scores. However, the multiple choice scores for subjects reading the passage in which 50% of the medium frequency words had been deleted were significantly higher than the multiple choice scores of subjects who took the test without reading an experimental version of the passage.

A significant difference (F(10,218) = 5.30, p<.001) was found in the 1 x 11 ANOVA performed on the set relation test scores. The Scheffé analysis indicated that the only subjects to score significantly higher than those who took the test without reading an experimental passage were the subjects assigned the Trad or the 10% medium frequency word deletion passages. Subjects assigned the 10% medium frequency word deletion passage also scored significantly higher than those assigned the 50% medium frequency word deletion passage. No other significant differences were found in the Scheffé analysis.

The 1 x 11 ANOVA performed on the number of nested test items answered correctly yielded an F of 2.62, df = 10,218, p<.01. The Scheffé analysis did not yield any significant differences. However, examination of the exact p-values indicated that the smallest p-value was in the comparison of the 10% medium frequency with the 50% medium frequency word deletion passages. Subjects assigned the passage which deleted 10% of the medium frequency words answered 46% more nested items correctly than subjects assigned the passage in which 50% of the medium frequency words had been deleted. Neither those subjects reading the experimental passages nor those reading the Trad passage performed significantly better than subjects who took the test only without reading a passage.

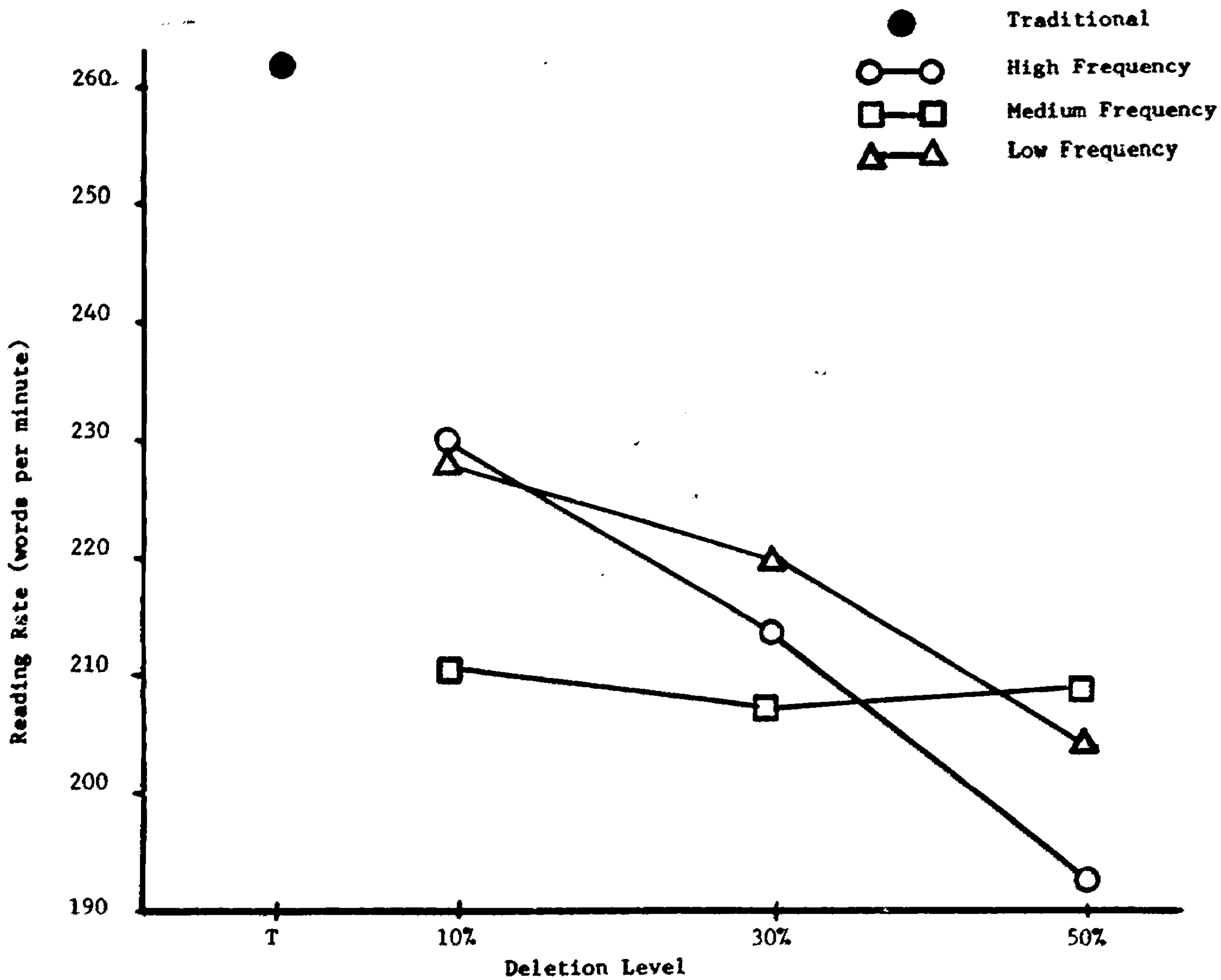

Figure 4.6. Reading rates for each of the ten experimental passages.

The 1 x 11 ANOVA performed on the number of disjunctive test items answered correctly revealed a significant difference across treatment conditions ($F(10,218) = 5.61$, $p<.001$). The Scheffé analysis indicated that subjects assigned the Trad, the 10% high frequency, the 10% medium frequency, the 10% low frequency, and the 50% high frequency word deletion passages answered significantly more items correctly than subjects who answered the disjunctive items without reading a passage. No other significant differences were found.

The 1 x 10 ANOVA performed on the reading efficiency measure indicated a significant difference ($F(9,200) = 3.17$, $p<.01$) across treatment conditions. Although the Scheffé analysis did not reveal any significant differences, examination of the exact p-values indicated that the largest difference in E_t was between the 50% low frequency word deletion passage and Trad ($p<.07$). The E_t score for Trad was 51% higher than the E_t score for the 50% low frequency word deletion passage.

Analysis of the "San Francisco" Passage

Table 4.4 presents the means and standard deviations for each of the eight dependent variables.

The results of the 3 x 3 ANOVA performed on reading times for the nine experimental versions of "San Francisco" indicated a significant difference for only the Frequency Level main effect ($F(2,173) = 3.64$, $p<.05$). The Scheffé analysis indicated a significant difference between the high frequency and low frequency word deletion passages. Subjects reading the high frequency word deletion passages required 11% more reading time than those reading the low frequency word deletion passages.

Significant differences were found in the 3 x 3 ANOVA for reading rates (wpm) both within the Frequency Level main effect ($F(2,173) = 3.86$, $p<.05$) and the Deletion Level main effect ($F(2,173) = 3.21$, $p<.05$). The Scheffé analysis performed on the means within the Frequency Level main effect indicated a significant difference between the reading rates of subjects assigned the high frequency word deletion passages and subjects assigned the low frequency word deletion passages. Subjects assigned the passages which deleted the low frequency words read at a 13% faster word per minute rate than those assigned the high frequency word deletion passages. The Scheffé analysis performed on the means within the Deletion Level main effect did not indicate any significant differences. However, the smallest p-value resulting from the pairwise comparisons was in comparing the 10% reduced passages with the 50% reduced passages. Subjects reading the 10% reduced passages read at an 11% faster rate than subjects reading the 50% reduced passages.

The 3 x 3 ANOVA performed on the total comprehension scores

TABLE 4.4

Means and Standard Deviations for Each of
11 Treatment Conditions (San Francisco)

Variable	High Frequency			Medium Frequency			Low Frequency			Traditional Passage	Test Only
	10%	30%	50%	10%	30%	50%	10%	30%	50%		
Reading Time (minutes)											
Mean	13.09	12.66	13.01	12.50	11.88	11.28	11.88	11.20	11.75	11.35	
S.D.	2.71	2.62	3.53	3.09	3.17	2.09	2.45	2.53	2.98	2.99	
Reading Rate (wpm)											
Mean	207.77	199.20	184.26	220.12	214.92	202.98	230.74	229.07	205.77	264.49	
S.D.	45.87	38.12	46.96	53.36	50.08	35.93	58.64	55.20	55.90	126.91	
Total Comprehension											
Mean	67.00	60.85	62.89	62.70	57.50	54.85	65.23	56.23	56.00	63.45	34.38
S.D.	6.68	7.90	6.34	9.72	8.25	9.62	5.11	10.79	9.78	7.16	7.97
Multiple Choice											
Mean	51.80	47.05	48.95	48.75	44.00	42.10	50.45	43.00	41.89	50.00	22.43
S.D.	5.38	6.94	5.65	7.53	7.27	8.41	4.24	8.79	8.58	6.19	6.99

TABLE 4.4

(Continued)

Variable	High Frequency 10%	High Frequency 30%	High Frequency 50%	Medium Frequency 10%	Medium Frequency 30%	Medium Frequency 50%	Low Frequency 10%	Low Frequency 30%	Low Frequency 50%	Traditional Passage	Test Only
Set Relations											
Mean	15.20	13.80	13.95	13.95	13.50	12.75	14.77	13.23	14.11	13.45	11.95
S.D.	2.17	1.77	1.81	2.67	1.67	2.07	1.69	2.69	2.16	1.99	2.96
Nested											
Mean	6.95	5.65	5.84	5.90	5.15	5.30	6.55	5.45	5.58	5.90	4.05
S.D.	1.39	1.27	1.92	1.59	1.35	1.45	1.41	1.68	1.77	1.45	1.88
Disjunctive											
Mean	8.25	8.15	8.11	8.05	8.35	7.45	8.23	7.77	8.53	7.55	7.90
S.D.	1.77	1.35	1.24	1.70	1.27	1.61	1.11	1.34	1.31	1.61	1.87
$E_t \frac{C \times 100}{R_t}$											
Mean	5.34	5.01	5.09	5.39	5.08	5.01	[illegible]	5.20	5.00	[illegible]	
S.D.	1.35	1.20	1.09	1.74	1.20	1.27	1.35	1.33	1.22	1.89	

revealed a significant difference within both the Frequency Level main effect ($F(2,173) = 6.76$, $p<.01$) and the Deletion Level main effect ($F(2,173) = 13.60$, $p<.001$). The Scheffé analysis indicated that the high frequency word deletion passages differed significantly from the medium and low frequency word deletion passages. Subjects assigned the high frequency word deletion passages answered 9% more items correctly than subjects assigned the medium frequency word deletion passages and 8% more items correctly than those assigned the low frequency word deletion passages. The Scheffé analysis performed on the means within the Deletion Level main effect revealed that the 10% reduced passages differed significantly from the 30 and 50% reduced passages. Subjects assigned the 10% reduced passages answered 12% more items correctly than subjects assigned the 30% reduced passages.

Significant differences were again found within the Frequency Level main effect ($F(2,173) = 7.13$, $p<.01$) and the Deletion Level main effect ($F(2,173) = 13.57$, $p<.001$) for the 3 x 3 ANOVA performed on the multiple choice test scores. According to the Scheffé analysis, the high frequency word deletion passages differed significantly from the medium and low frequency word deletion passages. Subjects assigned the high frequency word deletion passages answered 10% more multiple choice items correctly than subjects assigned the medium frequency word deletion passages and 9% more items correctly than those assigned the low frequency word deletion passages. The Scheffé analysis performed on the three deletion levels indicated significant differences between the 10% reduced passages and the 30 and 50% reduced passages. Subjects assigned the 10% reduced passages answered 13% more items correctly than subjects assigned the 30% reduced passages and 14% more items correctly than those assigned the 50% reduced passages.

The 3 x 3 ANOVA performed on the set relations test indicated a significant difference within the Deletion Level main effect ($F(2,173) = 5.35$, $p<.01$). The Scheffé analysis indicated that the 10% reduced passages differed significantly from the 30 and 50% reduced passages. Subjects assigned the 10% reduced passages answered 8% more set relations items correctly than subjects assigned the 30% reduced passages and 8% more items correctly than those assigned the 50% reduced passages.

A significant difference was found in the 3 x 3 ANOVA performed on the nested set relation items both within the Deletion Level main effect ($F(2,173) = 3.11$, $p<.05$) and the Frequency Level main effect ($F(2,173) = 8.07$, $p<.001$). The Scheffé analysis revealed a significant difference between the high frequency word deletion passages and the medium frequency word deletion passages. Subjects assigned the high frequency word deletion passages answered 13% more nested items correctly than subjects assigned the medium frequency word deletion passages. In addition, the Scheffé analysis indicated that the 10% reduced passages were significantly different from the 30 and 50% reduced passages. Subjects assigned the 10% reduced passages answered 19% more nested items correctly than subjects assigned the 30% reduced passages and 16% more items correctly than those assigned the 50% reduced passages.

The 3 x 3 ANOVA performed on the disjunctive set relation test items did not yield any significant differences. In addition, no significant differences were found in the 3 x 3 ANOVA performed on the efficiency measure.

The 1 x 10 ANOVA performed to compare the nine experimental versions and the Trad version of the passage indicated that there were no significant differences in the time required by subjects to read the ten versions of the passage. Reading rates, however, were found to be significantly different ($F(9,192) = 2.55$, $p<.01$). The Scheffé analysis performed on the means within the 1 x 10 ANOVA for reading rates did not indicate any significant differences in the pairwise comparisons. Examination of the exact p-values revealed that the largest difference was between the Trad passage and the passage in which 50% of the high frequency words were deleted ($p<.065$).

The 1 x 11 ANOVA which was used to compare the test scores of subjects assigned one of the nine experimental passages, the Trad passage, and a Test Only condition yielded a significant difference ($F(10,212) = 23.99$, $p<.001$) on the total comprehension score. The Scheffé analysis indicated that subjects reading the nine experimental and the Trad versions scored significantly higher than those who took the Test Only condition. The only significant comparison that was found in the Scheffé analysis other than the comparisons made with the Test Only condition was between the 10% high frequency and 50% medium frequency word deletion passages. Subjects assigned the 10% high frequency word deletion passage answered 22% more items correctly than those assigned the 50% medium frequency word deletion passage.

The 1 x 11 ANOVA performed on the multiple choice scores indicated a significant difference ($F(10,212) = 27.96$, $p<.001$) among treatment conditions. The Scheffé analysis performed on the multiple choice scores yielded the same significant differences that were found in the 1 x 11 ANOVA performed on the total comprehension scores. In addition to the significant difference found between the 10% high frequency and the 50% medium frequency word deletion passages, a significant difference was also found between the 10% high frequency and the 50% low frequency word deletion passages. Subjects assigned the 10% high frequency word deletion passage answered 23% more multiple choice items correctly than subjects assigned the 50% medium frequency word deletion passage and 24% more items correctly than those assigned the 50% low frequency word deletion passage. The multiple choice scores for the nine experimental passages and the Trad passage were found to be significantly higher than the Test Only condition.

A significant difference ($F(10,212) = 3.67$, $p<.001$) was found in the 1 x 11 ANOVA performed on the set relations test. The only significant differences found in the Scheffé analysis were in the comparisons of the Test Only condition with the 10% high frequency and the 10% ̄ w frequency word deletion passages. Subjects assigned t' 0% high frequency word deletion passage answered 27% more .t relation items correctly than those who took the Test Only, while subjects assigned the 10% low frequency word deletion passage answered 24% more items correctly than subjects who took the Test Only condition. No other significant differences were found.

While a significant difference was found in the 1 x 11 ANOVA performed on the nested set relation test items ($F(10,212) = 4.72$, $p<.001$), no differences were found in the 1 x 11 ANOVA performed on the disjunctive test items. The Scheffé analysis for the nested test items yielded the same significant differences that were found in the Scheffé analysis for the set relations test. That is, subjects assigned the 10% high frequency and the 10% low frequency word deletion passages answered significantly more nested items correctly than those who took the Test Only. Subjects assigned the 10% high frequency word deletion passage answered 72% more nested items correctly than subjects who took the Test Only condition; subjects assigned the 10% low frequency word deletion passage answered 62% more nested items correctly than the Test Only subjects.

The 1 x 10 ANOVA performed on E_t did not indicate any significant differences between Trad and any of the nine experimental versions of the passage.

Discussion and Conclusions

"Buena-I and Ralo" Passage

The results of the analyses performed on the comprehension data indicated that those subjects who read passages in which high frequency words were deleted scored significantly higher than those subjects who read passages in which medium or low frequency words were deleted. The interaction effect found in the 3 x 3 ANOVA for the total comprehension scores, the multiple choice test scores, and the disjunctive test scores indicated differences among the word frequency categories at the three deletion levels. While there was no significant loss in comprehension as the percentage of high frequency words deleted was increased, comprehension was sharply reduced when 30 or 50% of the medium or low frequency words were deleted.

These results were expected. Since the high information words are found in the medium and low frequency ranges, comprehension was expected to be adversely affected more by the deletion of these words than by the deletion of the low information words located in the high frequency range.

The analyses performed on the set relations data indicated that the only subjects to score significantly above chance level were those subjects assigned either the Trad passage or the passage in which 10% of the medium frequency words had been deleted. Analysis of the nested test items indicated that none of the groups scored significantly above chance level. Scores on the disjunctive test items were found to be significantly above chance level for the three 10% deleted passages and for the 50% high frequency word deleted passage. From these data it appears that the set relations test, especially the nested items, is not an adequate discriminator for assessing comprehension. However, examination of the actual words deleted provides some explanation for the rather poor performance on the the set relations test at the medium and low word frequency categories. Thirteen different words comprised the high frequency word category. In order of their frequency of occurrence, these words were: the, of, to, and, was, in, a, they, Bonese, on, that, their, had. In the medium frequency category, the words "all" and "some" appeared. Accurate recall of the set relation items depended on the ability of the subject to recall whether all or some elements or members comprised the group. The fact that some percentage of these words was omitted in both the medium and high word frequency categories undoubtedly affected comprehension of the set relations items.

Based upon previous telegraphic research, it was expected that reading rates and reading times would show a general decrease both as a function of increasing deletion levels and decreasing word frequency categories. It was expected that 50% deletion of low frequency words would produce decreased reading times especially in comparison to the Trad passage. These results were not obtained. The only explanation for this finding is that the omission of relatively high percentages of the words caused the subjects to engage in some type of "word guessing" activity as they read the passages. Some support for this notion was obtained in the 1 x 10 analysis of reading rates. The Scheffé analysis indicated the only significant difference was between the passage in which 50% of the high frequency words had been deleted and the Trad passage. But, if it is assumed that subjects do engage in a type of guessing or word estimation activity while reading the telegraphic passages, then it seems that reading rates would have been reduced more for the low frequency words, which are more difficult to predict from the passage context. A plausible explanation for these findings is not readily apparent at this time from results related to research on the telegraphic concept.

"San Francisco" Passage

The results related to the comprehension measures obtained from the "San Francisco" passage were similar to those obtained from "Buena-I and Kalo." Again, comprehension was least affected when the high frequency words rather than medium or low frequency words were deleted. However, no interaction was found between Deletion Level and Frequency Level. That is, the effects of increased deletion levels were the same across the three frequency categories. Subjects assigned the 10% reduced passages scored significantly higher than subjects assigned the 30 or 50% reduced passages for each of the comprehension measures except the disjunctive test items, for which no significant differences were found. The only subjects to score above chance level on the nested items of the set relations test were those subjects assigned the 10% high or the 10% low frequency word deletion passages. Subjects assigned the Trad passage did not score significantly above chance level on either the nested or disjunctive set relation test items. Based on these data, it can only be concluded that the set relations test was too difficult for the subjects involved in this experiment since the Trad passage contained the key words "some" and "all."

The 3 x 3 ANOVA on reading time revealed that subjects assigned the passages in which the high frequency words had been deleted required significantly more reading time than subjects assigned the passages in which the low frequency words had been deleted. However, the 1 x 10 ANOVA indicated no significant pairwise comparisons. These results were contrary to the expected results. Again, the expectation was that longer reading times would be associated with deletions of low frequency words.

Reading rates were found to be significantly slower for subjects assigned the passages in which high frequency words were deleted as compared to the reading rates for those assigned the passages in which low frequency words were deleted. These results are also contradictory to the expected findings. The medium and low frequency word deletion passages were expected to produce slower reading rates than the high frequency word deletion passages because of the elimination of important content words from the sentences. Subjects assigned the passage in which 50% of the high frequency words had been deleted had the slowest word per minute reading rate.

The fact that the elimination of high frequency words had little effect upon comprehension is consistent with the data presented in Table 4.2. The analysis of the total number of comprehension items not answerable as a function of word frequency categories clearly shows that the questions are more sensitive to the elimination of low frequency words than to high frequency ones. When 30% of the low frequency words were eliminated, 50% of the comprehension items could not be answered from the passage context. This is contrasted to the high frequency category where a 30% deletion level resulted in 23% of the items not answerable from the passage context. There was little difference in the percentage of items answerable as deletion levels were increased to 50% compared to the 30% level for all three frequency categories.

In conclusion, elimination of high frequency words had little effect upon total comprehension scores at any of the three deletion levels. However, comprehension did tend to decrease with increasing levels of deletion in the medium and low frequency word categories. The set relations test proved to be somewhat insensitive to the experimental manipulations due to its level of difficulty. Reading rates and reading times were not greatly affected by manipulations within the two independent variables. Contrary to expectation, when reading times and rates were influenced, the tendency was for the elimination of high frequency words to adversely affect these variables as opposed to low frequency words.

CHAPTER V

EXPERIMENT IV

EFFECTS OF A SUBJECTIVE DELETION SCHEME IN THE GENERATION OF TELEGRAPHIC PROSE

Introduction

The purpose of the present study was to determine the feasibility of developing telegraphic prose based on a subjective deletion scheme. The telegraphic reduction method used in this study was based on subjects rank ordering words in each sentence on the basis of the importance of the words in communicating the main sentence idea. The information obtained from the rank ordering was used to generate telegraphic passages at increasing levels of deletion. Low levels of deletion eliminated words judged to be relatively unimportant, whereas higher levels of deletion eliminated more important words. Subjectively deleted telegraphic prose was compared to randomly deleted telegraphic prose. The random deletion scheme was used as a baseline in order to determine to what extent the subjective scheme was superior to a random elimination of words.

Five telegraphic versions of the passage were constructed using each deletion scheme. The telegraphic versions consisted of a 10, 20, 30, 40, and 50% deletion of words within each sentence. The ten telegraphic versions and the traditional (Trad) version were compared with respect to comprehension, reading rate, reading time, and a measure of efficiency. The hypotheses were:

(1) There would be no significant differences between the traditional version and the reduced versions generated by either deletion scheme at the 10% level in relation to comprehension and reading rate.

(2) There would be significant differences in favor of the traditional version when compared to the reduced versions generated by the random scheme at 30, 40, and 50% deletions on comprehension and reading rate.

(3) The Deletion Scheme main effect would be significant in favor of the subject generated scheme.

(4) A significant interaction would exist between the two deletion schemes that would involve a relative

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This experiment was based upon a M.S. thesis by Charles Pantalion submitted to the Graduate College of Texas A&M University.

increase in comprehension, reading rate, and efficiency for the subject generated scheme with increasing percentages of deletion.

(5) The index of agreement among subjects on the rank order of words within each sentence would be significant.

Method

Subjects

The subjects for the study were undergraduate students enrolled in psychology classes at Texas A&M University. A total of 550 subjects were tested with 50 subjects randomly assigned to each of the eleven treatment conditions.

Design and Analysis

The basic design for the study was a 1 x 11 ANOVA to determine if any differences existed between treatment conditions in relation to comprehension, reading rate, reading time, and efficiency. The specific treatment conditions were five subject generated reductions consisting of 10 (S_1), 20 (S_2), 30 (S_3), 40 (S_4), and 50% (S_5) deletion of words from each sentence within the passage; five computer generated random reductions also consisted of a 10 (R_1), 20 (R_2), 30 (R_3), 40 (R_4), and 50% (R_5) deletion of words from each sentence within the passage; and a traditional version of the passage.

The Tukey Method of Multiple Comparisons (Winer, 1962) was used to determine the specific condition or conditions responsible for the significant differences.

A 2 x 5 ANOVA was performed to determine if any interaction existed between the reduced versions of the passage and the method utilized for reduction relative to comprehension, reading rate, reading time, and efficiency.

Further analysis involved the computation of the Kendall Coefficient of Concordance (Siegel, 1956) to determine the degrees of agreement among subjects on the rank order assigned to words within each sentence. In addition, the mean and standard deviation were calculated for the point within each sentence which indicated that further deletion would render the sentence meaningless.

Materials

The passage selected for this study was taken from an Air Force manual entitled History of the USAF. The manual is a reprint of the Air Training Command pamphlet 190-1. The specific passage, "Hemisphere Defense," consists of 67 sentences and appears on pages 4-7 and 4-8 of the manual. The passage consists of 16 paragraphs, contains 1,589 words, and the sentences average 23.7 words. The passage relates the problems confronted by the Army Air Force prior to World War II relative to the defense of the Western Hemisphere. The passage extracted from the manual was designated the traditional (Trad) passage. The development of the ten remaining treatment conditions was based upon the materials generated by the subject generated deletion scheme and the computer generated random deletion scheme.

Subject generated material. The construction of the five subject generated treatment conditions was based on a subjectively determined mean rank order for each word within each sentence. Subjects rank ordered each word within a sentence with respect to its significance to the intended meaning of the sentence. A rank order of one denoted the least significant word, and the rank order equivalent to the total number of words within the sentence denoted the most significant word. The rank order assigned to each word within a sentence was summed across all subjects and divided by the number of subjects to obtain the mean rank order.

The development of materials for the subject generated treatment conditions involved several procedures. First, a method for ranking each word within a sentence was developed. Following the development of this method, the subjects rank ordered the words. In addition, rules dictating the specific word, or words, and the number of words to be deleted from a sentence for each treatment condition were formulated. Finally, a computer program was developed to analyze the subject produced data and to construct the reduced versions of the sentences that comprised the treatment conditions.

The development of a method to facilitate the ranking of words within sentences involved the construction of two forms. One form, designated the "sentence form," consists of the unaltered passage typed lengthwise on an 8-1/2 x 14 inch paper. Sentences were spaced in such a manner as to appear to be a separate entity rather than a part of the passage. Each sentence was assigned a number corresponding to its sequential position within the passage (i.e., the first sentence was assigned the number one and the last sentence number 67). Similarly, each word within each sentence was assigned a number, sequentially. The first word within the sentence was assigned the number one, and the last word assigned a number equal to the total number of words within the sentence. The second form, labeled the "recording form," was used for entering the rank order of each word. The form consisted of numbered rows of blocks. The number of each row corresponded to the number assigned a sentence on the sentence form. In turn, the blocks within each row were also numbered. The blocks were numbered sequentially from one through the total number required to accommodate an entry for each word within a particular sentence.

To rank the words, the sentence form and recording form were used in conjunction. The ranking procedure involved three steps: (1) the subject read a sentence as presented on the sentence form; (2) the subject determined the least significant word in the sentence;and (3) the subject entered on the recording form the number assigned the word on the sentence form. The initial recording form entry was in the first block of the numbered row corresponding to the sentence being examined. The next least significant word was then determined and its number entered in the second block. This procedure was repeated successively until each word within the sentence was ranked.

A total of 220 subjects were asked to rank order the words within the sentences. Twenty subjects were randomly assigned to examine one of eleven sets of sentences. Ten sets consisted of six sentences, and one set consisted of seven sentences. The purpose of the study and instructions to be followed were presented to the subjects prior to their participation.

The analysis of the ranking data, the application of the deletion rules, and the actual word deletions from the sentences were accomplished by computer. The computer program was written in WATFIV FORTRAN language and performed by an IBM 360/65 computer. Using the Trad version of the passage and the rank order assigned words as entered on the recording form as input,the computer printed each sentence at each of the five specified levels of reduction. Construction of the specific treatment conditions was accomplished by placing the reduced sentences in passage form.

Computer generated material. The five computer generated reductions of the passage were formulated by randomly deleting words by sentence. The random deletion was performed by an IBM 360/65 computer utilizing WATFIV FORTRAN language and an extension of the WATFIV compiler for nonnumeric data processing.

The computer applied the rules formulated for the subject generated material for determining the number of words to be deleted from each sentence for a given treatment condition. However, the specific word or words deleted were based on a random deletion scheme generated by the computer program.

As with the subject generated material, the computer printed each sentence at a specified percentage of reduction. Construction of the actual treatment conditions involved placing the randomly reduced sentences into passage form. Regardless of missing words, the randomly reduced versions of the passage were punctuated at points indicated by the Trad version of the passage.

Test material. The assessment of subjects' comprehension on the eleven treatment conditions was made on the basis of the same test. The test, constructed from information contained in the Trad version of the passage, was a multiple choice test consisting of 50 items with four alternatives per item. The test was administered under an immediate recall situation.

A test was administered to 68 subjects. The subjects were undergraduate students in an introductory psychology class at Texas A&M University. The subjects were told that the experimenter was interested in measuring comprehension and reading rate on a particular passage. The subjects were asked to read the Trad version with the stipulation that no portion of the passage was to be re-read. Immediately following the completion of the reading task, the subjects were administered the test. An analysis of the results indicated relatively poor test item statistics. The specific method of analysis and the results are presented in Table 5.1.

TABLE 5.1

Test Item Statistics for the Original and Revised Comprehension Tests

Test Statistics	Original	Revised
Average Item Discrimination	.31	.33
Average Point-Biserial	.26	.29
Kuder-Richardson #20	.74	.79
Number	68	80

Test items indicated by the analysis as being unsatisfactory were either altered or deleted. Items indicated as acceptable by the analysis were retained. New test items replaced those deleted, and a second version of the test was constructed. The second version of the test was administered to an additional 80 subjects. The subjects were again students in an introductory psychology class at Texas A&M University. The administration of both test versions was identical. The results of the revised test were considered acceptable. The revised test was used as the criterion for assessing comprehension. The results of the analysis are presented in Table 5.1.

Additional material. Additional items used were a time recording form, a clock, and IBM answer sheets. 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 the reading rate and the reading time. A large clock, centrally located within the view of all subjects, was used as the timing device. The subjects used the IBM answer sheets to record test answers.

A test package consisting of a randomly assigned version of the passage, a time recording form, the test, and an IBM answer sheet was assembled for each subject. The subjects adhered to the following procedure: (1) read the passage at a comfortable rate, but no portion of the passage was reread; (2) recorded the time upon completion of the reading task; and (3) took the test.

Results

The major analysis involved comparisons among the means for each treatment condition on the following dependent variables: comprehension, reading rate, reading time, and an efficiency measure (E_t) which was defined as the number correct on the comprehension test times 100 divided by reading time. The means and standard deviations for each dependent variable are presented in Table 5.2.

Five 1 x 11 ANOVAs were used to analyze each of the dependent variables across all treatment conditions. Tukey's Method of Multiple Comparisons was used to determine the nature of the differences among the treatment conditions. These results are presented in Table 5.3. The .05 level of significance was used in making all comparisons.

The results of the 1 x 11 ANOVA on the comprehension variable yielded significance ($F(10, 549) = 17.97$, $p<.01$). As indicated in Table 5.3, all reduced versions of the passage did not significantly differ from the Trad version with the exception of S_5. With the exception of treatment condition R_1, all randomly reduced versions had significantly lower comprehension means compared to the Trad version.

For the variable of reading rate, the results of the 1 x 11 ANOVA were significant ($F(10,549) = 12.29$, $p<.01$). Table 5.3 shows that versions S_1, S_2, R_1, R_2, and R_3 did not differ significantly from the Trad version with respect to reading rate.

The results of the 1 x 11 ANOVA on the variable of reading time yielded significance ($F(10,549) = 11.69$, $p<.01$). Significantly less reading time was required by those subjects reading 40 and 50% reduced passages when compared to the Trad

TABLE 5.2

Means and Standard Deviations for Each of the
11 Treatment Conditions on the
Four Dependent Variables

Treatment Condition	Comprehension		Reading Rate		Reading Time		Efficiency (E_t)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Trad	29.30	6.20	172.60	34.93	575.74	122.36	5.27	1.54
S_1	27.64	7.55	179.99	48.01	505.80	124.31	5.78	2.08
S_2	26.38	5.63	162.56	38.03	495.12	121.58	5.63	1.82
S_3	26.78	6.98	141.24	32.37	499.20	112.77	5.80	2.33
S_4	26.74	6.07	136.37	35.89	441.30	97.97	6.35	2.12
S_5	25.02	5.78	120.49	22.80	398.26	65.90	6.38	1.52
R_1	25.78	5.56	174.42	35.10	508.32	87.55	5.22	1.48
R_2	21.56	5.29	158.80	46.95	512.94	138.09	4.51	1.63
R_3	20.70	4.37	154.45	53.55	473.80	132.84	4.68	1.64
R_4	19.60	4.19	139.69	53.63	443.66	107.62	4.71	1.75
R_5	19.86	4.11	125.42	37.07	398.34	77.97	5.22	1.72

TABLE 5.3

Results of the Significant Differences Between Treatment Means for the Dependent Variables Based Upon Tukey's Method of Multiple Comparisons*

Dependent Variables	Treatment Conditions										
Comprehension	T	S_1	S_3	S_4	S_2	R_1	S_5	R_2	R_3	R_5	R_4
Reading Rate	S_1	R_1	T	S_2	R_2	R_3	S_3	R_4	S_4	R_5	S_5
Reading Time	S_5	R_5	S_4	R_4	R_3	S_2	S_3	S_1	R_1	R_2	T
E_t	S_5	S_4	S_3	S_1	S_2	T	R_1	R_5	R_4	R_3	R_2

*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).

version. Versions S_1, R_1, and R_2 did not significantly differ from the Trad version.

For the variable of E_t, the results of the 1 x 11 ANOVA yielded significance ($F(10,549) = 6.33$, $p<.01$). Inspection of Table 5.3 for the E_t variable shows a superiority of subject reduced versions with treatment condition S_5 being most efficient. The subject reduced versions did not differ significantly from the Trad version.

Each of the four dependent variables was analyzed in a 2 x 5 ANOVA in which the independent variables were Deletion Level and Deletion Scheme. Again, Tukey's Method of Multiple Comparisons was used to determine the exact nature of the treatment differences.

Results of the analysis for comprehension scores indicated that there was significance within the Deletion Level main effect ($F(4,499) = 8.23$, $p<.001$) and the Deletion Scheme main effect ($F(1,499) = 98.10$, $p<.001$) as well as a significant interaction effect ($F(4,499) = 3.05$, $p<.05$). Regardless of the deletion scheme, the deletion of 10% was superior and significantly different from the remaining four levels of deletion. Figure 5.1 shows the interaction effect for comprehension. Generally, a relative decrease in comprehension occurred with a corresponding increase in percent deletion. Twenty and 30% deletion levels differed significantly from the 50% level. No significant differences were obtained between 20, 30, and 40% deletion levels or between 40 and 50% levels. The significant difference existing between the two types of deletion schemes was in favor of the subject deletion scheme. The interaction of Deletion Level by Deletion Scheme also favored the subject generated treatment conditions.

Analysis of reading rates revealed a significant F-ratio for the Deletion Level main effect ($F(4,499) = 25.22$, $p<.001$). Combining the reading rates at each deletion level for both deletion schemes indicated a significant decrease ($p<.001$) in reading rate at each successively higher level of deletion. No significant difference existed between the two types of deletion schemes. The interaction effect was not significant.

Analysis of required reading time indicated that the Deletion Level main effect was significant ($F(4,499) = 18.23$, $p<.001$). Generally, reading time was less with increasing percentages of deletion. Deletion levels of 40 and 50% were significantly different from each other and also significantly different from the remaining three levels of deletion. No significant difference existed between 30 and 20% or between 20 and 10%; however, there was a significant difference between 30 and 10%. No significant difference existed for the type of deletion scheme nor was there a significant interaction.

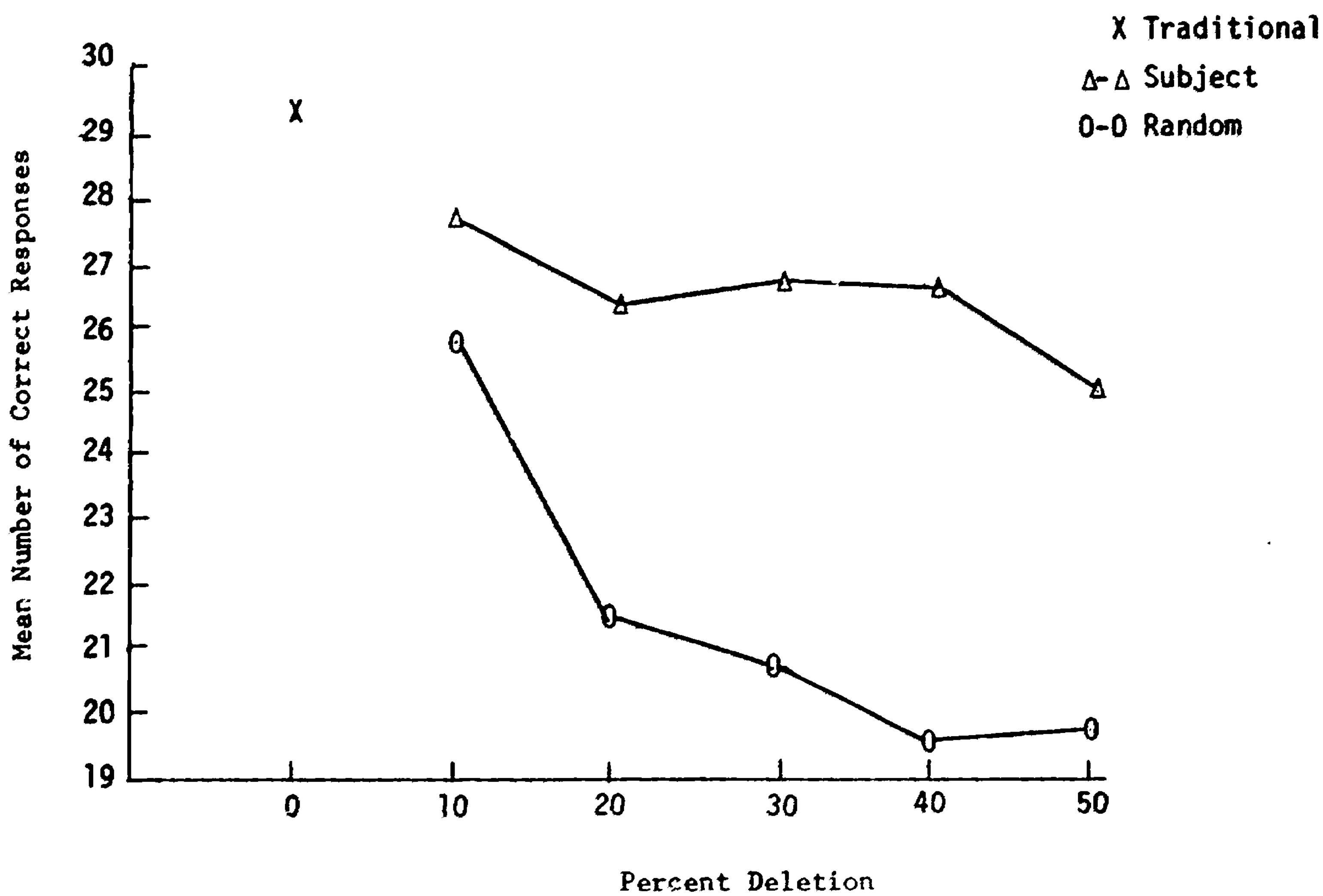

Figure 5.1. Interaction between Percent Deletion and Deletion Scheme for comprehension

The 2 x 5 ANOVA for E_t indicated a significant Deletion Level main effect ($F(4,499) = 2.40$, $p<.05$). Most efficient was the 50% deletion followed by the 40, 10, 30, and 20% deletions. With the exception of 40%, 50% deletion differed significantly from the remaining deletion levels. The 40% deletion was not significantly different from the 10% deletion, but was significantly different from 30 and 20% deletions. No significant difference was obtained between 10, 30, and 20% deletions. A significant F-ratio for the Deletion Scheme main effect was obtained and favored the subject generated scheme ($F(1,499) = 47.12$, $p<.001$). The interaction effect was not significant.

The Kendall Coefficient of Concordance (Siegel, 1956), used to determine the degrees of agreement among subjects relative to the rank ordering of words within each sentence, indicated significant agreement (.001) for each of the 67 sentences. An analysis of the point within each sentence where subjects indicated further deletion would render the sentence meaningless revealed a mean percentage of deletion across all sentences to be 61.7%.

Discussion and Conclusions

Results of the analysis for each dependent variable yielded both expected and unexpected findings. The hypotheses were generally confirmed; however, several findings related to the exploratory aspects of this study were not anticipated.

As expected, there were no significant differences between the Trad version and the reduced versions generated by either deletion scheme at the 10% deletion level for any of the five dependent variables. However, with the exception of the comprehension dependent variable, version S_1 was the superior of the three.

Hypothesis 2 predicted significant differences in comprehension between the Trad version and the 30, 40, and 50% random deletion levels. However, hypothesis 2 also predicted significant differences in reading rates for these same deletion levels when compared to the Trad version. The Trad version was superior and significantly different in comprehension when compared to 20% and higher random deletion levels. However, although superior and significantly different from versions R_4 and R_5 for reading rate, the Trad version was not significantly different from versions R_2 and R_3.

Hypothesis 3 stated that the Deletion Scheme main effect would be in favor of the subject generated scheme. This was confirmed for three of the five dependent variables. A significant F-ratio was not obtained for reading rate and reading time.

Contrary to expectations, with the exception of comprehension, significant interaction effects between the two deletion schemes across all deletion levels for each dependent variable were not obtained. In addition, again with the exception of comprehension, only E_t indicated that the subject generated versions were superior at each deletion level.

The hypothesis that there would be a high degree of agreement among subjects in relation to the rank ordering of words according to their significance for communicating the essential meaning of a sentence was confirmed. In addition, subjects also indicated that a relatively high percentage of words can be deleted from a sentence without altering its essential meaning.

Although each subject generated version other than S_5 compared favorably to the Trad version in relation to comprehension, they did not prove to be equivalent. The suoject generated versions were somewhat less effective than expected when compared to the Trad and randomly deleted versions in the remaining dependent variables. As with previous studies concerned with the telegraphic concept, a definition of essential information and the subsequent measurement of comprehension presented problems in the present study. The deletion of words, particularly at higher levels of deletion, automatically eliminated some of the information presented in the comprehension test. Nevertheless, versions S_1, S_2, S_3, and S_4 were statistically equivalent to the Trad version on this dependent variable. However, the question arises regarding essential information. Perhaps the versions S_3, S_4, and S_5 were equivalent to the Trad version in relation to essential information. The criterion test was constructed from the information presented in the Trad version prior to any analysis of the words deleted by subjects. The test questions and answers contained a large number of descriptive words that were deleted from the subject generated versions. How important these descriptive words are regarding essential information is not known and beyond the scope of the present study. Subjects indicated that such words were relatively unimportant. However, analysis of the number of test questions not answered (noncommon items) in each of the reduced versions indicated otherwise. The following number of noncommon items were present in each of the reduced versions: S_1, 0; S_2, 3; S_3, 6; S_4, 12, S_5, 19; R_1, 12; R_2, 19; R_3, 26; R_4, 34; and R_5, 37. Based on this information, subjects reading versions S_1, S_2, and S_3 performed rather poorly in relation to the performance of subjects reading versions R_2, R_3, R_4, and R_5. This is particularly striking when comparing the number of test questions answered in version R_5 (13) with the mean comprehension score (19.86) for subjects reading R_5. Nevertheless, the significant interaction that favored the subject generated versions does show a marked decrease in performance for subjects reading random deletions of 20% and higher.

A possible factor that contributed to a loss of comprehension for the subject generated versions was the specification of a certain percentage of deletion for each sentence. It is felt that some optimum level of deletion exists for a given sentence that was not presented in the present study. For some sentences 30% deletion was appropriate and seemed to relate the necessary information; for other sentences a 20, 40, or 50% deletion seemed more appropriate.

For those dependent variables involving any dimension of time (reading rate, required reading time, and E_t) a situation similar to that for comprehension existed. Reading rate may have had two extraneous factors present. Initially, the factor of no experience or the lack of familiarity with telegraphic prose may be responsible for the slower reading rates of subjects reading reduced versions. The second factor believed to confound the statistical analysis of reading rates involved a comparison of the reduced versions generated by the two types of deletion schemes. A cursory reading of the various reduced versions indicates that the subject generated versions are superior. This is particularly true at higher levels of deletion. Versions R_3, R_4, and R_5 were in effect complete nonsense. Consequently, it is felt that a substantial number of subjects reading those versions failed to properly attend to the task. This resulted in relatively high reading rates for subjects reading randomly reduced versions. The significant differences found between the various reduced versions for comprehension indirectly supports this interpretation.

However, regardless of the problems presented regarding variables dependent upon a time factor, the subject generated versions did compare relatively well with the Trad and randomly reduced versions for those variables. With respect to reading rate, version S_1 was superior to all treatment conditions including the Trad version. Both S_1 and S_2 were statistically equivalent to the Trad version. Versions R_1, R_2, and R_3 were also statistically equivalent to the Trad version. All other versions were statistically different and inferior to the Trad version.

The variable of reading time indicated that highly reduced versions regardless of deletion scheme were significantly different and superior to the Trad version. However, again when time and comprehension were considered together in the E_t dependent variable, the subject generated versions were superior to the Trad version and all of the randomly deleted versions. In addition, each randomly deleted version was inferior to the Trad version.

Two major conclusions were considered appropriate as a result of this research. Initially, the research was interpreted as support for the feasibility of a telegraphic concept based on a subjective deletion scheme. This conclusion was reached on the basis of three factors. One factor was the indication that the subject generated versions of 30 and 40%

deletion saved a significant amount of reading time when compared to the Trad version. The second factor was the lack of any significant differences among versions S_3, S_4, and the Trad version on comprehension. The third factor was that both S_3 and S_4 were more efficient than the Trad version as measured by E_t.

The second major conclusion was the rejection of a random deletion scheme as a viable approach for developing telegraphic prose. This conclusion was based primarily on the relatively poor comprehension achieved by subjects reading the randomly reduced versions; however, the analysis of the number of non-common items and the E_t variable for the randomly reduced versions were also contributing factors to such a conclusion.

Although this research was interpreted as support for the development of telegraphic prose based on a subjective deletion scheme, several additional factors should be investigated before any definite conclusions are made.

The problem of defining essential information must be solved. A possibility would be the deletion of words based on a prior knowledge of the criterion test.

In addition, further research should be directed toward investigating optimum levels of deletion for a given sentence, optimum sample size for generating telegraphic versions of selected passages, and the particular grammatical categories consistently deleted by subjects. The establishment of optimum levels of deletion for each sentence within a passage should enhance comprehension and may possibly increase ease of reading. With respect to sample size, the present study utilized a relatively large number of subjects for deletion to assess the agreement among subjects relative to the rank ordering of words within sentences. However, greater practicality of a subjective deletion scheme for developing telegraphic prose could be achieved if the scheme involved only one person. Moreover, the present study did not incorporate an analysis of the grammatical categories consistently deleted from sentences by subjects; however, it was noted that articles and conjunctions were generally the first words to be deleted from a sentence.

The concept and the study of telegraphic prose is a relatively new venture in the general area of verbal learning. Previous and present research has failed to yield definitive results and answers. However, this experiment does offer possibilities and it has undoubtedly created additional meaningful parameters to be investigated in subsequent research.

CHAPTER VI

EXPERIMENT V

COMPARISONS AMONG THE GRAMMATICAL, FREQUENCY, AND SUBJECTIVE DELETION SCHEMES

Introduction

The purpose of the study was to examine three methods of considering redundancy in written prose and to determine the effects of reducing the redundancy from a traditional prose passage. Each reduction method was applied to three different passages, a fiction story, a science article, and a news article in order to study the differences which may occur by reducing different literary styles. The reduced passages generated by the reduction methods were read by college undergraduates who were timed during the reading period and tested for comprehension in order to determine what effects the various redundancy reductions have on comprehension, reading time, reading rate, and presentation efficiency.

The development of telegraphic prose is based upon the assumption that redundancy exists in the language and that it can be identified and reduced or eliminated from a prose passage. The assumption that redundancy exists is commonly accepted; however, the extent to which it can be defined, measured, and located is a challenge which continues to be met as more is learned about the dependencies in the language. It is, in part, the purpose of this experiment to compare redundancy as identified in terms of grammatical parts of speech, word frequency, and subjective judgment.

The present experiment was designed to incorporate three methods of reducing prose by applying three reduction methods to each of three types of written prose. The methods included a subjective procedure used in Chapter V (SHORT method - Subjective Hierarchy of Relevant Terms), the grammatical procedure used in Experiment II, and the word frequency procedure used in Experiment III.

The procedure in this experiment for eliminating grammatical categories was the same as for eliminating high frequently occurring words. Only the unessential grammatical categories or most frequently occurring words were eliminated until 10% of the words were deleted and similarly 30 and 50% of the words were deleted from the traditional passages. Thus, even at the 50% reduction level, none of the essential grammatical categories, such as nouns and verbs, were eliminated nor were the low frequently occurring words eliminated.

This experiment was based in part upon a Ph.D. dissertation by Carolyn Bassin in the process of submittal to the Graduate College of Texas A&M University.

In addition to the comparative analysis of the three methods of reducing prose, made possible by utilizing a single design, an effort was made to determine what differential effects the methods may have on varying types of prose literature. It was therefore determined to apply the methods to each of three passages in three independent designs. In prior experiments, only the reduction of fiction type literature was of primary interest. Thus, in addition to a fiction type passage, a news article and a scientific journal article were included.

The passages were read by undergraduate college students and tested on the variables of comprehension (multiple choice and cloze), reading time, reading rate, and presentation efficiency. Evaluations were made on both the reduction method used (frequency, grammatical, SHORT) and the percent reduction level (Trad, 10, 30, and 50%).

Since the inclusion of both a scientific and a news article was largely exploratory, hypotheses were not constructed which differentiate between the passage types. However, based on the results of prior experiments, the following hypotheses were made.

(1) Differences will be found between the effects of the three reduction programs: frequency, grammatical, and SHORT, on the variables of comprehension, reading rate, reading time, and presentation efficiency.

(2) There will be a significant difference between the effects of reducing 10, 30, and 50% of the words from the traditional prose passages on the variables of comprehension, reading rate, reading time, and presentation efficiency.

(3) The mean differences in comprehension, reading times, reading rate, and presentation efficiency for the traditional passages and the 10% reduced passages will not be significant across all reduction methods.

(4) The mean of the passages generated by the SHORT method will be significantly higher than those generated by the frequency and grammatical deletion methods on all variables of comprehension at all deletion levels except the 10% level.

(5) For the variables of comprehension, reading time, reading rate, and presentation efficiency, the mean differences will be significant between the 10% reduced passages and the 30 and 50% passages, reduced by the frequency and grammatical methods.

(6) The means of the 10% reduced passages and the 50% reduced passages generated by the SHORT method will be significantly different on the variables of comprehension, reading time, reading rate, and presentation efficiency.

Method

Subjects

The subjects for this study were students enrolled in freshman and sophomore psychology or education courses at Texas A&M University. A total of 741 subjects were tested in Phase IV, the final phase of the experiment. The subjects were randomly assigned to one of 33 treatment groups for a total of 18 to 22 subjects in each group. In Phase III, 410 subjects were randomly assigned to one of 31 sentence sets so that at least 10 subjects rank ordered the words within each sentence for the development of the subjectively reduced passages.

Materials

Three traditional reading passages were selected for use in this experiment. Each passage was reduced by each of three different methods, which are described in three phases of materials development. Phase IV is a description of the materials developed in the first three phases which were used to test for comprehension and reading time.

Three reading passages were selected from different categories of reading material: fiction, news, and scientific literature. Since it was not possible to randomly select from all fiction stories, news articles, and scientific journals, the passages, with the exception of the fiction story, were selected from typical published material on the basis of four criteria. First, each reading passage was to contain between 2,000 and 3,000 words. Second, the scientific and news articles were to be selected from a scientific journal and a weekly news journal, respectively, and dated prior to 1972. Third, each prose passage was to contain factual information to allow for the construction of a comprehensive multiple choice test. Fourth, passages which referred to local geographic regions or were considered to be resque were eliminated.

A search was made of the 1970 and 1971 issues of *Time* and *Newsweek* magazines. The news article selected was "Japan: A Time of Decision," *Newsweek*, October 4, 1971, 32-34. The passage is an article about Japan's new status as an industrial superpower and her new sense of pride and independence. Permission to reprint this article was granted by Newsweek Incorporated. From a search through the issues of *American*

Scientist prior to 1972, the article by F. M. Berger, "Control of the Mind," American Scientist, March 1967, 55, 67-71, was selected. The article concerns the use of drugs and anxiety causing situations as methods which can be used to control mental behaviors. Permission to reprint the article was granted by American Journal of Pharmacy, where the article originally appeared. The fictional story, "San Francisco," was selected from four stories which had been written for experimental use (Martin & Hope, 1972). The three traditional passages selected for use in this experiment are presented in the Appendix, Volume II.

The level of reading difficulty based upon the Coleman-Liau (1974) readability measure was determined for each traditional passage. The Coleman-Liau formula was designed on the basis of two predictors, the number of letters and number of sentences, in a measured portion of a passage. The formula is advantageous because it is applicable to computer scoring (Coleman & Liau, 1974). Readability, based upon the first 1,000 words in each passage, was found to be easiest for the fiction passage with a score of 25. The news article scored 18 and the science article scored 15. These scores correlate favorably with the Flesch (1949) readability scale (.99). The Flesch scores for the fiction, news, and science passages were 58, 45, and 40, respectively, indicating that the fiction story was fairly difficult reading, whereas the news and science articles were difficult reading.

Phase I. The frequency method of reducing prose was applied to each of the three traditional reading passages. The high frequently occurring words in each passage were deleted so that reduced versions were generated at 10, 30, and 50% of the words in the traditional passages. Thus, three reduced passages were developed for each of the three traditional passages.

Phase II. Nine reduced passages were developed based on the grammatical method of reduction. Reduced passages of 10, 30, and 50% were generated by the elimination of specified parts of speech for each traditional passage.

Phase III. Two forms were used by college subjects in Phase III for the development of materials by the SHORT method. On the sentence form, the sentences of the traditional passages were numbered and typed sequentially on lengthwise sheets of 8-1/2 x 11 inch paper. The words within each sentence were numbered sequentially as well. Thus, the first word of each sentence was numbered one, and the last word corresponded to the number of words in the sentence. The recording form consisted of a row of sequentially numbered blocks for every word within a sentence. Each row of blocks was numbered to correspond with the number on the sentence form.

Based upon the subjective ordering of the importance of words in a sentence, three reduced passages were developed at 10, 30, and 50% reductions for each of the science and news passages. The subjectively reduced passages for the fiction story, "San Francisco," were developed by Peterson (1973).

Phase IV. A total of 30 treatment passage conditions developed in Phases I, II, and III were prepared for use in the final phase. Nine experimental versions were developed for each of the three traditional passages on the basis of three reduction methods. Specified percentages, 10, 30, and 50%, of the number of words in the traditional passages were deleted as each reduction method was applied to the traditional passages.

Three multiple choice tests and three cloze tests designed to measure comprehension were written, one each for the traditional passages. Each of the cloze tests contained 50 items. The number of items in the multiple choice tests varied due in part to the amount of test information available in each traditional passage. Sixty items appeared in the multiple choice test for the fiction story, 25 items appeared for the science article, and 32 items appeared for the news article. The percentage of questions nonanswerable in the reduced passages are presented in Table 6.1. A test-only treatment condition was also prepared for Phase IV consisting of a multiple choice test and a cloze test.

A time recording form, an IBM answer sheet and a large electric clock were also used in Phase IV. The time recording form was provided for recording the time elapsed while reading a treatment passage. The electric clock was used to time the reading of the assigned versions. The IBM answer sheets were used to record the test answers for the multiple choice tests.

Procedure

Phase I. The method of reducing words by the frequency with which they appear in a passage was first developed by Martin (1973). Accordingly, specified percentages of high frequently occurring words within a passage were omitted. The computer program written in FORTRAN IV-G computer language for the Martin experiment provided for the production of several information 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, 10, 30, and 50% of the words in the traditional passages were identified. A computer program was developed to delete the words identified and to print out

TABLE 6.1

Percentage of Unanswerable Multiple Choice Test Items in the Reduced Versions

Passages	Reduction Levels		
	10%	30%	50%
Fiction			
Frequency	0	0	25%
Grammatical	0	2%	22%
SHORT	0	2%	10%
Science			
Frequency	4%	4%	8%
Grammatical	4%	32%	40%
SHORT	12%	4%	12%
News			
Frequency	0	6%	19%
Grammatical	6%	9%	56%
SHORT	0	0	9%

reduced passages which subsequently contained 10, 30, and 50% 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%. Tables 6.2, 6.3, and 6.4 list the words deleted from each of the 10, 30, and 50% reduced passages for each of the three types of traditional passages. Table 6.5 presents the total number of words in each passage reduced by the frequency method.

The reduced passages generated by the computer were typed in traditional sentence format for duplication.

The rank lists of high frequently occurring words for each passage were based on the ranked frequencies of the words within each passage. A simple Pearson product correlation was used in order to determine to what extent the within passage frequency lists compared with a list based upon a large sample of English words. The Thorndike and Lorge (1944) list of 30,000 frequently occurring English words was selected The first 80 word types in the within passage ranked frequency lists were correlated with the rank list of words sampled by Thorndike and Lorge. In all three traditional passages, the correlations were relatively high, .88, .70, and .93, for the fiction, science, and news stories, respectively. Thus the decision to use either a word frequency list taken from a large sample or a word frequency list taken from a single passage would vary only to a moderate extent. On occasion, due to the within passage frequency listing, a noun, such as "Japan" in the news story, occurred frequently and was therefore a candidate for deletion at the 50% level of reduction. In this case, the word was restored to the first paragraph of the reduced passage, but was omitted thereafter in the passage.

Phase II. The second reduction method applied to each of the three traditional passages at 10, 30, and 50% reductions was termed the grammatical reduction method. Originally developed by Martin and Chitwood (1972) for Experiment II of this report, this procedure was designed to objectively delete percentages of words labeled by their grammatical parts of speech. The grammatical reduction method used in this experiment was a modification of the Martin and Chitwood experiment.

Each word in the three traditional passages was classified as to its part of speech within the sentence it was used. Thus, each word was categorized as: (1) noun, (2) verb, (3) article, (4) pronoun, (5) adjective, (6) adverb, (7) conjunction, or (8) preposition. Whereas in the Martin and Chitwood (1972) study, reduced passages were constructed by deleting words from each of five categories: nouns and pronouns; verbs; adjectives and adverbs; prepositions; and articles and conjunctions, the present study was designed to construct passages by deleting

TABLE 6.2

Percentage of the Word Types Deleted in the Fiction Story for the 10, 30, and 50% Reduced Passages by the Frequency Reduction Method

Reduction Level	Word Types
10%	the, of (86%)
30%	the, of, to, and, in, a, was, had, he, they, on, from, city, that, with, it (84%)
50%	the, of, to, and, in, a, was, had, he, they, on, from, city, that, with, it, for, were, be, their, group, by, out, them, mayor, there, have, at, Atkins, all, as, his, would, young, been, one, down, but, an, you, first, then, committee, who, state, when, government, see, back, or, earthquake, Palmer, we, time, plans, seemed, more, almost, some, volunteers, than, disaster, up, members, if, two, charge, this, me, only

Words unmarked by a percentage were deleted 100%.

TABLE 6.3

Percentage of the Word Types Deleted in the Science Article for the 10, 30, and 50% Reduced Passages by the Frequency Reduction Method

Reduction Level	Word Types
10%	the, of (86%)
30%	the, of, and, is, to, that, a, in, anxiety, it, have (15%)
50%	the, of, and, is, to, that, a, in, anxiety, it, have, as, not, they, by, or, are, for, such, this, would, which, an, these, been, can, more, was, behavior, from, used, control, what, state, our, any, mind, us, has, we, methods, there, prisoner, with, produce, also, about, its, their, drugs (60%)

Words unmarked by a percentage were deleted 100%.

TABLE 6.4

Percentage of the Word Types Deleted in the News Article
for the 10, 30, and 50% Reduced Passages
by the Frequency Reduction Method

Reduction Level	Word Types
10%	the, of, a (88%)
30%	the, of, a, to, and, in, that, Japan, Japanese, is, U.S., are, for, on, with, they (15%)
50%	the, of, a, to, and, in, that, Japan, Japanese, is, U.S., are, for, on, with, they, has, it, more, its, was, but, be, as, have, their, by, from, this, than, an, still, last, all, there, we, American, Nixon, national, president, when, many, world, Washington, no, economic, or, policy, not, one, will, Tokyo, trip, been, would, ago, such, years, own, them, at, into, also, his, whether, up, foreign, pride, people, administration, exports, united (25%)

Words unmarked by a percentage were deleted 100%.

TABLE 6.5

Total Number of Words Contained
in Each Treatment Passage

Reduction Method	Reduction Level		
	10%	30%	50%
Fiction			
(Trad = 2692)			
Frequency	2422	1883	1336
Grammatical	2422	1883	1336
SHORT	2420	1876	1309
Science			
(Trad = 2042)			
Frequency	1838	1429	1021
Grammatical	1838	1429	1021
SHORT	1833	1437	991
News			
(Trad = 2217)			
Frequency	1995	1552	1108
Grammatical	1995	1552	1103
SHORT	1973	1521	1073

the grammatical categories considered least important until 10, 30, and 50% of the words in the original passage had been deleted.

Each grammatical category was ranked by its designation as most important to least important for the comprehension of a sentence. In order, they were: nouns, verbs, adjectives, pronouns, conjunctions, adverbs, articles, and prepositions. The rank list was based on the results of four research studies in which the importance of various grammatical categories were considered by different measures (Coleman & Blumenfeld, 1963; Coleman & Miller, 1968; Martin & Chitwood, 1972; Sheffield, 1972).

An IBM 360/65 computer was programmed to print out a listing of each grammatical category and the number of times each category appeared in each of the three traditional passages. By the ranked frequency list of grammatical categories, 10, 30, and 50% of the words in each passage were identified. Similar to the frequency reduction method, a computer program, written in FORTRAN IV-G computer language, was developed to delete the grammatical categories identified and to print out reduced passages which subsequently contained 10, 30, and 50% fewer words than the original passage. In cases where only a percentage of a grammatical category was to be omitted, the program was designed to delete these words randomly. All other identified categories were deleted 100%. Table 6.6 lists the grammatical categories deleted from each of the 10, 30, and 50% reduced passages for the three types of traditional passages, and Table 6.5 presents the total number of words in the passages reduced by the grammatical method. The computer generated reduced passages were typed and punctuated according to traditional format and duplicated.

Phase III. The third reduction method of Subjective Hierarchy of Relevant Terms (SHORT), used to develop the subject generated treatment conditions, was based on a subjectively determined mean rank order of each word within each sentence of the science and news stories. The subjects in Phase III used both the sentence form and the recording form to rank order the words in each sentence assigned to them. The subject read a sentence as provided on the sentence form. The subject selected from the sentence the least significant word in the sentence and recorded the number of the word in the first block on his recording form. This process continued until all of the words in the sentence were ranked in the blocks on the recording form.

An IBM 360/65 computer analyzed the rank lists constructed by the subjects on the words in each sentence of the passages. The computer program was written in WATIV language for the Martin and Pantalion (1973) study. The computer program printed the Kendall Coefficient of Concordance (*W*) (Ostle, 1963) for each sentence and printed each

TABLE 6.6

Percentage of the Grammatical Parts of Speech Deleted
From the 10, 30, and 50% Reduced Passages
by the Grammatical Reduction Method

Reduction Level	Parts of Speech
Fiction	
10%	prepositions (77%)
30%	prepositions, articles, adverbs (77%)
50%	prepositions, articles, adverbs, conjunctions, pronouns, adjectives (43%)
Science	
10%	prepositions (72%)
30%	prepositions, articles, adverbs, conjunctions (33%)
50%	prepositions, articles, adverbs, conjunctions, pronouns, adjectives (52%)
News	
10%	prepositions (74%)
30%	prepositions, articles, adverbs, conjunctions (6%)
50%	prepositions, articles, adverbs, conjunctions, pronouns, adjectives (51%)

Words unmarked by a percentage were deleted 100%.

sentence at three levels of reduction. The sentences were typed in paragraph form and punctuation was added by the examiner. The total word count of all passages reduced by the SHORT method are presented in Table 6.5.

A multiple choice test was developed for each of the news and science passages and examined by item analysis. The multiple choice test for the fiction story had been written and analyzed by Martin and Hope (1972).

The 50-item cloze tests developed for this study consisted of selected paragraphs highlighting the major events of each of the traditional passages. The number of words in each test totaled 831 for the fiction story, 778 for the science article, and 674 for the news article. The cloze tests were designed by deleting 50 high content words, i.e., nouns and verbs, from the selected paragraphs leaving a uniformly spaced blank of 15 spaces in place of the missing word. High content words were selected for omission from the traditional passages because of the high probability of their remaining in all of the experimental passages following the application of the reduction methods.

In an effort to obtain some measure of validity on the cloze tests, designed by omitting only nouns and verbs, a comparison was made on a noun-verb cloze test and a traditional any-word cloze test which were developed on a single passage. First, a test form was developed by omitting 50 nouns and verbs from paragraphs highlighting the news article. Additionally, a second test form was developed by omitting every fifth word from the same paragraphs. These forms of the test were then combined for the construction of two treatment conditions. By alternating the paragraphs from both test forms, test condition one began with a paragraph in which nouns and verbs were omitted whereas condition two began with a paragraph in which every fifth word was omitted. Fifty-three subjects from a freshman psychology class were randomly assigned to two treatment groups. Those subjects who were tested on the cloze form beginning with the noun-verb omission comprised group one. Those tested on the form beginning with every fifth word omitted comprised group two.

A computer program packaged by Veldman (1967) was used to obtain a factor analysis for each form of the test. The intercorrelation matrices and the factor matrices for groups one and two are presented in Appendix D. The intercorrelations among the paragraphs in group one were fairly significant. The intercorrelations among the variables of group two were fair, but not as high as those found in group one. Similarly, the group one factor matrix indicates one significant factor, comprehension. Group two appears to be close to significance but is not as high as is group one. In each form, the first paragraph, nouns and verbs in form one, and every fifth word in form two, provided the highest loading and accounted for the most variability.

Rankin (1957) considered the validity of a cloze test in which nouns and verbs were omitted. A "noun-verb" form of the cloze test and an "any-word" form was constructed using the Story Comprehension sub-test of the Diagnostic Reading Test, Survey Scale. The noun-verb test correlated .57 with story comprehension and .39 with paragraph comprehension; whereas, the any-word test correlated .38 with story comprehension and .73 with paragraph comprehension. The hypothesis that a noun-verb cloze form tests "lexical comprehension" and the any-word form tests "structural comprehension" was confirmed. Rankin (1957) suggests that either cloze procedure may be used depending on the purposes of the test constructor.

Phase IV. In the final phase, test packages were randomly assigned to subjects containing: (1) an experimental passage, (2) a time recording sheet, (3) a multiple choice test, (4) an IBM answer sheet for the multiple choice test, and (5) a cloze test. Those taking the test-only condition received test packages containing: (1) an IBM answer sheet, (2) a multiple choice test, and (3) a cloze test. A large clock, placed in view of all subjects, was set to start at the time the subjects were instructed to begin reading their assigned passages. Immediately upon completion of the reading passage, each subject copied his reading time onto his time recording sheet and proceeded to the answering of the multiple choice and cloze test items. Those subjects who received only the test condition were instructed to answer the test items as well as possible without prior reading of the story.

Those subjects who failed to complete the required task, or who did not follow the instructions were eliminated from the study. A total of 59 subjects were eliminated, which included 12 who read the fiction passages, 15 who read the science passages, and 32 who read the news passages. The number of incompletes were fairly well distributed among the treatment conditions.

Design

An analysis was made of the ranked words in each sentence obtained in Phase III to determine the degree of agreement among subjects concerning the relative importance of the words in each sentence. The Kendall Coefficient of Concordance (W) (Ostle, 1963) was computed for each of the sentences. A Chi-square value for each coefficient of correlation was obtained in order to test the significance of the index of agreement on the rank ordering of the words in the sentences.

The dependent variables analyzed in Phase IV included two measures of comprehension: a multiple choice test and a noun-verb cloze test; reading time; reading rate; and presentation efficiency. The measures of comprehension were based upon the total number of correct items for each test. Reading time (R_t) was defined as the number of minutes required by the individual subject to read a given passage. Reading time and the total number of words in each reading passage were used to compute reading rate (wpm), the individual's average number of words read per minute. Presentation efficiency (E_t) was computed for each subject by multiplying the total comprehension (C) by 100 and dividing by the reading time (R_t). Thus, $E_t = \frac{C \times 100}{R_t}$.

A comparison between the three types of literature was not made due to the uncontrolled variability between the passages. A 3 x 3 ANOVA (Reduction Method x Reduction Level) was performed on each dependent variable for each of the three types of literature in order to determine any interaction effect between the levels of reduced passages and the reduction methods. A 1 x 10 ANOVA was used to examine each dependent variable for the three types of literature in order to determine any differences between the reduced passages and the traditional passages. In addition, a 1 x 10 ANOVA was performed on the multiple choice and cloze test dependent variables so that differences between the test-only conditions and the reading passage conditions could be analyzed.

Where significant differences were found in the analyses of variance between levels of the independent variables, a Scheffé analysis of post hoc comparison (Myers, 1972) was used to specify the exact location of these differences.

An F_{max} test for homogeneity of variance (Winer, 1971) was performed on each analysis of variance in order to evaluate the homogeneity of variance assumption.

Results

The results are presented in three major sections corresponding to the three types of literature, and on the basis of Phase III and Phase IV data. Phase III materials for the fiction story were developed by Peterson (1973), and are not included in this section. The results of the item analyses are presented in the final section of the results.

Fiction Phase IV. A 3 x 3 ANOVA was performed on the correct number of responses on the multiple choice test. The means and standard deviations for the correct number of responses on the multiple choice test are presented in Table 6.7. The analysis indicated a significant difference among the Reduction Level main effect ($F(2,174) = 38.19$, $p<.001$). A Scheffé test indicated that the 50% reduced passages differed

TABLE 6.7

Means and Standard Deviations for Number of Correct Responses on the Multiple Choice Test for the 11 Treatment Conditions (Fiction)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	49.00	47.80	36.52
S.D.	8.67	7.40	6.90
Grammatical			
Mean	48.91	46.50	39.16
S.D.	7.18	6.18	6.68
SHORT			
Mean	50.95	45.50	41.28
S.D.	6.07	5.30	7.29

Traditional Mean = 52.05 S.D. = 4.47

Test Only Mean = 22.35 S.D. = 7.16

significantly with both the 10 and 30% reduced passages. The results of the Scheffé test are shown in Table 6.8.

The 3 x 3 ANOVA was performed on the number of correct responses of the cloze test. Table 6.9 presents the means and standard deviations for the cloze test scores. A significant difference was found among the Reduction Level main effect ($F(2,174) = 4.79$, $p<.01$). An analysis of the location of differences among the reduction levels by a Scheffé test indicated that comprehension was significantly greater for the 10% passages than for the 50% passages. Table 6.8 presents the results of the Scheffé test for the Reduction Level main effect.

Another 3 x 3 ANOVA of reading time was performed on the number of minutes required to read each treatment passage. The means and standard deviations of the number of minutes are given in Table 6.10. The Reduction Level main effect showed a significant difference ($F(2,174) = 10.03$, $p<.001$). For the Scheffé test, presented in Table 6.8, it was found that the 50% reduced passages took significantly less time to read than the 10 or 30% reduced passages.

A 3 x 3 ANOVA for the assessment of differences on the variable of reading rate was performed. Presented in Table 6.11 are the means and standard deviations of the number of words read per minute for each treatment condition. The analysis indicated a significant difference for the Reduction Level main effect ($F(2,174) = 63.45$, $p<.001$). The Scheffé test results in Table 6.8 indicated that reading rate for the 10% reduced passages was significantly greater than for the 30 or 50% reduced passages. In addition, the 30% reduced passages were significantly greater on reading rate than the 50% passages.

Finally, the 3 x 3 ANOVA performed on the variable of presentation efficiency indicated no significant differences among the independent variables. Thus, performance on presentation efficiency was comparable regardless of the reduced passage read. Means and standard deviations for the presentation efficiency scores are presented in Table 6.12.

An F_{max} test for homogeneity of variance (Winer, 1971) was calculated for each 3 x 3 ANOVA performed. Homogeneity of variance was found for each ANOVA performed on the variables of comprehension, reading time, and presentation efficiency at the .05 level of significance. Significance was found on the variable of reading rate ($F_{max}(21) = 4.64$, $p<.05$). The F_{max} statistic was only slightly greater than the .05 level of significance ($p<.05 = 4.24$).

Five 1 x 10 ANOVAs were used to analyze each dependent variable across all treatment passage conditions, as follows.

TABLE 6.8

Significant Differences Between Treatment Means of Reduction Level Main Effect for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 3 x 3 ANOVA*

Dependent Variables	Treatment Conditions (Fiction)		
Multiple Choice Comprehension	10%	30%	50%
Cloze Comprehension	10%	30%	50%
Reading Time	10%	30%	50%
Reading Rate	10%	30%	50%

*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 ($p<.01$).

TABLE 6.9

Means and Standard Deviations for Number of Correct Responses on the Cloze Test for the 11 Treatment Conditions (Fiction)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	14.00	14.60	11.57
S.D.	6.36	4.74	5.30
Grammatical			
Mean	16.95	13.95	11.95
S.D.	7.50	4.11	4.21
SHORT			
Mean	15.50	15.00	13.67
S.D.	5.12	4.10	7.77

Traditional Mean = 16.86 S.D. = 5.73

Test Only Mean = 8.00 S.D. = 3.52

TABLE 6.10

Mean Reading Time (Minutes) and Standard Deviations for the 10 Treatment Conditions (Fiction)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	12.05	12.80	11.05
S.D.	2.69	3.46	2.36
Grammatical			
Mean	13.59	12.80	10.84
S.D.	2.61	2.50	1.95
SHORT			
Mean	12.77	11.75	10.72
S.D.	2.54	2.05	2.27

Traditional Mean = 12.77 S.D. = 2.07

TABLE 6.11

Mean Reading Rates and Standard Deviations for the 10 Treatment Conditions (Fiction)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	211.18	155.39	125.44
S.D.	49.58	34.57	23.02
Grammatical			
Mean	185.68	152.97	127.93
S.D.	42.04	32.55	28.81
SHORT			
Mean	196.51	164.09	127.26
S.D.	37.95	27.14	26.53

Traditional Mean = 216.95 S.D. = 40.85

The 1 x 10 ANOVA was used for the number of correct responses on the multiple choice test. The differences among groups was significant ($F(9,195) = 12.33$, $p<.01$). The means and standard deviations for the multiple choice scores are found in Table 6.7. The Scheffé test of multiple comparisons was performed on the means of each treatment group. Comprehension decreased significantly between the 50_S, 50_G, and 50_F versions and the Trad and 10_S versions. The 50_F versions indicated significantly less comprehension than the Trad, 10_S, 10_F, and 10_G versions. Subjects reading the Trad and 10_S versions performed significantly higher on comprehension than those who read the 50_G and 50_F versions. Reduction was possible up to the 30% level without resulting in a significant decrease in comprehension. The results of the Scheffé test are reported in Table 6.13.

On the variable of comprehension measured by the cloze test, a 1 x 10 ANOVA yielded a significant difference among treatment groups ($F(9,195) = 2.13$, $p<.03$). Means and standard deviations for the cloze scores are found in Table 6.9. The Scheffé test of multiple comparisons failed to show the exact locations of the differences due to the conservative nature of the test. However, differences between treatment means of the Trad and 50_F versions approached significance.

The 1 x 10 ANOVA was performed on the variable of reading time. The means and standard deviations computed for the number of minutes required to read each passage are presented in Table 6.10. A significant difference was found between the treatment means ($F(9,195) = 3.19$, $p<.002$). The Scheffé test failed to show the exact location of differences; however, the difference between the treatment means of the 10_G and 50_S versions demonstrated the greatest difference. The difference between the 10_G and 50_G versions approached significance.

The results of the 1 x 10 ANOVA on the variable of reading rate yielded a significant F-value ($F(9,195) = 19.66$, $p<.001$). Subjects reading the 30 and 50% reduced versions showed a significant reduction in reading rate when compared with those reading the 10% reduced versions or the Trad. The Trad, 10_F, and 10_S versions did not differ significantly with respect to comprehension. The means and standard deviations for the 1 x 10 ANOVA are presented in Table 6.11, and the Scheffé test results in Table 6.13.

For the variable of presentation efficiency, a 1 x 10 ANOVA was conducted. Table 6.12 presents the means and standard deviations of the treatment groups. No significant differences were found among the ten treatment conditions.

Each of the five 1 x 10 ANOVAs was subjected to an F_{max} test for homogeneity of variance. With the exception of the F_{max} test on the variable of reading rate, none of the F_{max} statistics approached the .05 level of significance.

TABLE 6.12

Mean Presentation Efficiency and
Standard Deviations for the 10
Treatment Conditions (Fiction)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	551.00	511.71	444.68
S.D.	179.71	143.71	109.01
Grammatical			
Mean	504.34	487.77	486.86
S.D.	145.37	110.92	128.97
SHORT			
Mean	537.65	525.04	534.97
S.D.	123.60	124.92	183.98

Traditional Mean = 561.79 S.D. = 138.61

TABLE 6.13

Significant Differences Between Treatment Means for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 10 ANOVA*

Dependent Variables	Treatment Conditions (Fiction)
Multiple Choice Comprehension	Trad 10_S 10_F 10_G 30_F 30_G 30_S 50_S 50_G 50_F
Reading Rate	Trad 10_F 10_S 10_G 30_S 30_F 30_G 50_G 50_S 50_F

*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<.04).

The $\underline{F}_{max}$ statistic for the ANOVA design on reading rate was significant ($\underline{F}_{max}(21) = 4.64$, $\underline{p}<.05$). Again, the $\underline{F}_{max}$ statistic was only slightly greater than the .05 level of significance ($\underline{p}<.05 = 4.24$).

A 1 x 11 ANOVA was performed for the variable of comprehension based upon the number of correct answers on the multiple choice test. A significant difference was found between the eleven treatment groups ($\underline{F}(10,214) = 33.33$, $\underline{p}<.001$). Table 6.7 presented the means and standard deviations on the multiple choice scores. The results of the Scheffé test of multiple comparisons presented in Table 6.14, indicated that all treatment passages differed significantly from the test-only (TO) conditions. In addition, the Trad and 10_S conditions were significantly superior to the 50_G and 50_F conditions. No significant differences were found among the Trad, 10 and 30% passages.

On the variable of comprehension measured by the cloze test, a 1 x 11 ANOVA yielded a significant difference among the treatment means ($\underline{F}(10,214) = 4.56$, $\underline{p}<.001$). Means and standard deviations are found in Table 6.9. The exact location of the significant differences was indicated by the Scheffé test presented in Table 6.14. The Trad, 10_S, and 10_G conditions differed significantly from the TO condition. No significant differences were found among the Trad, 10, 30, and 50% passages.

The $\underline{F}_{max}$ test for homogeneity of variance was performed for each of the 1 x 11 ANOVA designs. The $\underline{F}_{max}$ test on the multiple choice variable of comprehension was not significant, indicating homogeneity of variance. For the cloze test variable, the $\underline{F}_{max}$ statistic was significant ($\underline{F}_{max}(20) = 4.86$, $\underline{p}<.05$). The $\underline{F}_{max}$ statistic was only slightly greater than the .05 level of significance ($\underline{p}<.05 = 4.49$).

Science Phase III. Data from the college students in Phase III indicated significant agreement among subjects on the rank order of words in each sentence. A Kendall Coefficient of Concordance ($\underline{W}$) was used to test the degree of agreement among subjects with respect to the rank order of words for each sentence. The Chi-square statistic, used to determine the significance of the Kendall coefficient, indicated that all 96 sentences demonstrated a significant degree of agreement ($\underline{p}<.001$).

Science Phase IV. A 3 x 3 ANOVA was performed for the variable of comprehension based upon the number of correct responses on the multiple choice test. Means and standard deviations for the ANOVA are presented in Table 6.15. Significant differences were found among the reduction methods ($\underline{F}(2,173) = 10.34$, $\underline{p}<.001$) and among the reduction levels ($\underline{F}(2,173) = 14.42$, $\underline{p}<.001$). The Scheffé test of multiple comparisons performed for the Reduction Method main effect

TABLE 6.14

Significant Differences Between Treatment Means for the Comprehension Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 11 ANOVA*

Dependent Variables	Treatment Conditions (Fiction)
Multiple Choice Comprehension	Trad 10_S 10_F 10_G 30_F 30_G 30_S 50_S 50_G 50_F TO
Cloze Comprehension	10_G Trad 10_S 30_S 30_F 10_F 30_G 50_S 50_G 50_F TO

*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<.04).

TABLE 6.15

Means and Standard Deviations for Number of Correct Responses on the Multiple Choice Test for the 11 Treatment Conditions (Science)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	13.05	11.67	10.05
S.D.	4.35	2.73	2.46
Grammatical			
Mean	11.28	10.14	9.38
S.D.	3.54	2.39	2.85
SHORT			
Mean	15.15	13.05	10.60
S.D.	2.80	4.07	3.27

Traditional	Mean = 14.05	S.D. = 3.63
Test Only	Mean = 6.63	S.D. = 2.54

indicated that the grammatical method yielded significantly lower comprehension than the subjective method. There were no significant differences found between the frequency and grammatical or frequency and subjective methods. Results of the Scheffé are found in Table 6.16. Among the treatment means of the Reduction Level main effect, the Scheffé test indicated significant differences between the 10, 30, and 50% passages in order of decreasing comprehension. The results of the Scheffé tests are found in Table 6.17.

The 3 x 3 ANOVA performed for the cloze comprehension test did not yield significant results. The means and standard deviations of the total number of responses answered correctly are presented in Table 6.18.

On the variable of reading time, the 3 x 3 ANOVA yielded significance among the Reduction Level main effect ($\underline{F}(2,173) = 4.56$, $\underline{p}<.05$). Table 6.19 presents the means and standard deviations of the number of minutes required to read each passage. Analysis of the Reduction Level main effect by the Scheffé test resulted in the location of a significant decrease in reading time at the 50% level compared to the 10% level. No significant differences were found between the 10 and 30% levels nor between the 30 and 50% levels. Results of the Scheffé test are presented in Table 6.17.

A 3 x 3 ANOVA was performed on reading rate as measured by the number of words read per minute. The means and standard deviations for the ANOVA are presented in Table 6.20. A significant difference was found for the Peduction Level main effect ($\underline{F}(2,173) = 34.94$, $\underline{p}<.001$). The Scheffé test of multiple comparisons, presented in Table 6.17, indicated that reading rate decreases significantly as level of reduction increases. Thus the 10, 30, and 50% reduction levels differed significantly.

On the variable of reading efficiency, reduction method was significant as determined by a 3 x 3 ANOVA ($\underline{F}(2,173) = 4.78$, $\underline{p}<.01$). Means and standard deviations for presentation efficiency are presented in Table 6.21. The Scheffé test was performed indicating that the significant differences were located between the subjective and grammatical reduction methods, with a subsequent decrease in efficiency for the grammatical method. Results of the Scheffé are found in Table 6.16.

The $\underline{F}_{max}$ test for homogeneity of variance was calculated for each of the 3 x 3 ANOVAs performed on the science passage. The test indicated for the ANOVAs on multiple choice comprehension, cloze comprehension, reading time, and efficiency demonstrated a sufficient amount of homogeneity of variance. The $\underline{F}_{max}$ test was significant for the ANOVA on reading rate ($\underline{F}_{max}(20)$ 4.81, $\underline{p}<.05$), indicating that homogeneity of variance was in question. However, the $\underline{F}_{max}$ statistic for

TABLE 6.16

Significant Differences Between Treatment Means of Reduction Method Main Effect for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 3 x 3 ANOVA*

Dependent Variables	Treatment Conditions (Science)		
Multiple Choice Comprehension	S	F	G
Presentation Efficiency	S	F	G

*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<.01).

TABLE 6.17

Significant Differences Between Treatment Means of Reduction Level Main Effect for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 3 x 3 ANOVA*

Dependent Variables	Treatment Conditions (Science)		
Multiple Choice Comprehension	10%	30%	50%
Reading Time	10%	30%	50%
Reading Rate	10%	30%	50%

*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<.04).

TABLE 6.18

Means and Standard Deviations for Number of Correct Responses on the Cloze Test for the 11 Treatment Conditions (Science)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	15.57	11.90	11.30
S.D.	5.73	3.42	4.69
Grammatical			
Mean	11.50	13.10	12.14
S.D.	4.40	5.14	3.77
SHORT			
Mean	14.05	12.85	12.95
S.D.	3.25	4.77	3.79

Traditional Mean = 14.74 S.D. = 4.66

Test Only Mean = 10.11 S.D. = 3.83

TABLE 6.19

Mean Reading Time (Minutes) and Standard Deviations for the 10 Treatment Conditions (Science)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	10.86	9.24	9.80
S.D.	2.54	2.21	3.02
Grammatical			
Mean	11.11	10.10	9.62
S.D.	2.59	3.05	2.04
SHORT			
Mean	10.70	10.00	9.10
S.D.	3.44	2.03	2.81

Traditional Mean = 11.05 S.D. = 1.58

TABLE 6.20

Mean Reading Rates and Standard Deviations
for the 10 Treatment Conditions (Science)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	178.62	163.10	115.29
S.D.	44.42	37.79	40.34
Grammatical			
Mean	176.68	154.73	111.16
S.D.	55.87	48.64	25.57
SHORT			
Mean	187.06	149.37	120.34
S.D.	56.07	30.50	42.54
Traditional	Mean = 118.68	S.D. = 29.49	

TABLE 6.21

Mean Presentation Efficiency and
Standard Deviations for the 10
Treatment Conditions (Science)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	278.52	271.87	241.56
S.D.	116.79	95.82	109.49
Grammatical			
Mean	218.51	240.96	231.77
S.D.	84.31	67.43	86.46
SHORT			
Mean	297.66	276.62	285.69
S.D.	96.36	120.97	115.90
Traditional	Mean = 270.78	S.D. = 105.85	

reading rate did not greatly exceed the .05 level of significance ($p<.05 = 4.24$).

A 1 x 10 ANOVA was performed on the multiple choice comprehension scores. A significant difference was found among the groups ($F(9,191) = 6.88$, $p<.001$). Table 6.15 shows the means and standard deviations of the correct responses to the multiple choice test. By use of the Scheffé test of multiple comparisons, presented in Table 6.22, a significant decrease in comprehension was found for the 50_G, 50_F, 30_G, and 30_S passages in comparison with the 10_S passage. The 50_G passage differed significantly from the Trad and 10_S passages. In addition, no significant differences were found between the Trad, 10_S, 10_F, 10_G, 30_S, and 30_F passages.

On the variable of comprehension measured by the cloze test, a 1 x 10 ANOVA was performed on the ten treatment conditions. Means and standard deviations on the correct responses for each treatment group are found in Table 6.18. The differences among treatment groups was significant ($F(9,191) = 2.03$, $p<.05$). The Scheffé test failed to show the exact location of the significant differences, however, the results indicated that differences between the 10_F and the 50_F passages exceeded all other comparisons.

A 1 x 10 ANOVA was conducted yielding no significant differences among groups on the variable of reading time. Similarly, no significant differences were found for the 1 x 10 ANOVA performed on the variable of presentation efficiency. The means and standard deviations for the analysis of reading time are found in Table 6.19. Table 6.21 presents the means and standard deviations for the presentation efficiency variable.

Finally, a 1 x 10 ANOVA was performed for the variable of reading rate. The difference among the treatment groups was significant ($F(9,191) = 10.00$, $p<.001$). Means and standard deviations are presented in Table 6.20. The results of the Scheffé test indicated that reading rate for all 50% passages decreased significantly in comparison with the Trad and 10_S passages. Differences between the Trad, 10 and 30% passages were not significant. Similarly, no significant differences were found between the 30 and 50% passages. The Scheffé test results are displayed in Table 6.22.

Homogeneity of variace was again tested by the F_{max} test for the five 1 x 10 ANOVAs performed on each dependent variable. Homogeneity of variance was confirmed for the ANOVAs on multiple choice comprehension, cloze comprehension, and efficiency. The F_{max} statistic was significant at the .05 level ($F_{max}(20) = 4.72$, $p<.05$) for reading time, and similarly, the F_{max} statistic was significant for reading rate ($F_{max}(20) = 4.81$, $p<.05$). The F_{max} values indicated significance slightly beyond the .05 level ($p<.05 = 4.37$).

TABLE 6.22

Significant Differences Between Treatment Means for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 10 ANOVA*

Dependent Variables	Treatment Conditions (Science)
Multiple Choice Comprehension	10_S Trad 30_S 10_F 30_F 10_G 50_S 30_G 50_F 50_G
Reading Rate	Trad 10_S 10_F 10_G 30_F 30_G 30_S 50_S 50_F 50_G

*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<.03)

On the multiple choice comprehension variable, a 1 x 11 ANOVA was conducted, yielding a significant difference of ($F(10,209) = 10.95$, $p<.001$). Table 6.15 contains the means and standard deviations for the eleven treatment conditions. According to the results of the Scheffé test, significant differences were found between the Trad, 10_S, 10_F, 10_G, 30_S, and 30_F conditions and the test only (TO) condition. The 30_G, 50_G, 50_F, and 50_S conditions did not differ significantly from the TO condition. The Scheffé test results are found in Table 6.23.

A 1 x 11 ANOVA performed on the cloze comprehension variable was significant ($F(10,209) = 2.63$, $p<.01$). Means and standard deviations are presented in Table 6.18. Although the Scheffé did not show the exact location of the significant differences, it was found that the Trad, 10_S, and 10_F conditions tended to differ significantly from the TO condition.

The two 1 x 11 ANOVAs on multiple choice comprehension and cloze comprehension were subjected to the F_{max} test for homogeneity of variance. The resulting F-values did not approach significance at the .05 level.

News Phase III. From the data collected on college students participating in Phase III, the Kendall Coefficient of Concordance (W) was computed in order to examine the degree of agreement among subjects who rank listed the words in each sentence of the original news article. Significance of the correlation coefficients was tested by a Chi-square which indicated a significant agreement ($p<.001$) for all 94 sentences.

News Phase IV. On the comprehension variable based upon the correct number of responses on the multiple choice test, a 3 x 3 ANOVA was performed. Table 6.24 presents the means and standard deviations for the 3 x 3 ANOVA on multiple choice comprehension. Differences among treatment means were significant for the Reduction Method main effect ($F(2,175) = 5.54$, $p<.01$) and the Reduction Level main effect ($F(2,175) = 13.32$, $p<.001$). Interaction was not significant. The Scheffé test results, displayed in Table 6.25, for reduction method indicate the frequency method demonstrated significantly lower comprehension than the subjective method. No significant differences were found between the subjective and grammatical or the grammatical and frequency methods. For the Reduction Level main effect, the Scheffé showed no significant differences between the 10 and 30% levels, but significance was found between the 10 and 50% and the 30 and 50% levels with respect to comprehension. Results of the Scheffé test on reduction level are displayed in Table 6.26.

A 3 x 3 ANOVA conducted on the cloze comprehension variable resulted in a significant difference among the reduction levels

TABLE 6.23

Significant Differences Between Treatment Means for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 11 ANOVA*

Dependent Variables	Treatment Conditions (Science)
Multiple Choice Comprehension	10_S Trad 30_S 10_F 30_F 10_G 50_S 30_G 50_F 50_G TO

*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 6.24

Means and Standard Deviations for Number of Correct Responses on the Multiple Choice Test for the 11 Treatment Conditions (News)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	16.21	17.95	13.81
S.D.	5.71	3.38	4.46
Grammatical			
Mean	19.24	17.90	13.67
S.D.	5.31	4.77	4.36
SHORT			
Mean	19.80	19.30	16.86
S.D.	3.74	3.71	4.43
Traditional	Mean = 20.20	S.D. = 5.29	
Test Only	Mean = 10.00	S.D. = 2.03	

TABLE 6.25

Significant Differences Between Treatment Means of Reduction Method Main Effect for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 3 x 3 ANOVA*

Dependent Variables	Treatment Conditions (News)		
Multiple Choice Comprehension	S	G	F
Presentation Efficiency	S	G	F

*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<.03).

TABLE 6.26

Significant Differences Between Treatment Means of Reduction Level Main Effect for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 3 x 3 ANOVA*

Dependent Variables	Treatment Conditions (News)		
Multiple Choice Comprehension	10%	30%	50%
Cloze Comprehension	30%	10%	50%
Reading Rate	10%	30%	50%

*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 ($p<.04$).

at ($F(2,175) = 3.35$, $p<.05$). Treatment means and standard deviations are displayed in Table 6.27. The exact location of the significant differences were found by application of a Scheffé test. The 30% level demonstrated significantly higher comprehension than the 50% level. No differences were found between the 10 and 30% levels nor the 10 and 50% levels. The Scheffé results are displayed in Table 6.26.

A 3 x 3 ANOVA was performed on the variable of reading time. Means and standard deviations are presented in Table 6.28. Although no significant differences were found among levels of the independent variables, Reduction Level main effect approached significance at ($F(2,175) = 2.70$, $p<.07$). The greatest difference on the Scheffé test was found between the 30 and 50% levels.

A 3 x 3 ANOVA performed on reading rate resulted in a significant difference among reduction levels ($F(2,175) = 70.53$, $p<.001$). According to the Scheffé test, reading rate dropped significantly as reduction level increased. Means and standard deviations for the ANOVA design are presented in Table 6.29. Table 6.26 displays the results of the Scheffé test.

The variable of presentation efficiency caused a significant difference among reduction methods in a 3 x 3 ANOVA ($F(2,175) = 3.9$, $p<.05$). Means and standard deviations for the 3 x 3 ANOVA are presented in Table 6.30. The Scheffé test indicated a significant difference on efficiency between the subjective and frequency methods, favoring the subjective method. No differences were found between the subjective and grammatical, or the grammatical and frequency methods. Table 6.25 illustrates the Scheffé results.

The 3 x 3 ANOVAs were tested for homogeneity of variance by an F_{max} test. The F_{max} tests performed for the comprehension and presentation efficiency variables were not significant with respect to the F_{max} statistic indicating a sufficient degree of homogeneity of variance. The F_{max} test performed for reading rate was significant ($F_{max}(20) = 4.53$, $p<.05$). On the variable of reading time, the F_{max} test was significant beyond the .01 level ($F_{max}(20) = 11.39$, $p<.01$).

A 1 x 10 ANOVA design was conducted on the variable of multiple choice comprehension and analyzed by the Scheffé test of multiple comparisons. Means and standard deviations based upon total correct responses are presented in Table 6.24. The Scheffé results are displayed in Table 6.31. A significant difference was found among groups at ($F(9,194) = 5.44$, $p<.001$). The Scheffé test resulted in a significant decrease in comprehension when reading the 50_F and 50_G passages as when reading the Trad or 10_S passages. All other conditions did not differ significantly.

A 1 x 10 ANOVA performed on the cloze comprehension variable resulted in a significant difference between treatment groups

TABLE 6.27

Means and Standard Deviations for Number of Correct Responses on the Cloze Test for the 11 Treatment Conditions (News)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	11.26	15.10	11.43
S.D.	5.14	5.78	5.22
Grammatical			
Mean	13.05	13.76	10.95
S.D.	6.31	6.92	4.32
SHORT			
Mean	14.50	13.20	11.81
S.D.	6.52	4.09	5.73

Traditional Mean = 17.40 S.D. = 6.61

Test Only Mean = 7.35 S.D. = 3.08

TABLE 6.28

Mean Reading Time (Minutes) and Standard Deviations for the 10 Treatment Conditions (News)

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	12.63	12.15	11.00
S.D.	3.24	3.18	3.32
Grammatical			
Mean	10.86	11.76	11.57
S.D.	1.68	1.76	3.28
SHORT			
Mean	11.50	12.15	9.57
S.D.	2.14	5.68	3.03

Traditional Mean = 11.35 S.D. = 2.72

TABLE 6.29

Mean Reading Rates and Standard Deviations for the 10 Treatment Conditions (News)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	166.21	135.46	109.18
S.D.	36.55	31.71	31.75
Grammatical			
Mean	187.66	134.70	103.26
S.D.	27.00	19.50	29.36
SHORT			
Mean	176.97	140.30	119.73
S.D.	31.25	41.52	27.48
Traditional	Mean = 208.34	S.D. = 59.56	

TABLE 6.30

Mean Presentation Efficiency and Standard Deviations for the 10 Treatment Conditions (News)

Method of Reduction	Reduction Level 10%	30%	50%
Frequency			
Mean	233.66	287.96	243.66
S.D.	114.87	90.17	101.85
Grammatical			
Mean	303.23	277.50	234.59
S.D.	107.35	106.60	120.02
SHORT			
Mean	310.23	301.37	315.19
S.D.	111.38	118.13	109.82
Traditional	Mean = 354.26	S.D. = 148.78	

($\underline{F}(9,194) = 2.53$, $\underline{p}<.01$). Results of the means and standard deviations of each group are found in Table 6.27. The Scheffé test failed to locate exact differences between treatment means.

Between group performance with respect to reading time did not demonstrate significant differences as analyzed by a 1 x 10 ANOVA design. Means and standard deviations of total reading time for each treatment group are presented in Table 6.28.

The 1 x 10 ANOVA was conducted on the variable of reading rate. Means and standard deviations for the ANOVA are found in Table 6.29. The ANOVA resulted in a significant difference of ($\underline{F}(9,194) = 20.73$, $\underline{p}<.001$). According to the Scheffé test, a significant decrease in reading rate was found for the 50_S, 50_F, and 50_G passages in comparison with the Trad and 10_G passages. There were no significant differences with respect to reading rate between the Trad and all 10% passages. Similarly, no significant differences were found between the 30 and 50% reduced passages. The Scheffé test results are illustrated in Table 6.31.

Significant differences among the groups in a 1 x 10 ANOVA were found for presentation efficiency ($\underline{F}(9,194) = 2.41$, $\underline{p}<.05$). Table 6.30 presents the means and standard deviations of the treatment passages in the 1 x 10 ANOVA. Due to its conservative nature, the Scheffé failed to show the exact location of differences. It could be determined, however, that presentation efficiency dropped at the 50_F, 50_G, and 10_F passages to a point approaching significance from that of the Trad passage.

The $\underline{F}_{max}$ test for homogeneity of variance was applied to each of the five 1 x 10 ANOVAs. Again, the $\underline{F}_{max}$ test was not significant for either of the comprehension variables or presentation efficiency. The $\underline{F}_{max}$ tests for reading time and reading rate were significant ($\underline{F}_{max}(20) = 11.39$, $\underline{p}<.01$) and ($\underline{F}_{max}(20) = 9.32$, $\underline{p}<.01$), respectively.

A 1 x 11 ANOVA performed on the multiple choice comprehension variable resulted in a significant difference among groups ($\underline{F}(10,213) = 10.5$, $\underline{p}<.001$). Treatment means and standard deviations are presented in Table 6.24. According to the results of the Scheffé, the TO condition did not differ significantly from the 50_F and 10_G conditions. The means of the Trad and 10_S passages were significantly higher than the TO condition. Results of the Scheffé test are reported in Table 6.32.

A 1 x 11 ANOVA performed on the cloze comprehension scores yielded a significant $\underline{F}$-value ($\underline{F}(10,213) = 4.47$, $\underline{p}<.001$) among groups. The TO treatment condition demonstrated significantly lower comprehension than the Trad and 30_F conditions, according to the Scheffé test of multiple comparisons. The means and standard deviations of the treatment groups are found in Table 6.27. The results of the Scheffé test are illustrated in Table 6.32.

TABLE 6.31

Significant Differences Betweeen Treatment Means for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 10 ANOVA*

Dependent Variables	Treatment Conditions (News)
Multiple Choice Comprehension	Trad 10_S 30_S 10_G 30_F 30_G 50_S 10_F 50_F 50_G
Reading Rate	Trad 10_G 10_S 10_F 30_S 30_F 30_G 50_S 50_F 50_G

*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 6.32

Significant Differences Between Treatment Means for the Dependent Variables Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 11 ANOVA*

Dependent Variables	Treatment Conditions (News)
Multiple Choice Comprehension	Trad 10_S 30_S 10_G 30_F 30_G 50_S 10_F 50_F 10_G TO
Cloze Comprehension	Trad 30_F 10_S 30_G 30_S 10_G 50_S 50_F 10_F 50_G TO

*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).

The F_{max} test for homogeneity of variance was performed for the 1 x 11 ANOVAs. On the variable of multiple choice comprehension, nonhomogeneity was indicated ($F_{max}(20) = 7.94$, $p<.01$). The F_{max} test on the cloze comprehension variable yielded an ($F_{max}(20) = 5.04$, $p<.05$), indicating nonhomogeneity of variance at the .05 level.

Readability

In view of the results on comprehension and reading rate, the analysis of readability, which was performed for the three original passages, was extended to all 27 reduced versions. A readability formula by Coleman and Liau (1974) was selected because it had the advantage of being handled easily by computer.

The readability scores for each passage are presented in Table 6.33. Utilizing the readability scores from the three original passages, a 3 x 3 ANOVA (Reduction Method x Reduction Level) was performed. The Reduction Method main effect did not differ significantly, but as was expected, a significant difference was found for the Reduction Level main effect ($F(2,18) = 4.37$, $p<.05$). Means and standard deviations of the readability scores are given in Table 6.34. The Scheffé test of multiple comparisons was performed indicating a significant increase in difficulty at the 50% level as compared to the 10% level. The Scheffé test results are found in Table 6.35.

A 1 x 4 ANOVA was performed on readability for the means of the reduction level effect. Differences between groups were significant ($F(3,26) = 5.33$, $p<.01$). Means and standard deviations are presented in Table 6.34. The results of the Scheffé test, presented in Table 6.36, demonstrate that the 50% reduced versions were significantly more difficult to read than the Trad or 10% versions. The 30% level did not differ significantly from the Trad or 10% level or from the 50% level.

Item Analysis

Multiple Choice Test. Table 6.37 presents the results of the item analyses of the multiple choice comprehension tests. Average item discrimination values lay within the middle range of difficulty or between .25 and .70 as recommended by Ebel (1972). The average point-biserial correlations measured the relationship between performance on the items and total test score. According to Garrett's (1966) table of correlation coefficients, the values of point-biserial each indicated a significant relationship at the .01 level of significance.

A rather low reliability coefficient was found for the science test by the Kuder-Richardson #20. A factor influencing the result of the K-R #20 formula may have been the relatively small number of items in the multiple choice test.

TABLE 6.33

Coleman-Liau Readability Scores for Traditional and Reduced Passages

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Fiction	15.45	13.28	1.89
Science	- 5.30	-30.87	-25.59
News	9.79	- .95	-12.38
Grammatical			
Fiction	20.75	17.24	9.69
Science	8.55	- 7.83	-13.70
News	13.33	2.07	- 4.14
SHORT			
Fiction	23.26	18.87	15.22
Science	12.29	- 1.56	-15.86
News	6.77	- 2.82	.72

Traditional
Fiction = 25 Science = 15 News = 18

TABLE 6.34

Means and Standard Deviations for the Readability Scores on the 10 Treatment Conditions

Method of Reduction	Reduction Level		
	10%	30%	50%
Frequency			
Mean	10.18	- 6.18	-12.03
S.D.	5.09	22.53	13.74
Grammatical			
Mean	14.21	3.83	- 2.72
S.D.	6.15	12.63	11.76
SHORT			
Mean	14.11	4.83	.03
S.D.	8.39	12.18	15.55

Traditional Mean = 19.33 S.D. = 5.13

TABLE 6.35

Significant Differences Between Treatment Means on Reduction Level Main Effect for the Readability Scores Based Upon the Scheffé Test of Multiple Comparisons for the 3 x 3 ANOVA*

Treatment Conditions		
10%	30%	50%

*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 ($p<.03$).

TABLE 6.36

Significant Differences Between Treatment Means on Reduction Level Main Effect for the Readability Scores Based Upon the Scheffé Test of Multiple Comparisons for the 1 x 4 ANOVA*

Treatment Conditions			
Trad	10%	30%	50%

*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 ($p<.04$).

TABLE 6.37

Results of the Item Analysis for the Three Multiple Choice Tests

Item Statistics	Original Passage		
	Fiction	Science	News
Average Item Discrimination	.33	.36	.39
Average Point-Biserial	.35	.32	.33
Standard Error Measurement	2.90	2.19	2.54
Kuder-Richardson #20	.88	.65	.75
Number of Items	60	25	32
Number of Subjects	215	213	213

<u>Cloze Test</u>. The results of the item analyses for the cloze tests are presented in Table 6.38. Item discrimination indicated that the items were relatively difficult although the average item discrimination was very near .30 for the three tests. Values of point-biserial were significant at the .01 level. The Kuder-Richardson #20 yielded relatively good reliability coefficients for each of the three tests.

Discussion and Conclusions

Analysis of the number of correct responses on the fiction story multiple choice test showed that contrary to expectation, no one reduction method was significantly superior. Only at the 50% level of reduction did the SHORT method demonstrate some superiority to the frequency and grammatical methods.

Further analysis of the multiple choice comprehension variable revealed no significant differences between the fiction Trad, and the 10 and 30% reduced versions. Only at the 50% reduction level did comprehension drop to a significant extent when compared with the Trad and 10% versions. While in general, the elimination of 50% of the Trad passage resulted in a major reduction in comprehension, 10 and 30% of the words could be eliminated without significant consequences.

Examination of the multiple choice comprehension scores on the science article indicated greater differences between the reduction methods than was found for the fiction story. As was expected, application of the SHORT method resulted in significantly greater comprehension than the grammatical method, although the differences between the SHORT and frequency methods were not significant.

At each reduction level, comprehension dropped off significantly on the science passages. Thus, the 10% versions yielded greater comprehension scores than the 30 and 50% versions. Despite the apparent drop off in comprehension for the reduced passages, all 10% versions as well as the 30% SHORT and 30% frequency versions did not differ from the Trad.

Analysis of the multiple choice comprehension scores obtained for the passages of the news article indicated that the SHORT method resulted in significantly greater comprehension scores than the frequency method. Interestingly, none of the SHORT conditions were inferior to the Trad, whereas comprehension dropped off significantly at the higher levels of reduction by the frequency and grammatical methods.

Comprehension for the news passages was again superior at the 10% level and dropped significantly at the 50% level.

TABLE 6.38

Results of the Item Analysis for
the Three Cloze Tests

Item Statistics	Original Passage		
	Fiction	Science	News
Average Item Discrimination	.28	.21	.29
Average Point-Biser.al	.30	.25	.31
Standard Error Measurement	2.64	2.45	2.54
Kuder-Richardson #20	.79	.70	.82
Number of Items	49	50	50
Number of Subjects	205	215	213

The 30% level, however, and the 10% level did not vary from the Trad.

In summarizing the analyses of the multiple choice comprehension variable, it was found that up to 30% of the words by the SHORT, grammatical or frequency methods could be deleted without seriously affecting comprehension. This observation was applicable to each of the three types of stories. In addition, it was found that in general, the SHORT method was superior to either the frequency or grammatical methods. The fiction story conditions, however, did not contribute to this observation to any major extent. The overall results did not distinguish between the grammatical and frequency methods; in fact, the news and science articles were incongruent on this factor.

Analysis of comprehension with respect to performance on a cloze test was less indicative of differences between treatment conditions than the multiple choice test.

Among the reduced versions of the fiction story analyzed for cloze comprehension, the SHORT method was in general superior to either the frequency or grammatical methods of word reduction, but the difference was not great enough to be significant. As was expected, the 50% reduced passages demonstrated a significantly lower amount of comprehension gain than did the 10% versions, but comprehension did not decrease significantly when 30% of the words were eliminated.

For the science passages, differences in performance on the cloze test among the reduced and Trad passages were not sufficiently large to produce any significant differences.

The results of the cloze test performance on the news passages indicated that the SHORT method was again superior to the frequency or grammatical methods, although the difference was not significant.

With respect to the effect of reduction level on cloze test performance for the news passages, the results were unexpected. The 30% versions were superior to the 10% versions and significantly superior to the 50% versions. Although the 30% versions resulted in the greatest amount of comprehension, the Trad passage was superior to all reduced passages and differed most from the 50% versions.

Thus, in summary of the cloze test results, reduction by the SHORT method in general yielded higher cloze comprehension scores than did reduction by either the frequency or grammatical methods. Furthermore, it is apparent that up to 30% of the words can be removed without significantly diminishing the comprehension results. The analysis of cloze comprehension on the science passages did not contribute to these observations, but neither were they contradictory.

Reading time did not discriminate among reduction methods applied to the fiction story. The effect of reducing words from the story resulted in a parallel reduction of reading time. Passages reduced at the 50% level required significantly less reading time than the Trad story or passages reduced at the 10% level. Amount of reading time did not decrease significantly at the 30% level in comparison with the 10% level.

Reduction method had no effect on reading time among the science passages. The reduction level effect, however, resulted in a significant decrease in amount of reading time required for the 50% versions than the 10% passages. No other differences were found to be significant. As in the fiction story, reading time remained fairly constant up to the 30% level of reduction.

Again, reading time did not discriminate among the three types of reduction methods on the news passages. No significant differences were found among the passages with respect to level of reduction, but the 50% reduced versions required the least amount of reading time and approached significance.

In summary, analysis of reading time on all three passages indicated that type of reduction method used had no effect, whereas with respect to reduction level, as many as 50% of the words must be eliminated in order to obtain a significant reduction in reading time. This latter finding was contrary to the expectation that reading time would decrease significantly at each increasing level of reduction. Some explanation might be found in the discussion on reading rate.

Reading rate, which is to some extent comparable with reading time demonstrated a more dramatic trend. On the fiction passages, no difference was found between reduction methods on the variable of reading rate. Concerning reduction level, however, reading rate dropped off significantly at the 30 and 50% levels of reduction. Reading rate remained unchanged among the Trad, 10_S and 10_F versions. In general the 10% versions did not differ from the 30% versions, but all 30 and 50% versions resulted in signficantly slower reading rates than the Trad.

The results on the reading rate variable for the science passages were very similar to that of the fiction passages. Although reduction method effect did not differ significantly with respect to reading rate, the SHORT method tended to yield higher rates of reading than either of the other methods. Again, in comparison with the 10% passages, reading rate dropped off significantly at each increasing level of reduction. In comparison with the Trad, however, no significant differences were found between all 10 and 30% passages.

Similarly for the news passages, reading rate was not affected by the reduction method effect, but reading rate dropped off significantly at the 30 and 50% levels. In comparison with the Trad, reading rate remained stable up to the 10% level.

Thus, in general no one reduction method resulted in significantly higher reading rates than the others, although there was some tendency in the science passages for the SHORT method to be superior. The reduction of words had a significant effect on reading rate. Analysis of both the fiction and news passages indicated that reading rate dropped significantly at the 30% level and again at the 50% level in comparison with the Trad and 10% versions. A decrease in reading rate was not found until the 50% level for the science passages. Although it was anticipated that reading rate would decrease significantly at the 50% level, the general reduction of reading rate at the 30% level was disappointing. Related to this finding was the insignificant reduction of reading time at the 30% level.

The results of applying the readability formula to all treatment passages sheds some light on the disappointing effect of reduction level on reading time and reading rate. If level of readability increased in difficulty, reading rate would be expected to decrease and subsequently the necessary amount of reading time to complete the reading would increase.

The computational results of the readabilities indicated that as word reduction increased, the level of readability became increasingly more difficult. Such a result was not unexpected. Those words identified as redundant and reduced on the basis of three methods of selection were most often the function type words which are in general the shorter, more frequently occurring words in the language. Results of the analysis on readability as a function of reduction level indicated that readability of the passages became increasingly difficult at each successive level of reduction. In comparison with the Trad and 10% levels, readability became significantly more difficult at the 50% level. The 30% level did not differ significantly from the 50% nor from the Trad or 10% levels. It should be noted, though, that the analyses on readability were obtained from a sample size of only three.

Additionally, type of reduction method used had no effect on readability.

Another factor affecting reading rate and reading time was discovered by obtaining the subjects' verbal report on their reactions to reading reduced prose. Having reviewed the results of the experiment, a questionnaire was developed and distributed to those subjects who could still be contacted. These included 350 subjects who read either the science or news passages. Among those subjects who read a reduced version, 79% reported that their reading rate decreased. Ninety-five percent reported they had attempted to reread portions of the passage, despite having been instructed not to do so. Some 86% also reported slowing their reading rate in order to figure out or replace the words that were missing. Although the questionnaire provided only superficial results, the results tended to indicate either that word reduction increased the difficulty level of the passages to cause a reduced reading rate or that the unfamiliarity of reduced prose was in itself an inhibiting factor. Martin and Hope (1972) found that the reduction of redundant words resulted in a reduced reading rate due to the necessity of maintaining a comfortable rate of information input, which tends to support the effect on reading of increased difficulty level.

Finally, reduction method and reduction level had very little effect upon presentation efficiency. No significant differences were found on the efficiency measure among the fiction passages.

Among the science passages, the SHORT method of reduction was significantly superior to the grammatical method. No significant differences were found, however, for the reduction level effect. For these passages, presentation efficiency tends to reflect the comprehension results with respect to the effects of reduction method.

Presentation efficiency resulted in some differences among the news passages. Efficiency of the subjectively reduced passages was significantly superior to the frequency reduced passages. Although no significant differences among the reduction levels were found, the 50% level tended to be least efficient.

In summarizing the results of presentation efficiency, the SHORT method was significantly superior to either of the other methods and reduction level appeared to have little or no effect.

The $\underline{F}_{max}$ test for homogeneity of variance performed for each ANOVA resulted in some significant differences indicating that the assumption of equal population variances may have been violated. Winer (1971) reports that unless relatively large departures from the hypothesized homogeneity of variance are found, the experimenter need not be concerned. Similarly, Myers (1972) states that the $\underline{F}_{max}$ test is an overly sensitive method to departures from normality. With this in mind, the significant departures from homogeneity of variance among the ANOVAs performed for the fiction passages were relatively insignificant. They included the 1 x 11 ANOVA on cloze scores and the 3 x 3 and 1 x 10 ANOVAs on reading rate.

Some significant departures were found for the ANOVAs performed for the science article. Again, both the 3 x 3 and 1 x 10 ANOVAs on reading rate, as well as the 1 x 10 ANOVA on reading time departed significantly from homogeneity of variance. The significance lay between the .05 and .01 levels.

For the ANOVAs performed for the news article, some very significant departures were found. The 3 x 3 ANOVA on reading time, the 3 x 3 and 1 x 10 ANOVAs on reading rate, and the 1 x 11 ANOVA on multiple choice test scores resulted in departures beyond the .01 level of significance. The violation of equal population variances may tend to increase the size of alpha (Steel and Torri, 1960). An increase in the size of alpha would not have seriously affected the results of reading time since the differences were not great. However, a larger size alpha for the ANOVAs on reading rate and multiple choice comprehension may have resulted in seemingly larger number of significant differences found among the main effects.

In conclusion, no one style of passage, whether fiction, science, or news, produced unusually different results which could not be found in any of the other passages.

The subjective method of reduction proved superior to either the frequency or grammatical methods, but only with respect to multiple choice comprehension and to some extent presentation efficiency.

The efficiency of telegraphic prose as it is affected by the percentage of words reduced is justified when a satisfactory level of comprehension is maintained and required reading time decreases substantially. This study demonstrated that 10% of the words could be reduced without adversely affecting comprehension or reading rate. Reading time decreased, but not significantly. At the 30% level of reduction, comprehension remained at a satisfactory level, but a slower rate of reading was required. Again reading time decreased, but not significantly. At the 50% level, amount of reading time finally decreased significantly, but the level of comprehension did also, and reading rate decreased significantly. The subjects' inattention to strict adherence to the instruction that no portion of the passage should be reread and that each subject should read at his own rate of speed may have nullified the differences which might have been found for reading time and reading rate.

The function of readability as it is affected by the reduction of the shorter redundant words from an original version,tended to have a significant effect on this experiment. The selection of differing styles of literature for inclusion in the study was an attempt to consider the differing aspects of technical articles, news reports, and light fiction. The readability levels of the original passages selected for this study were nearly alike. All were of a difficult level of reading. By applying the reduction methods, however, readability of the passages reached a level which may have been well beyond the capabilities of the college students used in the experiment.

Therefore, in future experimentation of telegraphic prose, the examination of readability as it affects the variables of comprehension, reading rate, and reading time may be of greater value than the selection and treatment of differing styles of literary prose.

CHAPTER VII

EXPERIMENT VI

EFFECTS OF TELEGRAPHIC PROSE UPON THE READING BEHAVIOR OF BLIND AND SIGHTED STUDENTS

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 7.1 and 7.2.

Phase II

Sighted Subjects. The means and standard deviations for each of the five dependent variables are listed in Table 7.1 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 18% 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

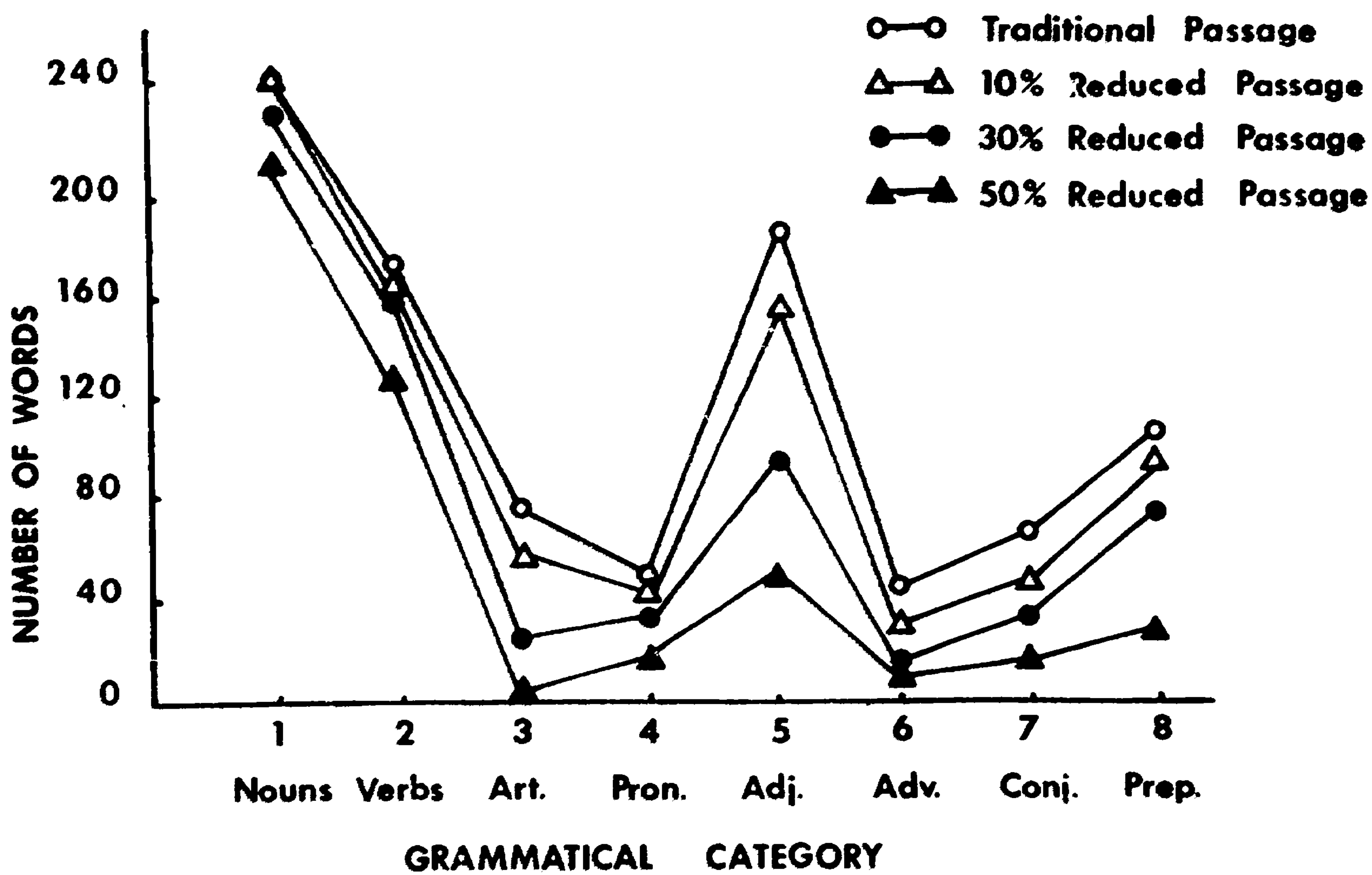

Figure 7.1. Number of words by grammatical category contained in the traditional version and the three reduced versions of the passage generated by sighted subjects.

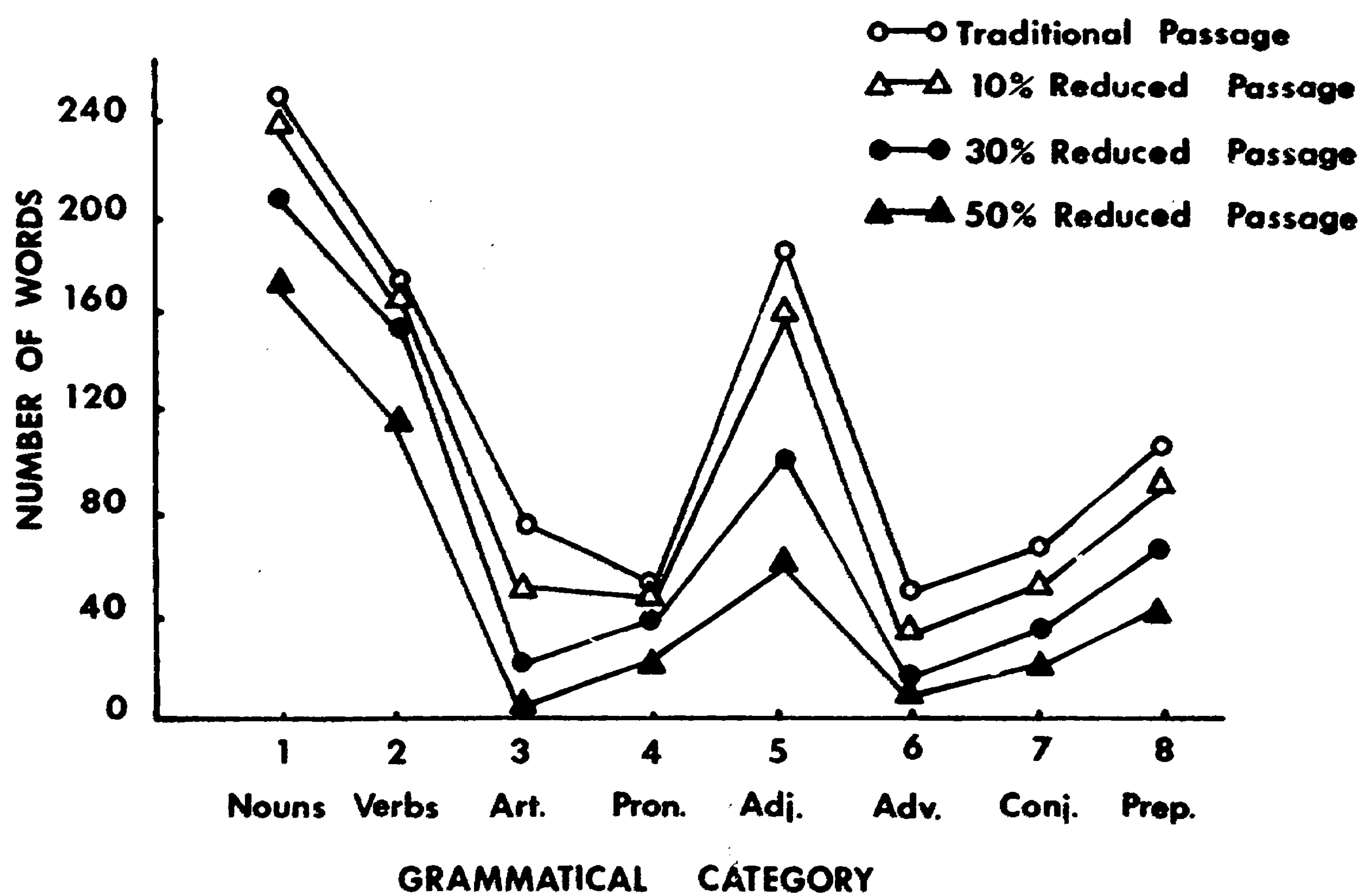

Figure 7.2. Number of words by grammatical category contained in the traditional version and the three reduced versions of the passage generated by blind subjects.

TABLE 7.1

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

$\underline{p}$-value ($\underline{p}<.08$) 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 $\underline{p}$-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 ($\underline{p}<.051$). Subjects assigned the 50% reduced passage answered 12% fewer set relation questions correctly than subjects assigned Trad.

A significant difference ($\underline{F}(3,132) = 36.33$, $\underline{p}<.001$) 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 ($\underline{F}(3,132) = 6.58$, $\underline{p}<.001$) 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 7.2. The 1 x 4 ANOVA design used to assess the combined multiple choice and set relations comprehension scores yielded ($\underline{F}(3,23) = 3.25$, $\underline{p}<.05$). 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 ($\underline{F}(3,23) = 3.03$, $\underline{p}<.05$) on the set relations test. However, the Scheffé test did not reveal where the differences were. The smallest $\underline{p}$-value obtained in the Scheffé analysis was in the comparison of the 50% reduced passage and the 30% reduced passage ($\underline{p}<.07$). 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 $\underline{F}$-value in the ANOVA design.

TABLE 7.2

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 7.2. 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 ferences between the blind and sighted subject samples. T. letion Level main effect was significant ($F(3,163) = ..18$, $p<.01$). 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 rsion, 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 differences 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 ($\underline{F}(3,163) = 5.81$, $\underline{p}<.01$) was found. Figure 7.3 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 ($\underline{F}(1,163) = 279.80$, $\underline{p}<.001$) between the two subject samples and across deletion levels ($\underline{F}(3,163) = 27.19$, $\underline{p}<.001$) in the 2 x 4 ANOVA design. A significant interaction effect ($\underline{F}(3,163) = 16.26$, $\underline{p}<.001$) was also found (Figure 7.4). 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.

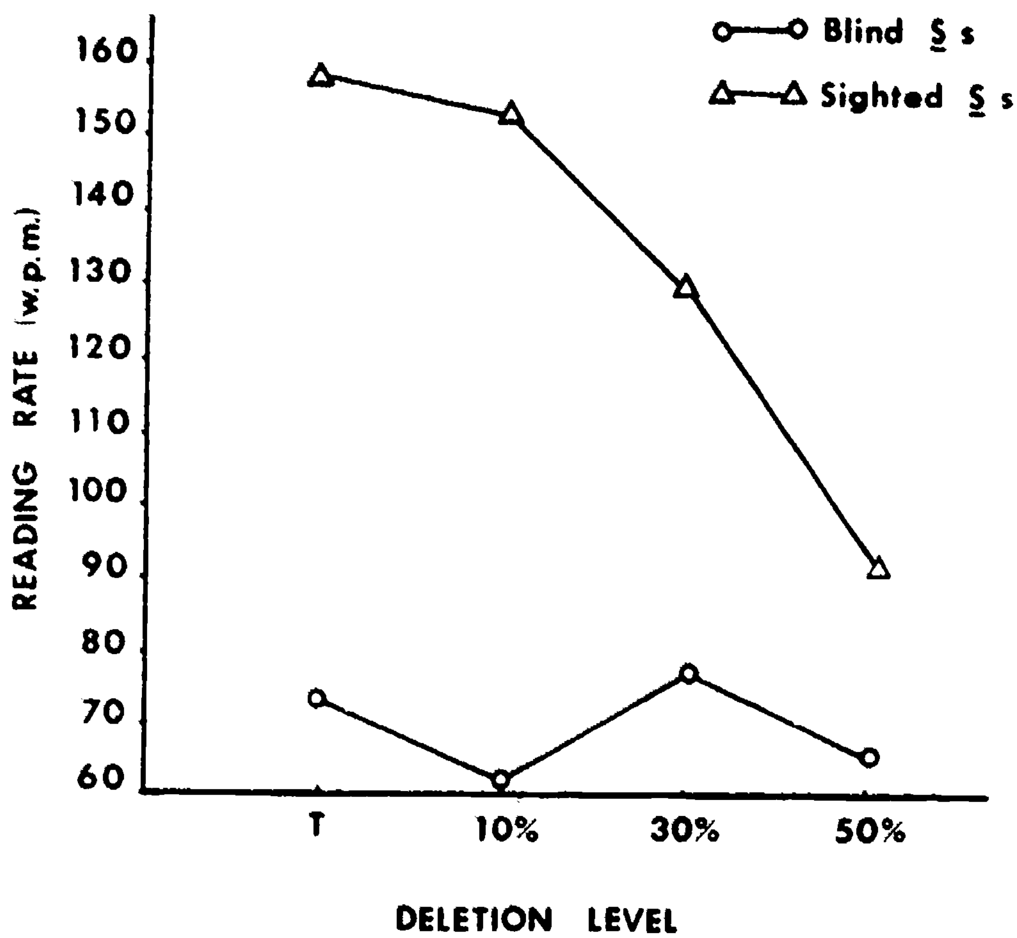

Figure 7.3. Interaction of Deletion Level and the two subject samples on reading rate.

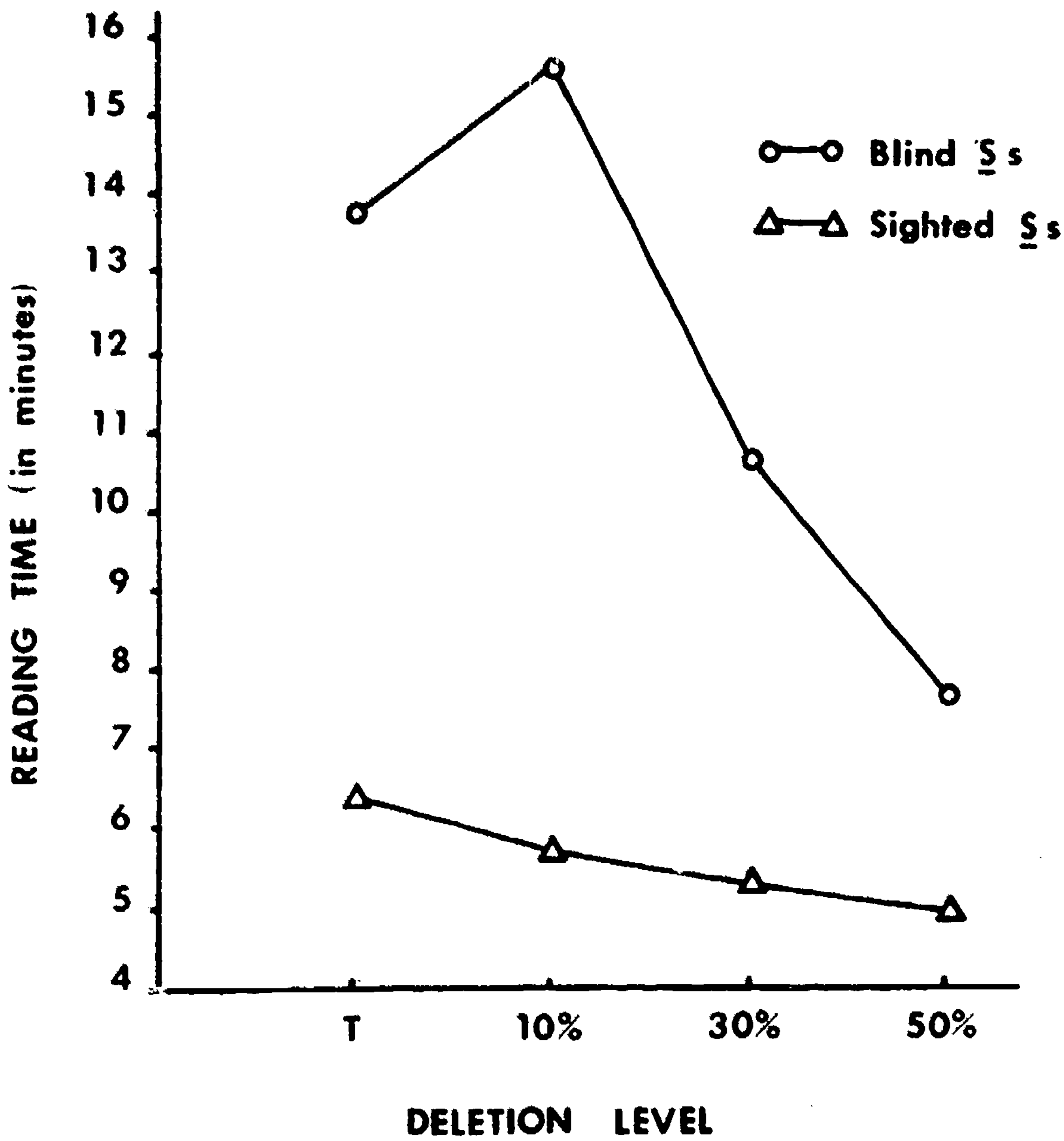

Figure 7.4. Interaction of Deletion Level and the two subject samples on reading time.

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 7.1 and 7.2 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 7.3 and 7.4 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 VIII
EXPERIMENT VII
EFFECTS OF TELEGRAPHIC PROSE AND COMPRESSED SPEECH UPON COMPREHENSION

Introduction and Literature Review

Substantive increases in the effective rate of information input and processing among both normal and handicapped learners depends upon the development of new information processing methodologies. For while an individual's capacity,within a given time interval, to handle information is ultimately circumscribed by definitive psychophysical limits, the relative inefficiency of traditional input systems assures that such limits are seldom, if ever, reached.

Investigations involving time-compressed speech techniques which permit the rate of speech to be increased without pitch distortion and telegraphic prose techniques which seek to increase learning efficiency through elimination of excess verbage appear to have significant potential for learners at all levels; but further systematic analyses of the contingent variables, relationship of modalities, and limitations of information input and storage are needed to define and delimit the parameters involved. The purpose of the present experiment is to determine the facilitative utility, if any, of employing together two experimental learning techniques, telegraphic prose and speech compression. To that end the differential and interactive effects of information quantity, presentation mode, and transmission rate will be examined.

The development and application of telegraphic prose techniques as described in the original grant proposal outline the manipulation of basic prose characteristics to facilitate information input. Similarly, time-compressed speech techniques also rely on the manipulation of basic stimulus structure to increase information acquisition and processing rate.

Time-Compressed Speech

Basic Characteristics. Methods initially developed at the University of Illinois by Fairbanks, Everitt, and Jaeger (1954) allow the word per minute (wpm) rate of recorded speech to be increased without affecting intelligibility through distortion of pitch or voice quality. Using the Fairbanks et al method to produce materials, a number of studies (Foulke, 1970; Orr, 1966; Sticht, 1968) have shown experimentally that speech rate can be

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This experiment was based in part upon a Ph.D. dissertation by Polly Peterson submitted to the Graduate College of Michigan State University.

increased, without significant loss in comprehension, to about 275 wpm, well above the average speaking rate of 125-175 wpm.

In a review of time-compressed speech research, Foulke and Sticht (1969) explain the technical procedure of producing accelerated speech tapes:

> The electromechanical process for accelerating speech is analogous to cutting out and discarding small, periodic samples of tape and splicing the remainder together to form a continuous tape. This process depends upon the fact that the duration of most speech elements is greater than actually needed for perception of the speech sounds. Due to this temporal redundancy, a considerable portion of a word may be deleted without totally impairing its intelligibility. Because the accleration process reduces the amount of time required to present a message, the message is said to be time-compressed.

Although time-compressed speech has been established as a workable experimental learning technique, controversy still surrounds the effects of training and practice, the limits to which speech can be compressed for effective learning, and its use in conjunction with other modes of learning.

Compression rate. Numerous studies have shown that compression is effective for information processing until the normal speech rate is doubled, but beyond 50% compression (275-300 wpm) comprehension suffers severely (Heise, 1971). In terms of learning efficiency, however, even though higher comprehension scores are associated with slower wpm rates, efficient input may take place at faster wpm rates (Woodcock, 1971).

Foulke and Sticht (1967) found that both comprehension and intelligibility decreased as compression increased but that comprehension declined significantly more rapidly than intelligibility. Sticht (1970), using 280 army inductees in a study designed to evaluate the relationship of mental ability and capacity to comprehend compressed speech tapes of varying wpm speeds, concluded that "the comprehension of fast rates of speech appears to be a function of the information capacities of the listener." This investigation, as well as a number of other studies, suggests that the processing capacity of the individual learner and not the fidelity of the time-compressed stimulus ultimately determines the comprehension ceiling for fast rates of speech. The problem of increasing information input beyond this ceiling is thus a problem of human, rather than mechanical, engineering. As Carver (1973) notes, compressed speech would be most beneficial and efficient when and if it becomes possible and practical for the individual to control the input rate.

The relationship between the rate of compressed speech and comprehension is critical from both the theoretical and practical standpoint. Some amount of processing time, which probably varies according to individual ability, is necessary for transduction of material. In normal speech (125-175 wpm) there is more than enough time to complete the necessary operations on all incoming material to make it fully understandable (Overmann, 1971). Often there is extra, unnecessary time in which the individual's attention can wander dysfunctionally. However, as the wpm rate is increased, a level is ultimately reached at which there is insufficient time for the individual to perform necessary storage operations and comprehension declines rapidly.

Miller (1953, 1956) used the concept of a communication channel with finite capacity to explain the input threshold. If more information is presented than an individual can handle, some of the information will be lost. Miller emphasizes that compressed speech complicates the transduction process all the more. In the language of the computer storage model, because fewer cues are present in the compressed word to assist the recognition process, more items in the individual's vocabulary repertoire must be rejected before the correct match is discovered. The compression process essentially reduces the intraword redundancy of the words in the message. Thus, as available real processing time decreases with increasing wpm rate, reduced word redundancy (or greater word uncertainty) increases the demand for processing time.

The suggestion that decreased redundancy increases required processing time should be equally as applicable to telegraphic prose as to compressed speech. In telegraphic prose the visual rather than the aural stimulus is altered to lessen redundancy, and concomitantly, to reduce the repertoire of cues presently available for word identification and comprehension processes. After the capacity of a channel is reached, comprehension should begin to decrease, and should continue to decrease at an increasing rate as the rate of compression (or deletion level in telegraphic prose if a constant input rate were maintained) is increased. Foulke (1968) notes that extant experimental evidence offers tentative support for this hypothesis.

In a study employing 140 undergraduate students, Overmann (1971) presented both standard time-compressed tapes and tapes in which the compressed sentences were followed by pause times (which restored the tape time to normal speech production time). The additional processing time provided by the latter materials resulted in significantly improved comprehension at the 250 wpm and 325 wpm levels. However, 400 wpm rate comprehension remained below that of the control group which listened to the same material at a normal, uncompressed rate.

Training effects. Most studies of compressed speech have been conducted with subject populations having no previous training in listening to compressed speech. Since any exposure to speech rates of 200 wpm or over is rare in normal speaking environments, it would seem logical that practice or training sessions should improve the listener's ability to comprehend compressed materials. Studies investigating the effects of practice, however, have resulted in conflicting findings.

Blind students depend almost solely on the aural channel for information processing; therefore, they would be expected to have capacity for higher aural input rates than most sighted normal learners. Blind students, for example, are known to have trained themselves to listen with good comprehension to normally recorded tapes or records played at a faster than recorded rate. Foulke (1964) evaluated the efficiency of four different training methods with blind subjects and found that none yielded significant improvements in the comprehension of compressed speech. Voor and Miller (1965) found that practice improved comprehension in the warm-up stage of listening to compressed speech but not thereafter. In a study using 700 students (including mentally retarded and culturally deprived individuals) in grade levels three to six, Woodcock (1971) found that after two or three exposures to compressed speech recordings, continued practice produced little improvement in performance. Orr and Friedman (1967), by contrast, found a significant practice effect on the comprehension of compressed speech. According to Orr (1971), much of the conflict in research findings on the effects of practice may center around problems of measurement. Some of the shortcomings Orr cited were the difficulties in constructing reliable multiple choice comprehension tests, accounting for prior knowledge of the listener, and the actual definition of comprehension.

Combined techniques. A number of studies have investigated the effects of adding a visual stimulus to the compressed aural message. Woodcock (1971) found that listening plus slide viewing was a more effective and efficient medium for learning than listening alone; and among an elementary school level population which included mental retardates, listening alone was better than reading since many subjects were not skilled readers. Travers (1964) presented passages by compressed speech; listening alone, reading alone, and combined listening/reading. At the lower compression rates no advantage was found for the audio-visual presentation, but at higher speeds the combined modalities proved to be superior. Similarly, among junior college students, Parker (1971) found that combined listening/reading presentations resulted in significantly better comprehension than reading presentations alone. That comprehension decreased significantly at a 275-300 wpm rate level for the listening only treatment led Parker to conclude that the combined modalities should be used if the compression rate is 50% or above.

Hypotheses

Since previous research has investigated neither the combined inputs of telegraphic style prose and time-compressed speech nor the effects of visual, aural, and aural/visual modalities upon this combination of learning techniques, the absence of comparative data limited the predictions that reasonably could be made. However, on the basis of research work involving telegraphic prose and compressed speech techniques, separately, and studies of listening and reading comprehension, the following hypotheses are advanced.

1. A differential drop in comprehension occurs as a function of increasing presentation rate (compressed speech tapes) and deletion level or compaction (telegraphic prose).

2. The effective word per minute comprehension rate (EWC) will be highest at the 275 wpm presentation rate for the traditional and 20% deleted passages. EWC will decline for the 40 and 60% reduced materials at 275 wpm and for all story versions at the 400 wpm rates.

3. Presentation of the material at the highest reduction level and fastest presentation rate will result in significant decrements in comprehension.

4. The combined listening/reading modality will enhance comprehension compared with the single listening modality or reading modality.

5. Reliance by the majority of subjects on the reading modality alone is predicted for the 40 and 60% telegraphic versions at the 275 wpm and 400 wpm rates for the combined listening/reading modality. The aural tapes will be extremely difficult to comprehend for these treatments.

An exploratory aspect of this experiment will be the comparison of experimental treatments to determine whether or not an optimally efficient and facilitative combination of telegraphic prose and compressed speech can be identified.

Method

Subjects

The subjects were 560 undergraduate and graduate students in the Schools of Architecture, Education, and Psychology at the University of Miami. Of these, 480 subjects were randomly assigned to each of 24 listening and listening/reading treatments such that each treatment group contained 20 subjects. Males, graduates, and individuals identifying Spanish as a first language were randomized as separate groups. Approximately equal numbers of these subjects participated in the project as a class requirement and as volunteers, but all subjects were tested outside of class.

The remaining 80 subjects were selected from among students enrolled in four sections of a developmental reading course in the Department of Educational Psychology and were assigned to one of four control reading treatment groups, 20 subjects per group. On the basis of individual Nelson-Denny Reading Test scores, these subjects were judged to be a representative sample of the undergraduate population. The developmental reading classes included students ranging in class rank from freshman to senior and in course objective from specific reading vocabulary or study skills remediation to development of increased reading rate and flexibility in preparation for graduate school admission. Males constituted 59% of the control groups compared to 28% of the experimental treatment groups. Participation for all control subjects was a class requirement and was accomplished during a regular period in each of the four course sections.

Materials

The basic textual materials for the 24 experimental and four control treatments was a fictional prose composition entitled "San Francisco" (Martin & Hope, 1972). The story focuses on the impact of a devastating earthquake in the major urban area of San Francisco. Activities of city and state officials interacting in the aftermath of destruction as well as evacuation and rescue work provided by a commune group, which had previously borne the resentment of the local police, are the central events depicted.

The 2,692-word traditional (Trad) version of "San Francisco" and accompanying comprehension test were designed to meet the following criteria: (1) the story should be of sufficient interest among undergraduate college students to promote positive motivation in a testing situation, (2) the reading level of the prose material should be of appropriate difficulty for college students, (3) the test questions assessing comprehension should have high reliability, and (4) the length of the story and comprehension test should allow for completion of both in one, 50-minute class period.

From the Trad version of the story, three telegraphic versions were generated utilizing the SHORT procedure as described in Experiment IV. These versions reflected deletions of 20, 40, and 60% of the subjectively ranked least important words.

To identify basic informational set relationships and assure homogeneity of essential content across versions, content analysis based on Dawes' (1964) set relations model (detailed in Experiment I) was applied to the four story texts. Flesch (1949) readability scores calculated for sample passages in the Trad version indicated an average "Fairly Difficult" (10th-12th grade) level classification.

The control condition and those experimental treatments involving reading were reproduced double spaced on white 8-1/2 x 11 inch paper. The Trad, 20, 40, and 60% telegraphic versions of "San Francisco" are provided in the Appendix, Volume II.

Time-Compressed Tape Recordings

Each story version was recorded by a male reader at his natural speaking rate through the facilities of the Center for Rate-Controlled Recordings at the University of Louisville. Characteristics of these original recordings are given in Table 8.1. Since the highly compact format of the 40 and 60% deleted versions appears to have caused the reader to automatically decrease his speaking rate, as noted in Table 8.1, a second recording of the 60% version was made. The original recording was too slow (105 wpm) for effective time-compression at the 400 wpm rate stipulated in the study design. Each of these four original recordings was then time-compressed to 175, 275, and 400 wpm rates using a 20-millisecond discard interval.

The recordings were open-reel recorded on separate one-half inch width tapes at seven and one-half inches per second to produce 12 individual tapes (four story versions x three presentation rates). Five per cent wpm rate accuracy was guaranteed by the Center for Rate-Controlled Recordings. Table 8.2 presents specific data on the time-compressed tapes.

TABLE 8.1

Information on the Original Recordings of "San Francisco"

Version	# of Words	Tape Time	WPM Rate
Trad	2692	16.25	165.7
20%	2158	14.75	146.3
40%	1617	13.60	118.9
60%	1075	8.15*	131.9

*Second recording.

TABLE 8.2

Data on Time-Compressed Speech Tapes for the San Francisco Passage

Item	Deletion Level			
	Trad	20%	40%	60%
Number of Words	2692	2158	1617	1075
175 wpm Rate				
Perfect Tape Time*	15.38	12.33	9.34	6.14
Actual Tape Time	15.58	12.75	9.75	6.55
Actual wpm	173	169	166	164
EWC**	173	211	276	411
275 wpm Rate				
Perfect Tape Time*	9.78	7.85	5.88	3.90
Actual Tape Time	9.93	8.23	6.23	4.23
Actual wpm	271	262	260	265
EWC**	271	327	432	636
400 wpm Rate				
Perfect Tape Time*	6.73	5.40	4.04	2.69
Actual Tape Time	6.70	5.58	4.24	2.87
Actual wpm	402	387	381	375
EWC**	402	482	635	938

*Perfect Tape Time = Errorless time-compressed recording such as $\frac{\text{T/2692 words}}{\text{175 wpm}} = 15.38$

**Effective wpm Comprehension = $\frac{\text{2692 words of Trad version}}{\text{Tape Time}}$

Evaluatory Material

Multiple choice items. A 60, four-alternative multiple choice comprehensive test was constructed from the factual material contained in the 60% deleted version of "San Francisco," and verified as applicable to all story versions. These 60 items assessed the recall of factual information (presumably in a manner approximating typical classroom methods for measuring comprehension) and were ordered for test presentation according to the story sequence.

Additionally, based on identified informational set relations, 20, two-alternative questions were constructed to evaluate comprehension of both nested and disjunctive set relations. These 20 items were appended to the 60 multiple choice questions to create an 80-item instrument. The multiple choice and set relations tests are presented in the Appendix, Volume II.

Recording and Playback Equipment

Three Wollensack tape recorders, each equipped with a six-outlet listening station, were used for presenting the taped materials. Subjects listened through individual headsets so as to assure low-distortion, intelligible input, allow individual volume adjustment, and reduce distractions.

Miscellaneous Materials

Prior to testing, all subjects completed a preference sheet on which they indicated convenient times for participation and rated their preferred learning mode, reading rate, and conversational speech rate.

The 240 subjects assigned to the combined listening/reading treatment groups were given a modality utility form immediately after task presentation on which the mode (aural, visual, or aural/visual equally) believed to have been most relied upon was indicated.

All comprehension test responses were recorded on IBM answer sheets. For control group testing, a stopwatch was used; and elapsed time was written in five second intervals on a blackboard to enable each subject to record individual reading time.

Procedure

Listening and Listening/Reading Treatment Conditions

Of the 480 subjects randomly assigned the 24 treatment conditions, 12 groups of 20 subjects each were assigned to listening treatments and 12 equivalently sized groups were as assigned to listening/reading treatments.

Standardized test situations were maintained for all subjects. The basic study was explained in each of 30 education and educational psychology classes from which volunteers were obtained. Specific instructions were given individually or in very small groups to all participants. Because most subjects were totally unfamiliar with the concepts of compressed speech or telegraphic prose, instructions were modified according to the randomly assigned treatment condition.

A pilot presentation of the compressed speech tapes to graduate students not in the subject population revealed that the unique style and speed of the tapes initially monopolized the subjects' attention and therefore interfered with content acquisition, especially for the 400 wpm tapes and for the highly deleted versions. Thus, subjects were given a detailed description of the speech rate and word reduction level to which they would be listening or simultaneously listening and reading.

The basic instructional sets associated with the listening and the listening/reading treatments are presented in Appendix F.

Reading Treatment Conditions

The 80 subjects assigned to the four control reading treatment conditions completed the appropriate assigned story and comprehension test during one, 50-minute class period of the developmental reading course in which they were enrolled. The four story versions were randomly distributed in the classes. Specific instructions (Appendix F) were given to each of the four control groups.

Comprehension Test and Comments

No time limit was imposed on the comprehension test; most students completed the 80-item sequence within 25-30 minutes. All tests were hand scored with separate items correct scores given for multiple choice, nested set relations, disjunctive set relations, total set relations, and total test item categories. All subjects were invited to write comments about their particular treatment condition on the back of the answer sheet.

Reporting Results to the Subjects

In order to enhance motivation and interest, all subjects in the listening and listening/reading treatment groups were given a postal card to be self-addressed if they wished to know their individual test score and treatment group rank. All subjects except one self-addressed a card; and results were mailed after completion of the project.

Individual cards listing total test score, wpm reading rate, effective wpm comprehension, and rank within treatment group were given to each subject in the control groups.

Post-Test Optional Participation

After completing the test, subjects assigned to the listening and listening/reading treatment conditions were invited to listen to additional tape segments in order to understand more clearly the effects of combining time-compressed speech and telegraphic prose presentation techniques. Many subjects remained to listen to several complete tapes.

Design and Analysis

The entire study was organized as a 2 x 3 x 4 factorial ANOVA design with a collateral 1 x 4 simple ANOVA analysis of controls. The factors in the 2 x 3 x 4 matrix were mode of presentation (listening, listening/reading), presentation rate (175, 275, 400 wpm), and deletion level (Trad, 20, 40, 60%). Factors for the 1 x 4 matrix were reading rate and deletion level. Each of the 28 treatment conditions contained an N of 20. Figure 8.1 presents the experimental design and legend.

Analyses of variance were performed across all treatment conditions for each of the five dependent comprehension variables: multiple choice, total set relations, nested set relations, disjunctive set relations, and effective wpm comprehension (EWC) scores. For each subject, the EWC score was computed by dividing the total number of words in the Trad version (2692) by the tape or reading time (T_t or R_t) and multiplying the quotient by the percent of multiple choice items correct (C). Thus, $EWC = \frac{2692}{T_t \text{ or } R_t} \times C$

For the reading treatment groups, wpm reading rate and reading time were also treated as dependent variables in the analyses of variance. The Scheffé post hoc comparison was applied to identify the precise nature of differences among treatment means yielding significant F values.

Item analyses were completed on both the multiple choice and set relations comprehension tests to generate indices of difficulty and discrimination (for control group subjects). Test reliability was determined by the Kuder-Richardson #20 correlation coefficient.

All analyses were performed through the facilities of the Human Learning Research Laboratory and the Data Processing Center at Texas A&M University, using an IBM 360/65 computer programmed in FORTRAN WATFIV language.

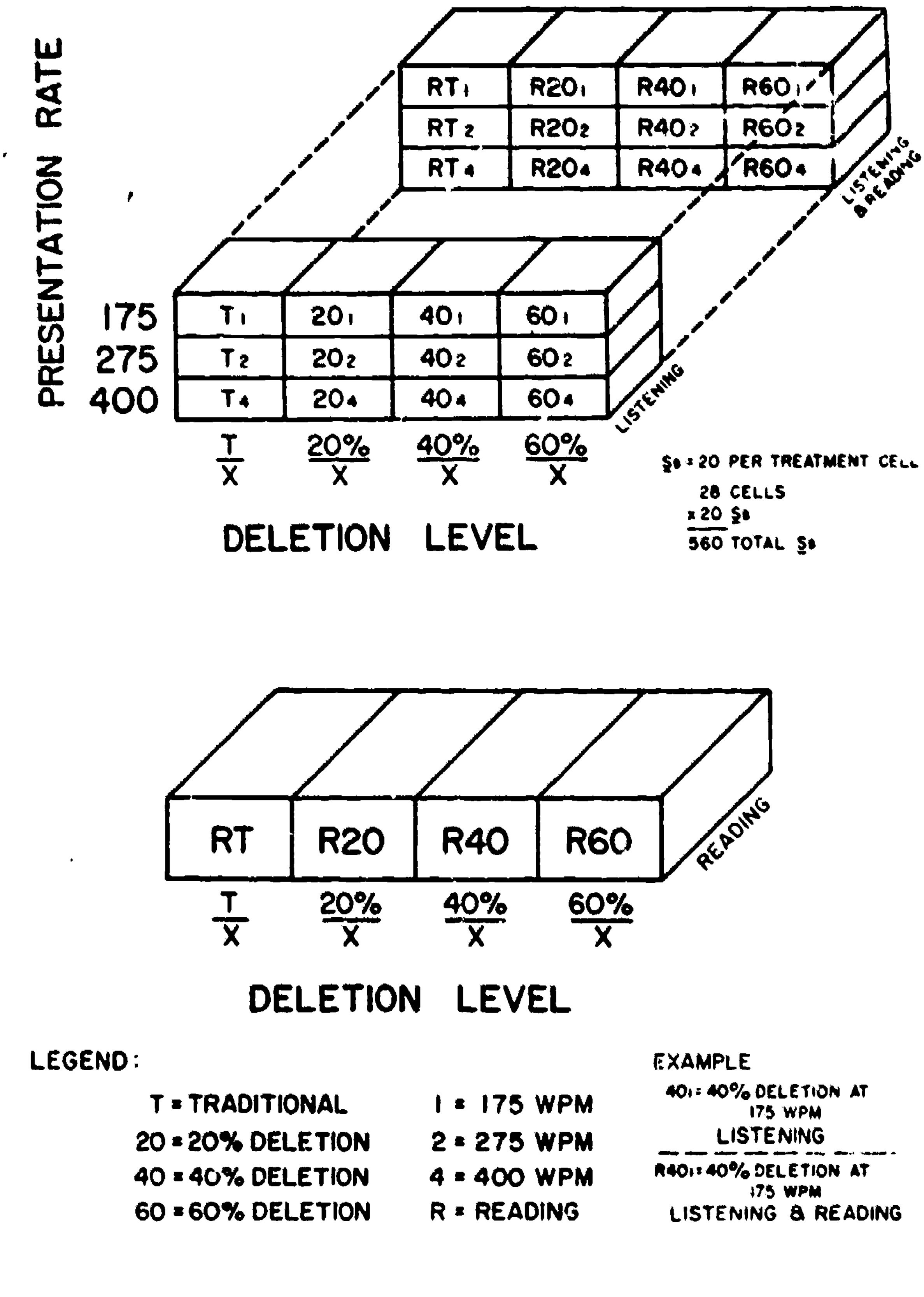

Figure 8.1. Research design showing treatment conditions analyzed by the analysis of variance model.

Results

The results are presented in five sections: (1) comprehension test item analysis, (2) reading treatment analyses, (3) listening treatment analyses, (4) listening/reading treatment analyses, and (5) comparative analyses of listening and listening/reading treatments. For each of the dependent variables described previously, significant ANOVA main effects and interactions are reported across Mode of Presentation, Presentation Rate, and Deletion Level, as appropriate. Specific differences identified by Scheffé post hoc analyses are also reported.

Comprehension Test Item Analysis

Item analysis of the 60 multiple choice questions and the 20 set relation questions comprising the comprehension test was performed on the 80 tests completed by the four reading treatment groups. Results of this analysis are given in Table 8.3.

TABLE 8.3

Item Analysis of the Total Multiple Choice Items and Set Relation Items for the Reading Treatment

Item Statistics	Multiple Choice	Set Relations
Mean Number Correct	38.41	12.29
Standard Deviation	9.06	2.55
Mean Item Discrimination	0.37	0.29
Mean Point-Biserial	0.34	0.28
Kuder-Richardson #20	0.87	0.42
Standard Error of Measurement	3.26	1.95

Mean comprehension scores were 64 and 62% for the multiple choice and set relation items, respectively. The .37 mean discrimination score for the multiple choice items exceedes the recommended .30 minimal significant discrimination value (Ebel, 1965), while the .29 discrimination score for the set relation items approaches the recommended value within acceptable limits.

The mean point-biserial correlation measures the relationship between performance on individual test items and total test performance. The Kuder-Richardson #20 correlation coefficient indicates a high degree of reliability for the multiple choice items. Although the corresponding reliability coefficient for the set relation items is considerably lower, the relatively small number of items and t' eir apparent difficulty may have been factors depressing the correlation. The mean number of total correct responses for the set relations component (12.29) is not significantly above the expected chance score (10.00).

Reading Treatment Analyses

Reading time. The means and standard deviations for reading times, reading rates, and EWC are presented in Table 8.4.

TABLE 8.4

Means and Standard Deviations for Reading Time, Reading Rate, and Effective WPM Comprehension Rate (EWC) in the Reading Treatments

Treatment		Reading Time		Reading Rate		EWC	
Conditions	N	Mean	S.D.	Mean	S.D.	Mean	S.D.
Trad	20	9.33	1.35	294.81	45.74	235.22	54.52
20%	20	7.96	1.96	285.15	62.30	228.92	71.80
40%	20	7.10	1.30	236.58	54.45	221.30	68.93
60%	20	8.39	2.02	135.86	35.08	191.05	52.33

Reading times were found to be significantly different ($F(3,76) = 5.96$, $p<.005$) among the four treatment groups. The Scheffé test revealed that compared to the Trad version, reading time was reduced by 2.22 minutes on the 40% version, but was not significantly different from the 60% version. However, that subjects read the 60% version (containing 1075 words) in 8.39 minutes and the Trad version (containing 2692 words) in an average of 9.33 minutes indicates a significant advantage in effective reading time on a wpm basis for the 60% version.

Reading rate. Reading rates were significantly different ($F(3,76) = 41.68$, $p<.001$) among the four story texts except between the Trad and 20% versions. The Scheffé post hoc comparison revealed that, compared to the Trad passage, reading rates were reduced 20% in the 40% version ($p<.01$) and 55% in the 60% version ($p<.001$). With respect to the 20% deleted passage, reading rate decreased 18% on the 40% version ($p<.05$) and 53% on the 60% version ($p<.001$). Reading rate decreased by 100 wpm (43%) on the 60% material compared to the 40% version.

Figures 8.2 and 8.3 illustrate the differential effects of reading rates and reading times for the four reading treatment groups.

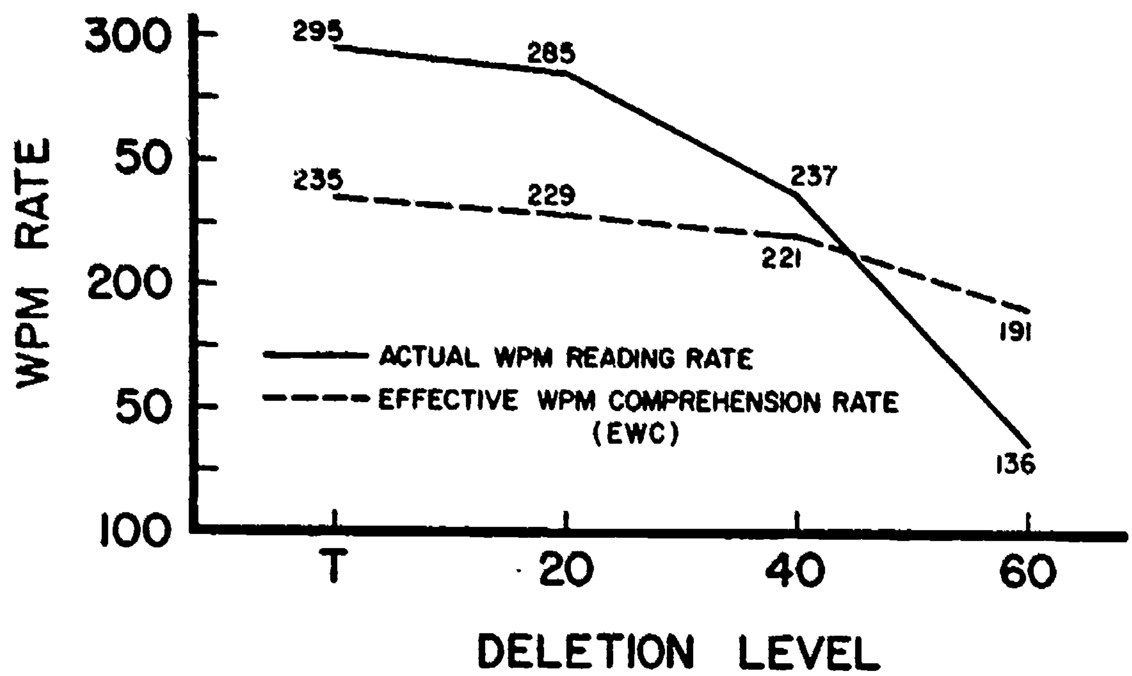

Figure 8.2. Effect of deletion level on the two measures of reading rate for the reading treatments.

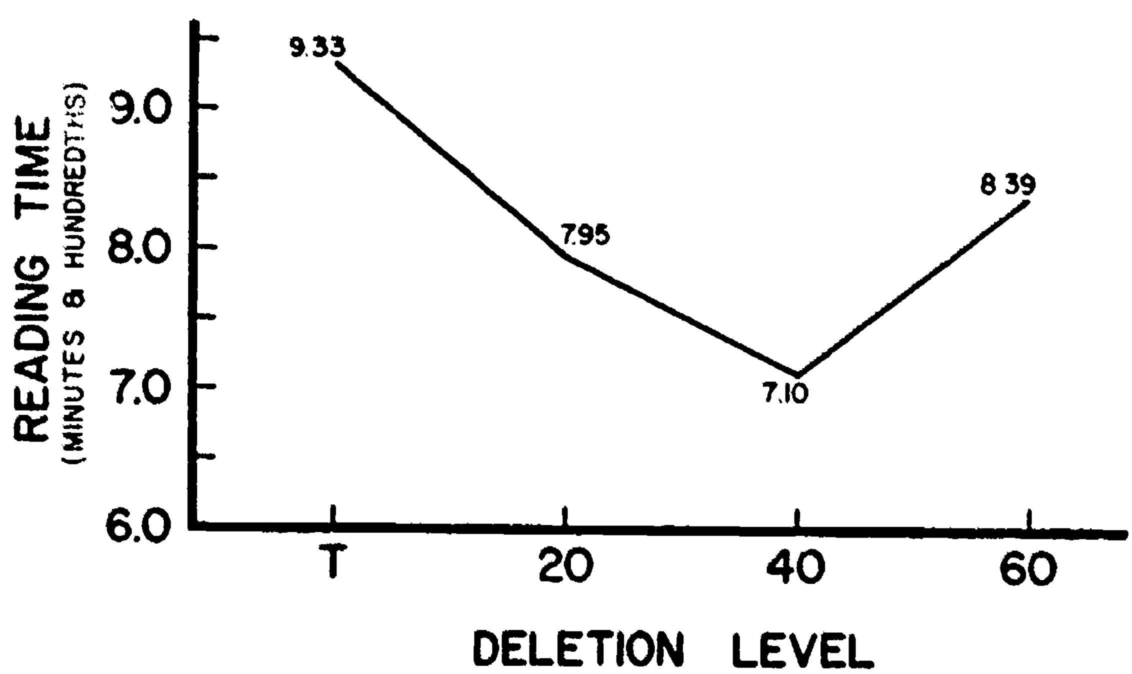

Figure 8.3. Effect of deletion level on reading time for the reading treatments.

Four 1 x 4 ANOVAs were employed to analyze the four other dependent variables across the deletion levels. The means and standard deviations for these variables are presented in Table 8.5

Multiple choice items. The ANOVA for the multiple choice items revealed highly significant differences (F (3,67) = 16.49, p<.001) for the Deletion Level main effect.

The Scheffé test revealed that the Trad passage resulted in significantly higher comprehension scores than each of the three telegraphic versions.

Subjects assigned to read the Trad version answered 18, 28, and 27% more questions correctly than subjects reading the 20, 40, and 60% versions, respectively. No significant differences were found between other groups.

Other dependent variables. No significant differences were found in the 1 x 4 ANOVAs for total set relation item, nested set relation item, disjunctive set relation item, or EWC scores across the four deletion levels.

Listening Treatment Analyses

Multiple choice items. A 3 x 4 ANOVA for multiple choice items revealed highly significant differences in the Presentation Rate main effect (F(2,228) = 28.00, p<.001) and the Deletion Level main effect (F(3,228) = 38.18, p<.001). No significant interaction was found between main effects.

The Scheffé test was used to identify specific differences among treatment means. The Trad and 20% versions were significantly superior at all three presentation rates. For all four versions of the material, comprehension at the 175 wpm and 275 wpm rates were equivalent, but for the Trad version, comprehension decreased 8% (from 68 to 60%) at the 400 wpm rate as compared to the 175 wpm and 275 wpm presentations. Likewise, 20% deletion affected comprehension negatively only at the 400 wpm rate, subjects answering 12% fewer items correctly than at the 175 wpm and 275 wpm rate levels. The Scheffé analysis revealed additional significant differences between the Trad and 40%, between the Trad and 60%, and between the 20 and 60% versions (p<.001). Significant differences were also found between the 20 and 40% (p<.005) and between the 40 and 60% (p<.05) deletions. For the Deletion Level main effect, comprehension decreased from a mean of 65% for the Trad to 60% for the 20% version, to 50% for the 40% version, and to 42% for the 60% version across the three presentation rates. The differential effects of Presentation Rate and Deletion Level on these 12 treatments for the multiple choice test are summarized in Figure 8.4.

TABLE 8.5

Means and Standard Deviations for Four Dependent Variables in the Reading Treatments

Dependent Variables	Deletion Level			
	Trad	20%	40%	60%
Multiple Choice				
Mean	47.20	38.70	33.75	34.10
S.D.	6.79	9.18	6.40	5.78
Set Relations				
Mean	12.60	12.05	12.40	12.35
S.D.	2.98	2.63	1.60	2.89
Nested				
Mean	6.70	6.35	6.15	6.40
S.D.	1.81	1.46	1.42	1.85
Disjunctive				
Mean	5.90	5.70	6.15	5.95
S.D.	1.65	1.45	1.04	1.39

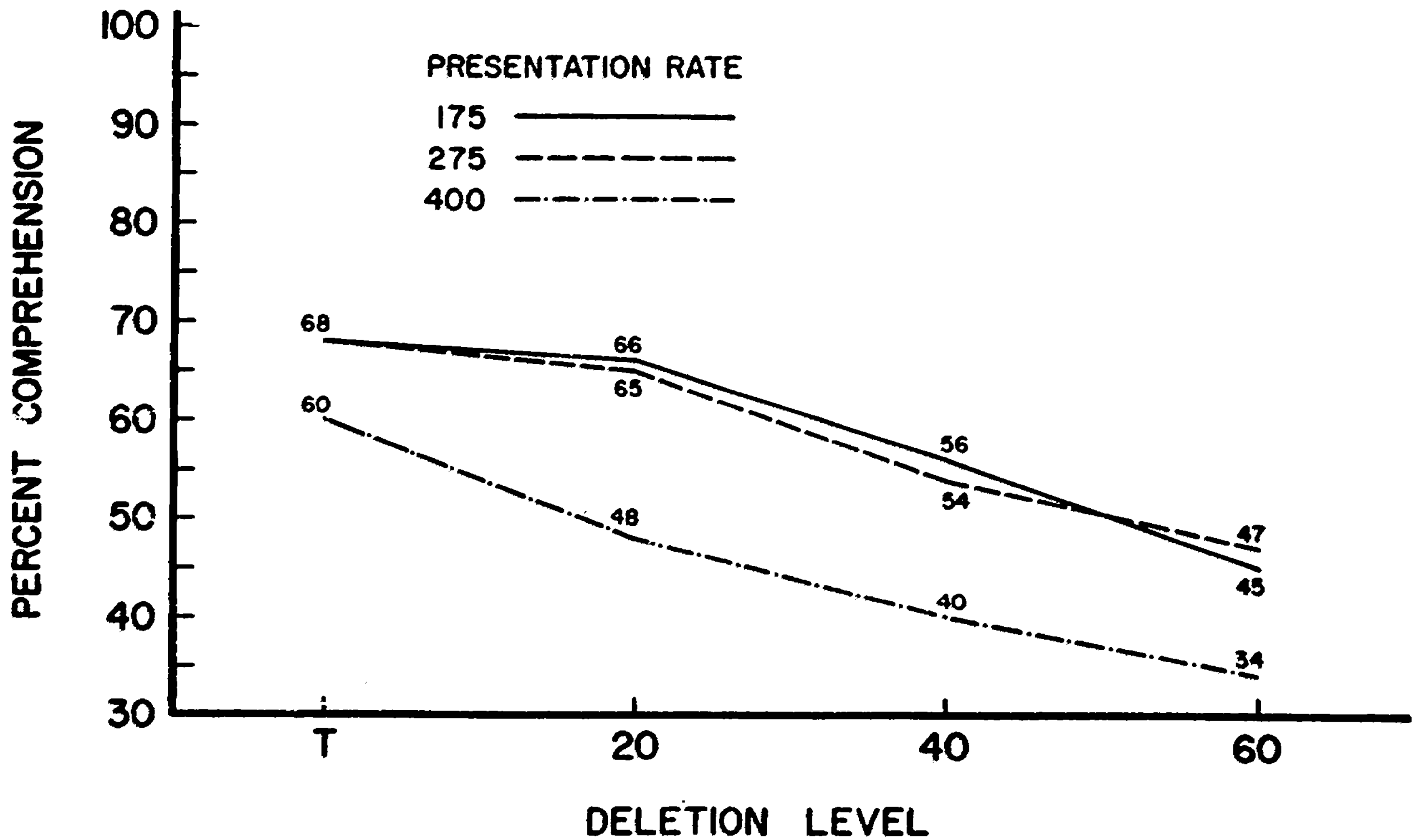

Figure 8.4. Mean comprehension levels for multiple choice in the 12 listening treatments.

Set relation items. The 20-item total set relation, nested set relation, and disjunctive set relation scores were each analyzed in a separate 3 x 4 ANOVA. A significant F-value was obtained for the total set relations mean score across deletion levels ($F(3,228) = 4.24$, $p<.01$). The Scheffé test revealed that subjects scored significantly higher on the Trad than on the 40 ($p<.05$) and 60% ($p<.06$) versions. No significant differences for presentation rate were found.

Analyses of nested and disjunctive set relation scores indicate that the disjunctive items were responsible for the significant difference found among the total set relation scores. While the 3 x 4 ANOVA for nested items showed significant differences for the Deletion Level main effect ($F(3,228) = 2.69$, $p<.05$), the Scheffé test failed to indicate where those differences lay. The only relationship to approach significance ($p<.10$) was between the 20 and 40% deletion levels. Significant differences were found in the same locations for the disjunctive scores as for the total set relation scores. The disjunctive F-ratio ($F(3,228) = 3.57$, $p<.01$) was shown to be due to significantly higher scores on the Trad than on the 40 ($p<.09$) and 60% ($p<.05$) versions. The means and standard deviations for multiple choice and set relation items and for nested and disjunctive set relation items are given in Table 8.6.

Table 8.7 presents the means and standard deviations for the five dependent variables across the 12 listening treatment groups.

EWC scores. For EWC scores, significant differences were found between the Presentation Rate main effect ($F(2,228) = 95.16$, $p<.001$) and between the Deletion Level main effect ($F(3,228) = 32.48$, $p<.001$), but no significant main effects interaction was indicated. The Scheffé test revealed that subjects listening at 275 wpm rates comprehended the material in all versions at an average of 84 wpm (36%) faster than subjects listening at 175 wpm ($p<.001$). At the 400 wpm level, subjects processed the information more efficiently by 110 wpm (43%) than at the 175 wpm ($p<.001$) and by 27 wpm (11%) than at the 275 wpm rate ($p<.01$).

On the basis of EWC, comprehension became more efficient as deletion levels increased. With respect to the Trad version, the Scheffé comparison revealed higher efficiency rates for the 40 and 60% deletion levels (30 wpm (14%) and 88 wpm (33%), respectively ($p<.001$)). The 60% deletion level was also significantly different ($p<.001$) from both the 20 and 40% deletions at an increased wpm efficiency of 74 wpm (28%) and 58 wpm (22%), respectively. Table 8.8 presents the means and standard deviations computed in the analysis of EWC.

TABLE 8.6

Means and Standard Deviations for Multiple Choice,Set Relations, Nested and Disjunctive for Presentation Rate and Deletion Level in the Listening Treatment

Dependent Variables	Presentation Rate			Deletion Level			
	175	275	400	Trad	20%	40%	60%
Multiple Choice							
Mean	35.23	35.10	27.22	39.18	35.72	29.95	25.22
S.D.	10.34	9.07	8.63	8.13	10.55	8.26	6.92
Set Relations							
Mean	12.38	12.44	11.84	12.98	12.58	11.60	11.70
S.D.	2.71	2.30	2.80	2.67	2.61	2.33	2.64
Nested							
Mean	6.36	6.30	6.03	6.37	6.68	5.88	5.98
S.D.	1.81	1.42	2.03	1.77	1.94	1.69	1.58
Disjunc-tive							
Mean	5.97	6.15	5.78	6.58	5.85	5.70	5.73
S.D.	1.49	1.42	1.63	1.50	1.57	1.24	1.60

TABLE 8.7

Means and Standard Deviations for Each of the Five Dependent Variables in the 12 Listening Treatments

Treatment Conditions	Dependent Variables: Multiple Choice Mean	Multiple Choice S.D.	Set Relations Mean	Set Relations S.D.	Nested Mean	Nested S.D.	Disjunctive Mean	Disjunctive S.D.	EWC Mean	EWC S.D.
$Trad_1$	41.00	7.25	13.25	3.27	6.85	2.01	6.40	1.57	118.07	20.89
20_1	39.40	11.29	12.40	2.56	6.50	1.73	5.75	1.94	138.65	39.74
40_1	33.65	9.25	11.40	2.80	5.80	2.09	5.60	1.19	154.85	42.55
60_1	26.85	6.98	12.45	1.88	6.30	1.26	6.15	1.09	184.26	47.42
$Trad_2$	40.80	8.67	13.45	1.79	6.65	1.27	6.80	1.06	184.35	39.16
20_2	39.15	9.50	12.80	2.63	6.65	1.91	6.30	1.22	213.43	51.82
40_2	32.25	6.03	11.25	1.71	5.75	1.64	5.50	1.32	232.25	43.46
60_2	28.20	5.50	12.25	2.49	6.30	1.13	6.00	1.78	299.11	58.36
$Trad_4$	35.75	7.66	12.25	2.71	5.60	1.76	6.55	1.82	239.40	51.27
20_4	28.60	6.93	12.55	2.74	7.05	2.21	5.50	1.43	229.96	55.73
40_4	23.95	5.67	12.15	2.37	6.10	1.74	6.00	1.21	244.22	57.82
60_4	20.60	5.91	10.40	3.03	5.35	2.06	5.05	1.70	322.04	92.33

TABLE 8.8

Means and Standard Deviations for EWC for Presentation Rate and Deletion Level Main Effects for Multiple Choice in the Listening Treatments

EWC	Mean	S.D.
Presentation Rate		
175 wpm	148.95	45.32
275 wpm	232.28	63.96
400 wpm	258.90	74.88
Deletion Level		
Trad	180.60	63.11
20%	194.01	63.08
40%	210.44	62.16
60%	268.45	90.89

Listening/Reading Treatment Analyses

The pattern of results for the listening/reading modality is comparable to the significant findings for the listening mode.

The major difference between the two modes is that comprehension scores and information processing efficiency were consistently better for the combined listening/reading treatment groups than for the listening treatment groups.

Multiple choice items. Analysis of the listening/reading treatment revealed significant F-values in the 3 x 4 ANOVA of multiple choice scores for both the Presentation Rate main effect ($F(2,228) = 31.78$, $p<.001$) and Deletion Level main effect ($F(3,228) = 54.45$, $p<.001$).

Table 8.9 presents the multiple choice and set relation means and standard deviations for the main effects in the listening/reading conditions. For presentation rate, the Scheffé test revealed differences to exist between the 175 wpm and 400 wpm rates as well as between the 275 wpm and 400 wpm rates. Subjects answered 20 and 16% fewer questions correctly at 400 wpm than at 175 wpm and 275 wpm, respectively.

As in the listening treatments, comprehension at the 175 wpm and 275 wpm rates was equivalent for the Trad and 20% deletion materials. For the Deletion Level main effect, significant differences were found for both the Trad and 20% deleted passages in comparison with the 40 and 60% versions. The probability of F was less than .001 in all comparisons. With respect to the Trad version, comprehension scores decreased by 25 and 32% for the 40 and 60% versions, respectively. Compared to the 20% version, the corresponding decrements were 20 and 27%.

As in the listening treatment conditions, no significant interaction was found for the main effects. Figure 8.5 presents the mean comprehension levels for the multiple choice test in the listening/reading treatments.

Set relation items. For the total set relation items, significant differences were found for the Deletion Level main effect ($F(3,228) = 4.57$, $p<.005$). The means and standard deviations are presented in Table 8.9. The Scheffé test revealed that subjects scored significantly higher on the Trad than on the 40 ($p<.05$) and 60% ($p<.05$) versions.

As for the listening treatments, the disjunctive set relation items produced the significant difference found in the total set relations scores ($F(3,228) = 5.37$, $p<.005$). The Scheffé analysis showed that significantly higher scores were obtained on the Trad than on the 40 ($p<.005$) or 60% ($p<.05$) versions. The means and standard deviations for nested and disjunctive items are presented in Table 8.9.

TABLE 8.9

Means and Standard Deviations for Multiple Choice, Set Relations, Nested, and Disjunctive for Presentation Rate and Deletion Level in the Listening/Reading Treatments

Dependent Variables	Presentation Rate			Deletion Level			
	175	275	400	Trad	20%	40%	60%
Multiple Choice							
Mean	40.81	38.76	32.37	44.52	41.23	33.17	30.33
S.D.	9.03	8.80	9.28	8.83	8.24	7.52	6.56
Set Relations							
Mean	12.85	12.65	12.68	13.65	12.60	12.23	12.42
S.D.	2.26	2.25	2.60	2.37	2.60	2.27	1.99
Nested							
Mean	6.69	6.38	4.49	6.92	6.28	6.45	6.42
S.D.	1.55	1.72	1.81	1.72	2.07	1.45	1.42
Disjunctive							
Mean	6.17	6.27	6.24	6.73	6.33	5.78	6.02
S.D.	1.28	1.42	1.56	1.35	1.37	1.45	1.36

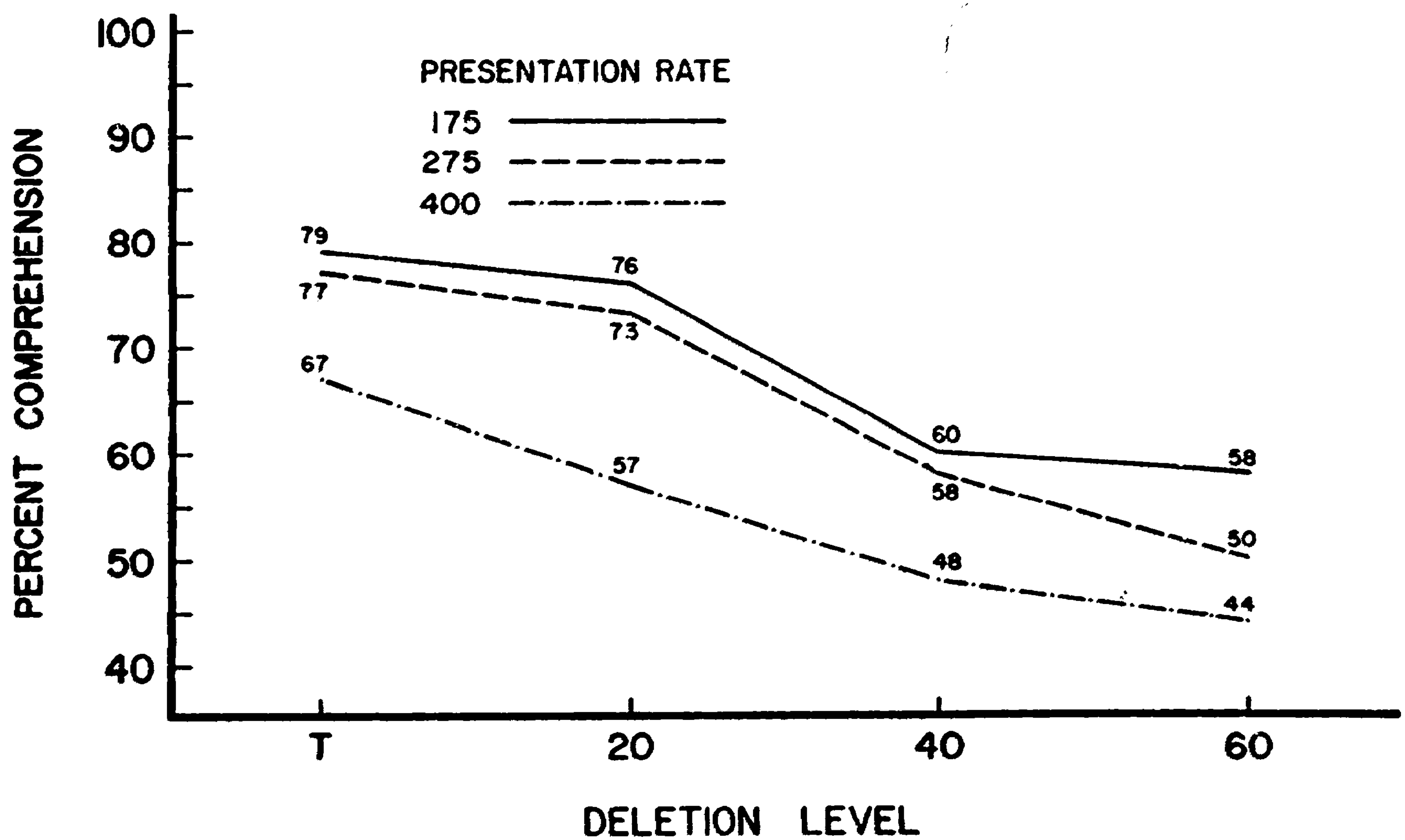

Figure 8.5. Mean comprehension levels for multiple choice in the 12 listening/reading treatments.

EWC scores. Significant differences in the analysis of EWC based on the multiple choice test were found for presentation rates ($F(2,228) = 145.19$, and for deletion levels ($F(3,228) = 61.69$, $p<.001$). Table 8.10 presents the means and standard deviations. The interaction effect was not significant.

For presentation rates, the Scheffé test revealed that subjects simultaneously listening and reading processed material in all versions 80 wpm faster at the 275 wpm rate and 137 wpm faster at the 400 wpm rate than at the 175 wpm rate. Subjects also comprehended 57 wpm (19%) more efficiently at 400 wpm than at 275 wpm. The probability of F was (.001) for differences among the three presentation rates.

Comprehension was also more efficient on the basis of EWC as deletion levels increased. Compared to the Trad passage, the Scheffé test showed that subjects had a higher efficiency rate of 32 wpm (14%) for the 40% version and 118 wpm (37%) for the 60% version. The 60% deleted text was also significantly higher in comprehension efficiency ($p<.001$) than the 20 or 40% versions (98 wpm (30%) and 86 wpm (27%), respectively).

The Scheffé test showed that the listening/reading treatments produced significantly higher EWC rates ($p<.001$) for all four story versions at 275 wpm and at 400 wpm compared to the Trad version presented at 175 wpm. The 60% version at 400 wpm was processed more efficiently by 174 wpm (42%) than at 175 wpm and 92 wpm (22%) faster than at 275 wpm.

As Figure 8.6 illustrates, EWC consistently increases across presentation rate and deletion level for both the listening and listening/reading treatments. Because the multiple choice test scores were significantly higher for the listening/reading treatments than for the listening treatments, EWC is also significantly higher for the listening/reading groups.

The means and standard deviations for the five dependent variables for the 12 listening/reading treatment conditions are presented in Table 8.11.

Comparative Analyses of Listening Treatments and Listening/Reading Treatments

Multiple choice items. A 2 x 3 x 4 ANOVA employed to assess the relationship of the main effects for the multiple choice test revealed significant differences for Presentation Rate ($F(2,456) = 58.64$, $p<.001$), Deletion Level ($F(3,456) = 90.34$, $p<.001$), and Mode of Presentation ($F(1,456) = 50.67$, $p<.001$). No significant interactions were identified. The means and standard deviations for the multiple choice test for main effects are presented in Table 8.12.

TABLE 8.10

Means and Standard Deviations for EWC for Presentation Rate and Deletion Level for Multiple Choice in the Listening/Reading Treatments

Variables	Mean	S.D.
Presentation Rate		
175 wpm	174.53	49.56
275 wpm	254.79	57.59
400 wpm	312.10	91.22
Deletion Level		
Trad	204.31	70.62
20%	225.26	63.50
40%	236.43	73.91
60%	322.56	95.31

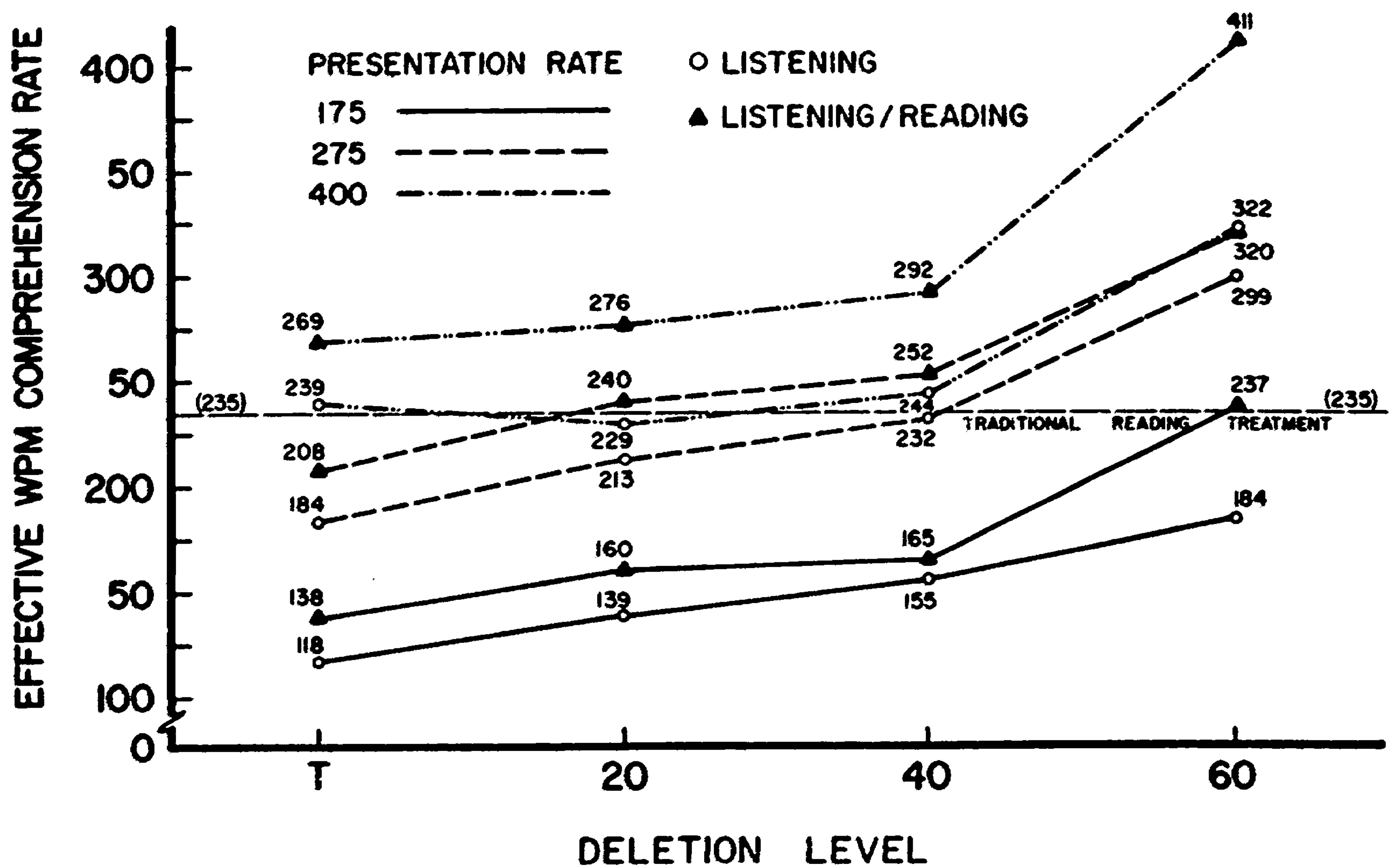

Figure 8.6. EWC rates comparing the listening and listening/reading treatments and the control reading treatment.

TABLE 8.11

Means and Standard Deviations for Each of the Five Dependent Variables in the 12 Listening/Reading Treatments

Treatment Conditions	Dependent Variables									
	Multiple Choice		Set Relations		Nested		Disjunctive		EWC	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
$Trad_1$	47.50	7.45	13.10	2.31	6.65	1.63	6.45	1.28	136.79	21.46
20_1	45.35	7.43	13.35	2.64	6.95	1.90	6.40	1.35	159.58	26.14
40_1	35.80	6.92	12.70	2.34	6.75	1.33	5.95	1.39	164.74	31.83
60_1	34.60	6.71	12.25	1.65	6.40	1.31	5.90	1.07	237.01	45.95
$Trad_2$	45.95	6.60	13.95	1.73	7.05	1.64	6.90	1.17	207.62	29.81
20_2	43.95	5.17	12.35	2.64	5.90	2.10	1.45	1.43	239.60	28.16
40_2	35.05	7.49	12.50	1.73	6.60	1.14	5.90	1.45	252.42	53.92
60_2	30.10	4.46	11.80	2.33	5.95	1.70	5.85	1.46	319.52	46.87
$Trad_4$	40.10	10.54	13.90	2.94	7.05	1.93	6.85	1.60	268.53	70.60
20_4	34.40	7.37	12.10	2.47	6.00	2.13	6.30	1.38	276.60	59.29
40_4	28.65	6.28	11.50	2.59	6.00	1.77	5.50	1.54	292.14	64.00
60_4	26.30	5.69	13.20	1.77	6.90	1.07	6.30	1.53	411.15	89.03

TABLE 8.12

Means and Standard Deviations for Multiple Choice and Set Relations for Presentation Rate and Deletion Level in the Listening Treatments Compared to the Listening/Reading Treatments

Variables	Multiple Choice		Set Relations	
	Mean	S.D.	Mean	S.D.
Presentation Rate				
175 wpm	38.02	10.07	12.61	2.50
275 wpm	36.93	9.10	12.54	2.27
400 wpm	29.79	9.30	12.26	2.73
Deletion Level				
Trad	41.85	8.86	13.32	2.54
20%	38.47	9.83	12.59	2.59
40%	31.56	8.03	11.92	2.31
60%	27.77	7.19	12.06	2.36
Listening	32.52	10.06	12.22	2.62
Listening/Reading	37.31	9.90	12.72	2.37

For presentation rate, the Scheffé analysis indicated significant differences ($p<.001$) between the 400 wpm rate ($\bar{X} = 29.79$) and both the 175 wpm rate ($\bar{X} = 38.02$) and the 275 wpm rate ($\bar{X} = 36.93$). Subjects assigned to the 400 wpm rate answered 22% fewer items correctly than those assigned to the 175 wpm rate and 19% fewer items correctly than those assigned to the 275 wpm rate.

The Scheffé comparison yielded significant differences between each of the four deletion levels. The Trad version elicited significantly more correct test responses than did the 20, 40, or 60% reduced versions. Subjects assigned to the Trad passage answered 34% more items correctly than subjects assigned to the 60% deleted material. In addition, the 20% version subjects answered 18 and 29% more items correctly than on the 40 and 60% versions, respectively. Comparison of the 40 and 60% versions revealed that subjects answered 13% more items correctly on the former passage.

Total set relation items. The means and standard deviations for set relation items are presented in Table 8.12. A 2 x 3 x 4 ANOVA for set relations yielded significant differences for the Deletion Level main effect ($F(3,456) = 8.22$, $p<.001$) and Mode of Presentation main effect ($F(1,456) = 5.29$, $p<.05$). A significant interaction was found among Presentation Rate, Deletion Level, and Mode of Presentation ($F(6,456) = 3.18$, $p<.005$). The Scheffé analysis revealed that significant differences existed between the Trad and 40% and between the Trad and 60% materials. Subjects answered 7% fewer items on both the 40 and 60% versions than on the Trad version. The Scheffé test failed to identify where the differences lay in the pairwise comparisons of the 24 treatment conditions.

Nested and disjunctive set relation items. Means and standard deviations for the 2 x 3 x 4 ANOVA for nested and disjunctive items are shown in Table 8.13.

Separate 2 x 3 x 4 ANOVAs performed on the nested and disjunctive set relation items yielded significant differences in both cases. For the nested items, an F value ($F(6,456) = 2.82$, $p<.05$) was found for the interaction of Presentation Rate, Deletion Level, and Mode of Presentation main effects. The respective probability levels were .09, .06, and .08 for Deletion Level, Mode of Presentation, and Deletion x Mode; but the Scheffé analysis failed to indicate the exact location of differences in the pairwise comparisons for all 24 treatment conditions.

For the disjunctive items, significant differences were found to exist for the Deletion Level ($F(3,456) = 9.54$, $p<.001$) and Mode of Presentation ($F(1,456) = 4.01$, $p<.05$) main effects. The Scheffé comparison revealed significant differences between the Trad and 20% versions, between the Trad and 40% versions ($p<.001$), and between the Trad and 60% versions

TABLE 8.13

Means and Standard Deviations for Nested and Disjunctive for Presentation Rate and Deletion Level in the Listening Treatments Compared to the Listening/Reading Treatments

Variables	Nested		Disjunctive	
	Mean	S.D.	Mean	S.D.
Presentation Rate				
175 wpm	6.52	1.69	6.07	1.39
275 wpm	6.34	1.57	6.21	1.42
400 wpm	6.26	1.93	6.01	1.61
Deletion Level				
Trad	6.64	1.76	6.66	1.42
20%	6.48	2.01	6.12	1.49
40%	6.17	1.59	5.74	1.34
60%	6.20	1.51	5.88	1.49
Listening	6.23	1.77	5.97	1.52
Listening/Reading	6.52	1.69	6.23	1.42

($p<.001$). Subjects assigned to the Trad text answered 6% more items correctly than subjects assigned the 20% version, and 8% more items correctly than subjects assigned to either the 40 or 60% versions.

EWC scores. The 2 x 3 x 4 ANOVA for EWC revealed highly significant differences across Presentation Rate ($F(2,456) = 234.87$, $p<.001$), Deletion Level ($F(3,456) = 9.29$, $p<.001$), and Mode of Presentation ($F(1,456) = 50.69$, $p<.001$) main effects. Significant interactions between Presentation Rate and Deletion Level ($F(6,456) = 2.57$, $p<.05$) and between Presentation Rate and Mode of Presentation ($F(2,456) = 4.23$, $p<.05$) were also indicated. Figures 8.7 and 8.8, respectively, provide a graphic description of these interactions. Means and standard deviations are given in Table 8.14.

The pairwise comparisons of main effect independent variables by the Scheffé test indicated significant differences. The three levels of presentation rate were found to differ at/or greater than the .001 level. Mean EWC scores were 161.74 for the 175 wpm rate, 243.54 for the 275 wpm rate, and 285.50 for the 400 wpm rate. The 400 wpm presentation rate was 124 wpm (43%) and 42 wpm (15%) more efficient than the 175 wpm and 275 wpm rates, respectively.

Significant differences were found for deletion levels between the Trad and 40% versions ($F(3,456) = 7.11$, $p<.001$) and between the Trad and 60% deleted texts ($F(3,456) = 78.71$, $p<.001$). The 20 and 60% versions and the 40 and 60% versions were also significantly different at the .001 level. EWC was 31 wpm (14%) faster for the 40% version and 104 wpm (35%) for the 60% version compared to the Trad text. Further, EWC for the 60% version was 86 wpm faster than for the 20% deleted passage and 70 wpm faster than for the 40% version. The mean EWC rates for the Trad, 20, 40, and 60% versions were 192.45, 209.64, 223.44, and 295.51, respectively.

The means and standard deviations for the five dependent variables for the 12 listening treatments compared to the 12 listening/reading treatments are presented in Table 8.15.

Discussion

Presentation Rate

For presentation rate, comprehension was maintained at 275 wpm at almost the same level as at 175 wpm across both the listening and listening/reading treatment conditions. Based on the Trad story form, comprehension was 68% at these speeds for listening and 79% for listening/reading. Comprehension for subjects assigned to the 400 wpm rate decreased to 60% for listening and to 67% for listening/reading on the

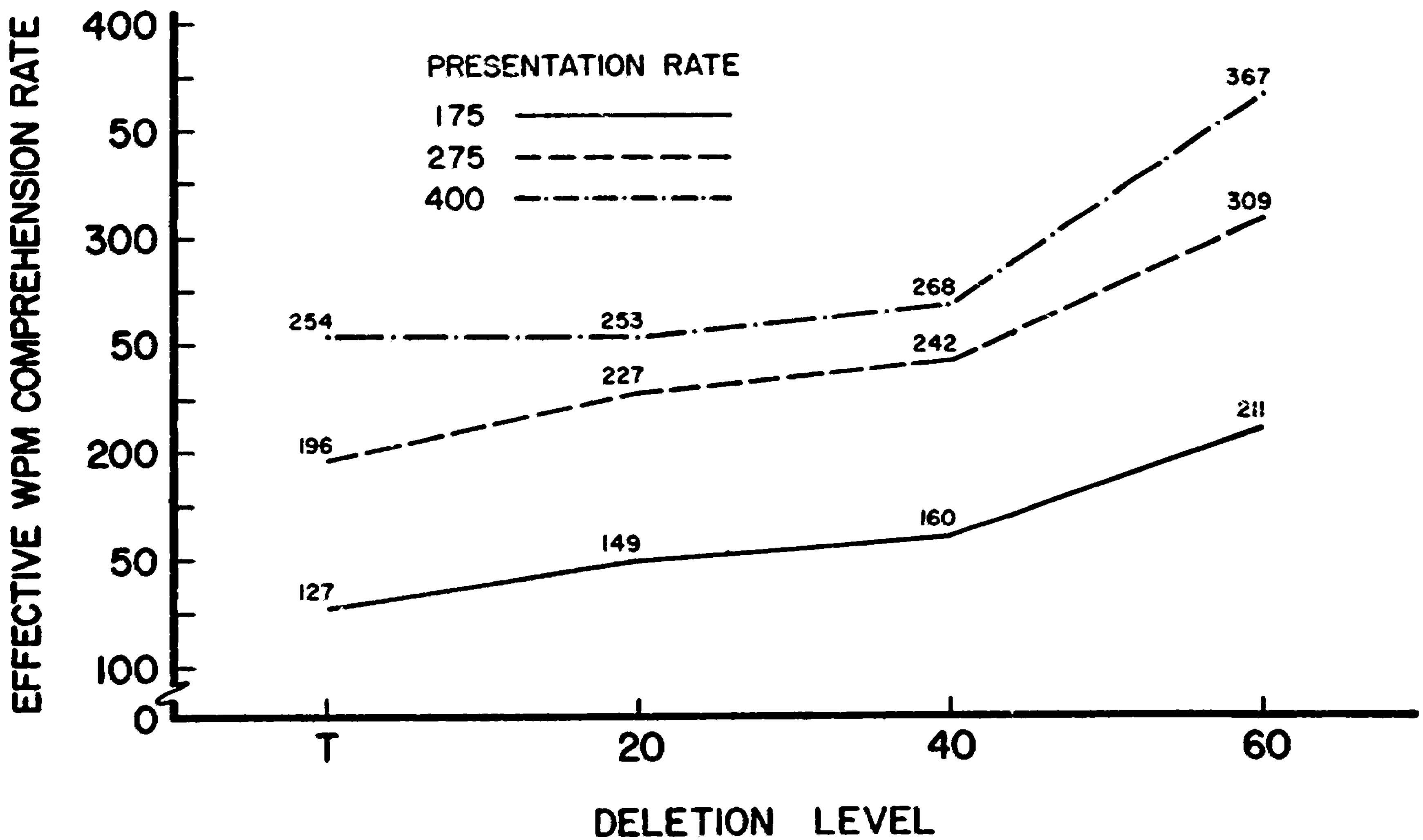

Figure 8.7. Interaction between Presentation Rate and Deletion Level for EWC in the 3 x 4 x 2 ANOVA.

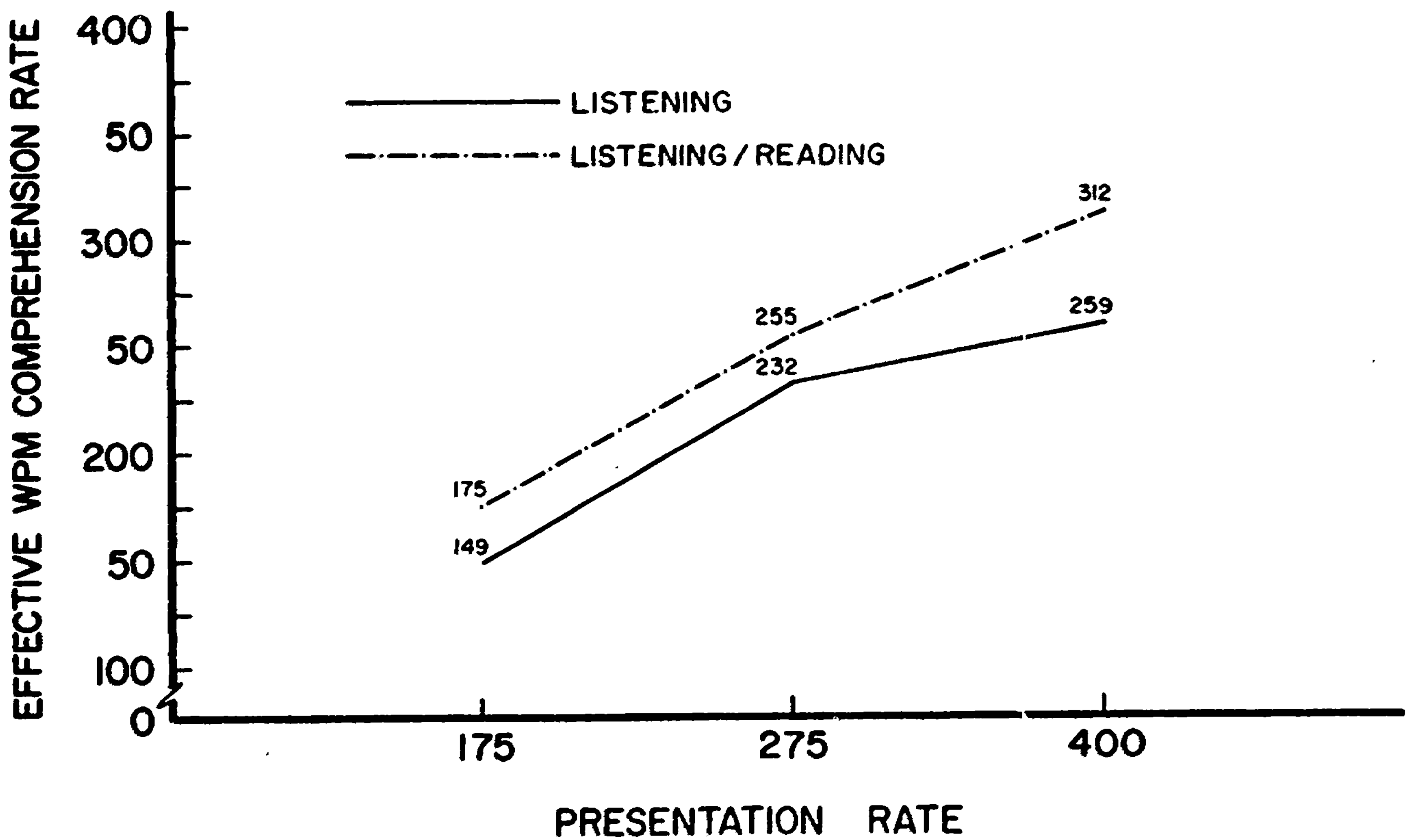

Figure 8.8. Interaction between Presentation Rate and Modality for EWC in the 3 x 4 x 2 ANOVA.

TABLE 8.14

Means and Standard Deviations for EWC for Presentation Rate and Deletion Level in the Listening Treatments Compared to the Listening/Reading Treatments

Variables	Mean	S.D.
Presentation Rate		
175 wpm	161.74	49.05
275 wpm	243.54	61.71
400 wpm	285.50	87.36
Deletion Level		
Trad	192.46	67.74
20%	209.64	64.95
40%	223.44	69.24
60%	295.51	96.63
Listening	213.38	78.02
Listening/Reading	247.14	88.63

TABLE 8.15

Means and Standard Deviations for Each of the Five Dependent Variables in the Listening Treatments Compared to the 12 Listening/Reading Treatments

Treatment Conditions	Variables									
	Multiple Choice		Set Relations		Nested		Disjunctive		EWC	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
$Trad_1$	44.25	7.97	13.17	2.80	6.75	1.81	6.42	1.41	127.43	22.95
20_1	42.38	9.90	12.88	2.61	6.72	1.81	6.08	1.69	149.11	34.85
40_1	34.72	8.13	12.05	2.63	6.27	1.80	5.78	1.29	159.79	37.43
60_1	30.72	7.82	12.35	1.75	6.35	1.27	6.03	1.07	210.63	53.27
$Trad_2$	43.38	8.04	13.70	1.76	6.85	1.46	6.85	1.10	195.98	36.32
20_2	41.55	7.93	12.57	2.61	6.20	2.00	6.38	1.31	226.51	43.24
40_2	33.65	6.86	11.88	1.81	6.17	1.22	5.70	1.38	242.34	49.40
60_2	29.15	5.04	12.02	2.39	6.13	1.44	5.93	1.61	309.32	53.26
$Trad_4$	37.92	9.36	13.07	2.91	6.32	1.97	6.70	1.70	253.96	62.66
20_4	31.50	7.65	12.32	2.59	6.52	2.21	5.90	1.45	253.28	61.51
40_4	36.30	6.37	11.82	2.47	6.05	1.74	5.75	1.39	268.18	64.91
60_4	23.45	6.41	11.80	2.83	6.13	1.80	5.68	1.72	366.59	100.26

Trad version. Subjects assigned to the reading treatment conditions read the Trad story at a mean rate of 295 wpm with almost the same comprehension (80%) as did those assigned to the same version at the 275 wpm rate in the listening/reading treatment condition (77%).

Deletion Level

For deletion level, comprehension for the 20% reduced level was almost as high as that for the Trad version for both listening and listening/reading at both the 175 wpm and 275 wpm rates. The reading modality resulted in a significant decrease (14%) in comprehension for the 20% version compared to the Trad story. The actual wpm reading rates for subjects assigned to the Trad and 20% versions for the reading treatments were comparable (285 wpm and 295 wpm, respectively).

Compared to the Trad test, the 20% version produced significantly reduced comprehension for both listening and listening/reading at the 400 wpm rate.

At 40% deletion, comprehension across all treatment conditions dropped significantly below that associated with the Trad and 20% materials. Subjects assigned to the 40% version, however, answered almost the same percentage of answers correctly at 275 wpm as at 175 wpm in both the listening (55%) and the listening/reading (59%) treatment conditions. Reading treatment subjects assigned to the 40% deleted story scored an average of 56% correct at a mean reading rate of 237 wpm. While the 60% version resulted in a 1% higher comprehension score than the 40% text in the reading treatment conditions, actual wpm reading rate for the former version was a significant 101 wpm below that for the latter text. Subjects assigned to the 60% version at 175 wpm in the listening/reading modality obtained an average comprehension score of 58% compared to 57% for the same version in the reading modality where mean reading rate was 136 wpm.

The most significant comprehension decrements in both the listening and listening/reading groups occurred between the 20 and 40% deletion levels at all except the 400 wpm rate. At 400 wpm, a significant reduction in comprehension across both the listening and listening/reading treatments was associated with the 20% reduced text. As shown in Table 8.16, the 40% deletion level resulted in significant loss of comprehension across all treatment conditions and thus constituted the point of diminishing returns for efficiency of telegraphic style prose.

Table 8.16 compares each of the 28 treatment conditions with respect to percent of items correct on the multiple choice test. The effect of deletion level on comprehension within each presentation rate, the effect of presentation rate on comprehension within each deletion level, and the percent

TABLE 8.16

Percent Correct for Multiple Choice Test Showing the Effect of Deletion Level, Presentation Rate, and Mode of Presentation for all 28 Treatment Conditions

Control Treatment Condition	Reading Rate	Reading % Correct	% Difference
Trad	295	80	
20%	285	65	-15
40%	237	56	- 9
60%	136	57	+ 1

Experimental Treatment Conditions	Listening			Listening/ Reading			% Increase of L/R over L
	%C	%DL	%PR	%C	%DL	%PR	
$Trad_1$	68			80			+12
20_1	66	- 2		76	- 4		+10
40_1	56	-10		60	-16		+ 4
60_1	45	-11		58	- 2		+13
$Trad_2$	68		0	77		- 3	+ 9
20_2	65	- 3	- 1	73	- 4	- 3	+ 8
40_2	54	-11	- 2	58	-15	- 2	+ 4
60_2	47	- 7	+ 2	50	- 8	- 8	+ 3
$Trad_4$	60		- 8	67		-10	+ 7
20_4	48	-12	-17	57	-10	-16	+ 9
40_4	40	- 8	-14	48	- 9	-10	+ 8
60_4	34	- 6	-13	44	- 4	- 6	+10

Legend: C = % items correct
DL = % difference in items correct due to deletion level within 1 wpm rate as between $Trad_{175}$ and 20_{175}
PR = % difference in items correct due to presentation rate within one level of deletion as between $Trad_{175}$ and $Trad_{275}$

increase in comprehension for the listening/reading mode compared to listening mode is presented for each treatment condition.

Mode of Presentation

As indicated in Table 8.16, consistently higher comprehension scores resulted for the listening/reading treatments than from the listening treatments. The listening treatments also resulted in lower comprehension scores than the Trad story reading treatment. This finding agrees with the Martin and Hope (1972) study in which the aural mode was found to produce consistently lower comprehension scores than the visual (reading) modality. That college students are accustomed to learning by listening without reinforcement through reading or note writing may partially account for this result.

The listening/reading modality failed to produce higher comprehension scores in any of the 12 treatment conditions than the Trad story version reading treatment. However, as shown in Table 8.16, the listening/reading modality produced better comprehension scores in five treatment conditions ($Trad_1$, 20_1, $Trad_2$, 20_2, $Trad_4$) than the 20% version reading treatment; and all but three of the 12 listening/reading treatments solicited higher comprehension than either the 40 or 60% reading treatments.

One explanation for the failure of any listening/reading treatment to produce comprehension scores higher than the Trad story reading treatment is that subjects were unfamiliar with the presentation style of either telegraphic prose or compressed speech.

Additionally, as suggested by Broadbent (1958) and by Jester (1966), subjects may be unable to efficiently use the two modalities concomitantly. Jester's work has established that some individuals are more adapted to the aural modality than to the visual and vice versa. And, since individuals from each modality class preference have been employed as subjects in research involving simultaneous presentation of visual and aural material without consideration of that preference, the conclusion that joint modality presentation is most effective may be erroneous. His research indicates that a simultaneous two mode presentation would inevitably yield higher comprehension scores than a one mode presentation because each subject can select the modality he finds most efficient.

The reliance upon both listening and reading modes for learning (Tables 8.19 and 8.20) identified in this experiment, however, tends to not support the idea that only one modality at a time can be used efficiently.

Reading Rate

Through the development reading course in which they were enrolled, the subjects assigned to the reading treatment conditions had undergone eight weeks of intensive training to increase reading speed and comprehension prior to the experiment. The 480 subjects assigned to the listening and listening/reading treatment groups did not receive such training. That the control group reading rates obtained in this experiment were significantly higher than those of comparable subject populations for the same "San Francisco" materials at Texas A&M University suggests a bias engendered by the developmental reading course training. The effect of these higher than expected reading rates, however, was to cause the experimental listening and listening/reading treatments to appear less efficient by comparison than they may actually be. Had the reading rates obtained at Texas A&M University been used for the comparison control, the experimental treatments would have appeared significantly more efficient. In addition, since practice sessions can significantly improve comprehension for fast rates of compressed speech (Orr, 1965), prior training of experimental treatment group subjects would have been justified.

In the reading treatment conditions, less actual time was required to read the three telegraphic versions than the Trad. The mean reading times for the 20, 40, and 60% versions were 15, 24, and 10% less than for the Trad version. Reading time for the 60% test, however, was 5 and 14% longer than for the 20 and 40% versions, respectively. Thus, wpm reading rates for the 40 and 60% telegraphic versions were significantly lower than for the Trad text. That the 60% version was read at less than one-half the rate of the Trad version agrees with findings in the Martin and Alonso (1967), Martin and Herndon (1972), Martin and Pantalion (1973), and Sheffield (1972) studies, that highly deleted texts are read at a markedly reduced rate.

For highly telegraphic materials, subjects must both compensate for the deleted words and deal with the extreme compaction of information and will automatically decrease normal reading speed to achieve adequate comprehension. While Martin and Hope (1972) conclude that the slower rate results from the compactness of information, the results of the present experiment suggest that the decrease in redundancy may mediate the drastic rate decrement. In the listening treatment groups where subjects were forced to increase their voluntary rate of information processing, multiple choice comprehension scores for the 60% text were, compared to the reading group scores for the same version (mean reading rate 136 wpm), 12% lower at 175 wpm and yet only 10% lower at 275 wpm. Similarly, the listening/reading treatment mean score for the 60% version at 175 wpm was equivalent to the reading treatment score for the 60% version at 136 wpm, and for the

60% text at 275 wpm was only 7% less than the corresponding reading treatment score.

The reading rate decrement for the 40 and 60% reduced versions, as established in previous research studies on telegraphic prose, supports the contention that telegraphic material is more informationally compact and therefore more difficult. The ability of subjects to process telegraphic material with only 7% less comprehension when they were forced to double their voluntary reading rate suggests two alternative explanations:

1. The combined listening/reading modality may have served as a significant reinforcer especially in the 40 and 60% reduced versions. Students may have used the two simultaneously presented modalities more efficiently than the reading or listening modalities alone.

2. Although subjects voluntarily decrease their reading rate when faced with high telegraphic materials, they actually may be able to comprehend the material at a faster input rate if they are forced to do so. Many subjects assigned to the listening/reading 60% version at 275 wpm noted that although they believed they had little recall of the material at the end of the presentation, facts seemed to come to mind when the test questions were read. The objective test measure surely aided such recall more than an essay evaluation would have done.

Specific Comparison of Treatments

Basic to the present experiment was the determination of which treatment conditions produced acceptable levels of comprehension. Since reading is: (1) required of and relied upon by students at every educational level, (2) fundamental to every academic learning environment, and (3) essential to the foundation of formal education, the reading treatment groups were used as a comparative base. Table 8.17 shows which of the experimental listening and listening/reading treatment conditions corresponded most closely to the four control reading treatments for comprehension scores and wpm rates.

In order to more precisely compare the relative efficiency of each treatment condition, the mean 80% comprehension level of the Trad story reading treatment was established as a reference norm and assigned a standard value of 100%. Table 8.18 presents this comparison of the 28 treatment groups. Mean raw scores and percentages are rounded to the nearest whole number.

As Table 8.18 shows, with respect to EWC, listening at 400 wpm to the Trad version was slightly more efficient than reading the Trad version. Although comprehension decreased for the Trad story at 400 wpm in the listening treatment

TABLE 8.17

Reading Treatment Conditions Compared to Listening and Listening/Reading for Multiple Choice Test

Reading Conditions				Listening or Listening/Reading Conditions Corresponding Most Closely to Reading			
Deletion Level	Mean wpm	Mean Score	% Correct	Treatment Condition	Mean wpm	Mean Score	% Correct
Trad	295	47.70	80	L/R T_1	175	47.50	80
				L/R 20_1	275	45.95	76
				L/R T_2	175	45.35	77
				L/R 20_2	275	43.95	73
20%	285	38.70	65	L T_2	275	40.80	68
				L/R T_4	400	40.10	67
				L 20_1	175	39.40	66
				L 20_2	275	39.15	65
40%	237	33.75	56	L/R 40_2	275	35.05	58
				L/R 20_4	400	34.40	57
				L 40_1	175	33.65	56
				L 40_2	275	32.25	54
60%	136	34.10	57	L T_4	400	35.75	60
				L/R 60_1	175	34.60	58
				L/R 40_2	275	35.05	58
				L/R 20_4	400	34.40	57

Legend: L = Listening
R = Reading
T = Traditional

TABLE 8.18

Comparison of All of the Experimental Treatment Conditions
to the Control Reading Condition (Traditional)
for the Multiple Choice Test

Treatment Condition	Mean Raw Score	% of Normal	EWC	+ 235	* $235\bar{c}$ 75-89%	** $235\bar{c}$ 90-100%
Reading (Control)						
Trad	48	100	235			
20%	39	81	229			
40%	34	70	221			
60%	34	72	191			
Listening						
Trad$_1$	41	85	118			
20$_1$	39	81	139			
40$_1$	34	71	155			
60$_1$	27	56	184			
Trad$_2$	41	85	184			
20$_2$	39	81	213			
40$_2$	32	67	232			
60$_2$	28	58	299	+		
Trad$_4$	36	75	239	+	*	
20$_4$	29	660	230			
40$_4$	24	50	244	+		
60$_4$	21	44	322	+		
Listening/Reading						
Trad$_1$	48	100	137			
20$_1$	45	94	160			
40$_1$	36	75	165			
60$_1$	35	73	237	+		
Trad$_2$	46	96	208			
20$_2$	44	92	240	+	*	**
40$_2$	35	73	252	+		
60$_2$	30	63	320	+		
Trad$_4$	40	83	269	+	*	
20$_4$	34	71	277	+		
40$_4$	29	60	293	+		
60$_4$	26	54	411	+		

condition, the input rate was 105 wpm faster than for the Trad version reading condition, making it more efficient when task time and comprehension level are considered together. This result is unexpected for three reasons. First, compared to the visual mode, the aural modality was presumed to and did result in generally lower comprehension scores generally for normal college students unaccustomed to relying solely on listening in learning situations. The Martin and Hope study (1972) found that listening comprehension scores were lower than reading scores even at a normal conversation speech rate (120 wpm). Secondly, the research in compressed speech has established that presentation rates of over 275 wpm to 300 wpm greatly reduce comprehension of material. Thirdly, these subjects had no experience or training in listening to compressed speech and the initial sound and speed of the 400 wpm tape had an obvious startling and distracting effect on most. Yet in this experiment, 400 wpm input rate was comprehended better than predicted and produced a higher EWC level than the reading control treatment.

The 20% version at 275 wpm for the listening condition (20_2) was equivalent in comprehension (81%) and EWC scores to the 20% version reading condition. The actual 285 wpm reading rate for the 20% version reading treatment is also comparable to the 275 wpm aural tape rate. The equivalency of these two groups was unexpected since the listening treatments were predicted to produce a lower level of learning efficiency in general than the reading treatments.

EWC for the 60% version listening/reading condition at 175 wpm was also equivalent to the Trad listening treatment at 400 wpm and to the 20% reading condition although actual comprehension was lower for the 60% learning/reading group. The 20% listening/reading treatment condition at 275 wpm corresponded most closely to the Trad version reading control treatment for EWC.

Effective Word Per Minute Comprehension (EWC)

The basic purpose of this experiment was to study the effects of combining telegraphic prose and compressed speech techniques on the efficiency of information processing. The experimental alteration of the stimulus material content (by subjective word deletion) and the rate of input (by speech compression) were intended to increase learning efficiency relative to time. Consequently, to meaningfully assess the amount of information processed from the telegraphic materials, a measure of comprehension based on the total number of words found in the Trad passage was required. The EWC values given in Table 8.18 appropriately describe the efficiency of each experimental condition.

As shown in Table 8.19, of 486 undergraduate subjects completing a self-rating form on preferred mode of learning,

TABLE 8.19

Results of Subjects' Self Rating on Mode of Learning Efficiency, Reading Rate, and Conversational Speech Rate

Question	Female		Male		Total Subjects Male-Female	
	Number	Percent	Number	Percent	Number	Percent
Most Efficient Mode of Learning						
Listening	77	20%	33	33%	110	23%
Reading	53	14%	4	4%	57	12%
Combined Listening/Reading	256	66%	63	63%	319	65%
Conversational Speech Rate						
Slow	6	2%	10	10%	16	3%
Average	266	69%	74	74%	340	70%
Fast	114	29%	16	16%	130	27%
Reading Rate						
Slow	75	19%	33	33%	108	22%
Average	252	65%	61	61%	313	64%
Fast	59	16%	6	6%	65	14%
Total	386		100		486	

reading rate, and conversational speech rate, a majority (65%) indicated that the combined modes of listening and reading were considered most efficient for learning. Although most subjects were expected to cite reading as the most efficient learning mode, significantly more of those subjects stipulating a single presentation mode listed listening, not reading, as most efficient. Twenty percent of the female subjects and 33% of the male subjects believed listening to be the best means of learning compared to 14 and 4%, respectively, who believed reading is most efficient. Thirty-three percent of the male subjects also ranked their reading rate as slow.

Post-Test Modality Form for Listening/Reading Treatments

As Table 8.20 illustrates, on the post-test modality utility form, a majority of subjects judged that they relied equally on the aural and visual modalities for input of information in listening/reading treatment conditions. Reliance on listening alone was predicted to decrease for the 40 and 60% deletions especially at the 275 wpm and 400 wpm rates. However, increased reliance on reading only, rather than on the combined modalities equally, was also predicted for those treatment conditions. Significantly more males (27%) than females (13%) preferred to rely on listening alone. This result is noteworthy because only 4% of the 100 males responding to the pre-study self-rating form indicated reading as their most efficient learning mode.

These results lend support to the contention that subjects are able to use two sensory modalities simultaneously in learning and agree with the results of the pre-study self-rating form.

Summary of Hypotheses

The main focus of this research was to study the effects of combining compressed speech and telegraphic prose upon comprehension. Although it was postulated that more efficient ways to process information are possible, it was assumed that individuals do have a limited capacity for input of information. Investigation of that capacity was one of the concerns of this study.

Because this experiment used a unique combination of learning techniques, some of the hypotheses advanced were exploratory in nature.

Hypothesis one predicted a differential drop rate in comprehension as a result of increasing the speech compression (Presentation Rate) and the word compaction (Deletion Level). Although a decrease in comprehension occurred, a differential drop was not found since no significant interaction existed between these two main effects except for the dependent EWC

TABLE 8.20

Modality Relied Upon Most in Listening/Reading Treatment Conditions as Checked by Each Subject

Treatment Condition	Female			Male		
	Aural	Visual	A/V Equally	Aural	Visual	A/V Equally
175 wpm						
Trad	2	2	10	2	1	3
20%	1	3	10	0	1	5
40%	1	2	12	3	0	2
60%	4	1	10	3	1	1
275 wpm						
Trad	3	4	9	0	1	3
20%	3	4	9	0	1	3
40%	2	2	11	2	1	2
60%	2	5	7	3	1	2
400 wpm						
Trad	2	3	11	1	2	1
20%	2	6	6	2	1	3
40%	0	9	5	1	3	2
60%	0	4	7	1	8	0
Total						
175 wpm	8	8	42	8	3	11
275 wpm	10	15	36	5	4	10
400 wpm	4	22	29	5	14	6
Total	22	45	107	18	21	27
Percent of Total	13%	26%	61%	27%	32%	41%
Females = 174						
Males = 66						
Total % for All 240 Subjects	17%	27%	56%			

variable. Previous research has established that comprehension does decrease at rates above 275 wpm. Thus, the speech compression technique was used also as a means of studying information density of telegraphic prose in this study. The lack of strong interaction effects are interpreted as not supporting the density aspect of telegraphic prose. Presentation Rate and Deletion Level main effects caused significant decrements in comprehension which were additive rather than multiplicative.

Hypothesis two, which predicted that EWC would decrease at high deletion levels and fast presentation rates, was rejected as EWC increased at even the highest presentation rates and deletion levels (Table 8.18). Although there was a significant decrement in comprehension for the 40 and 60% deletion levels at the 275 wpm and 400 wpm presentation rates, this decrease was offset by the faster presentation time. EWC increased a total of 204 wpm comprehended from the Trad version at 175 wpm (EWC=118) to the 60% reduced version at 400 wpm (EWC=322) for the listening treatment condition. For the combined listening/reading modalities, EWC increased a total of 273 wpm comprehended from the Trad version at 175 wpm (EWC=138) to the 60% reduced version at 400 wpm (EWC=411). The only decrease for EWC occurred in the control reading treatments where it dropped from 235 wpm comprehended for the Trad version to 191 wpm comprehended for the 60% deleted version. This decrement was a result of subjects voluntarily decreasing their actual wpm reading rate by 54% on the 50% version as compared with the Trad prose story.

Hypothesis three stated that the most extreme experimental treatment conditions would present the material at too fast a rate and at too greatly a reduced level for subjects to adequately comprehend the material. This was confirmed on the basis of the multiple choice test as comprehension dropped well below acceptable limits. However, with respect to EWC, while the 40 and 60% deletion levels at the 275 wpm and 400 wpm presentation rates appear too difficult for one exposure learning, the treatments were not as unacceptable as was predicted.

Hypothesis four predicted that the combined listening/reading modalities would enhance comprehension compared with the listening modality alone. This hypothesis was confirmed. As shown in Tables 8.16 and 8.18, comprehension increased for each experimental treatment for listening/reading over listening. The results of this study confirm that subjects made efficient use of the combined modalities rather than relying on the selective use of only one (Table 8.19 and 8.20).

Hypothesis five which postulated that a majority of subjects would rely on the reading modality alone for the 40 and 60% deleted versions at the 275 wpm and 400 wpm rates for the combined listening/reading modality, was rejected. Although it was predicted that the aural mode would be confusing and would tend to be ignored in these treatments, a majority of subjects continued to rely on both listening and reading for input of information.

Finally, this experiment was concerned with determining that combination of deletion level and presentation rate which produced the most efficient presentation condition. For both the listening and listening/reading modalities, the Trad and 20% reduced versions at 275 wpm were best and compared favorably with the reading control conditions for these versions. On a basis of time efficiency, however, subjects performed well enough on the Trad and 20% reduced versions at 400 wpm to indicate that they could master the material by listening twice to these tapes (a process which would require a little more time than reading the material once). Listening to materials under such conditions might be advantageous to handicapped readers and to blind students. For the listening/reading modality, the practical application of these experimental treatments would effect increased efficiency of information processing in normal learners at a variety of educational levels.

Conclusions

The results of this study are interpreted as supporting the implementation of the combined telegraphic prose/compressed speech techniques for a spectrum of learning environments. Modality was shown to be an important variable which can be manipulated according to the needs and the conditions of the learner. Listening to compressed speech/telegraphic prose materials has great potential for increasing the learning rate of the blind who must spend approximately three hours reading materials in braille for every hour needed by a sighted reader. Visual texts, slides, or even movie frames using telegraphic prose could offer exciting means to increase learning efficiency for the deaf and hearing impaired.

Despite the rightful concern for ways to increase learning efficiency for the handicapped, an even greater need exists for application of new techniques of information input and storage to normal learners. The subjects' positive reaction to the telegraphic prose/compressed speech learning techniques used in this study was unexpected as was the majority preference for the simultaneous use of two modalities. A major conclusion of this research is that telegraphic materials of 10 to 25% deletion combined with compressed speech of 400 wpm would benefit many university students by significantly increasing the efficiency of learning. Additionally, the simultaneous use of the listening and reading modalities would provide increased levels of information processing for most subjects.

While investigations continue to question whether there is a neurological limitation to information processing capacity, the majority of recent studies seem to concur that such a threshold does exist. The results of this study fully support the existence of a limit on central processing ability, but the conclusion which requires emphasis is that this is an individual capacity or threshold. The basic problems in increasing learning efficiency are ultimately human rather than technological, but this study as well as others have demonstrated that the input rate of information can be significantly increased without loss of comprehension by learning techniques such as a combination of telegraphic prose, compressed speech, and modality. Although the upper limit at which information can be processed may be quite inflexible, it is surely a highly individualized limit which may be significantly altered by the modality or modalities used and/or by presentation rate and deletion level employed.

CHAPTER IX

EXPERIMENT VIII

COMPARISON OF TWO SUBJECTIVE DELETION SCHEMES UPON THE COMPREHENSION OF TELEGRAPHIC PROSE

Introduction

Examination of the preceding methods for generating telegraphic prose reveals some problems. The frequency reduction scheme requires that word frequencies be determined and the grammatical reduction scheme requires that each word be classified according to its grammatical category. Another shortcoming of these two methods is that word reduction within the categories is a random process. The SHORT method, which produces some of the best results, is quite involved in terms of time and personnel.

The application of text reduction techniques on a large scale basis will require rather practical and straightforward reduction procedures. One objective of this experiment was the formulation of a system of rules that can be followed by a telegraphic editor in order to achieve some reduction of traditional narrative text. The objective of this study was to explore the possibility of developing a more practical method for transforming traditional materials into a telegraphic style.

This study was conducted in three phases. The rules for deriving telegraphic passages were established in the first phase. Several pages of narrative material were subjectively reduced at the sentence and paragraph levels.

The second phase of the experiment was concerned with producing the telegraphic materials. Two methods were used to generate the reduced passages: (1) the SHORT method and (2) the editorial method based on Phase I guidelines.

The final phase of the experiment tested the telegraphic materials developed in Phase II. A multiple choice test and completion test were administered immediately after the subjects finished reading the prose selection. A questionnaire concerning the subjects' reactions to the basic concepts of telegraphic prose and methods for producing such materials was also included. In addition, long term retention was measured by having the subjects respond again to the comprehension test one week after the initial testing.

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

The present study was generally exploratory in nature in that the purpose was to evaluate a different method of generating telegraphic prose. The only method related to the one used here is the approach Martin and Alonso (1967) took in first constructing reduced passages. Thus, predictions that could be made on the basis of previous research were somewhat limited. The following outline presents either specific testable hypotheses or more general expectations regarding both the nature of the materials and the direction of the data.

I. Phase I

A. The lowest level of deletion will involve the omission of articles.
B. The higher deletion levels will result from restructuring the sentence.

II. Phase II

A. There will be a significant ($p<.05$) index of agreement on the rank ordering of the words in the sentences.
B. The subject generated and the editorially produced passages reduced by 10% will tend to have the same words deleted.

III. Phase III

A. The subject generated and the editorially produced passages reduced by 10% will not be significantly different from each other nor from the traditional version on any of the following dependent variables: total comprehension, comprehension as measured by the multiple choice test, comprehension as measured by the completion test, reading rate, reading time, and presentation efficiency.
B. Subjects reading the 50 and 67% deleted passages produced by the SHORT method will score significantly lower than those reading the traditional passage on all three measures of comprehension.
C. Subjects reading the 50 and 67% reduced passages generated by the editorial method will not differ significantly from those reading the traditional on the comprehension measures, but their reading rates will be significantly faster, their reading times will be significantly shorter, and their presentation efficiency will be significantly higher.
D. The passages generated by the editorial method will be superior to those generated by the SHORT method on the comprehension variables at all levels except the 10% deletion level.
E. Long term retention of those subjects reading the traditional and 10% reduced versions

generated by either the SHORT or editorial methods will not differ significantly from each other.

F. Subjects reading the 50 and 67% deleted versions produced by the SHORT method will retain significantly less material than those subjects reading the 50 and 67% reduced versions produced by the editorial method.

Method

Subjects

The subjects for Phases II and III were enrolled in liberal arts courses at Texas A&M University. In Phase II, 225 subjects were asked to rank order the words in each set of sentences. From 10 to 16 subjects were randomly assigned to one of the 20 sets of sentences. In Phase III, 212 subjects read the telegraphic passages produced by the two methods and responded to the comprehension tests. Subjects were randomly assigned with the restriction that 23 or 24 subjects were included in each treatment condition. A test only or chance condition was given to 56 subjects to determine the chance comprehension scores on the two tests.

Materials

The materials were developed in three phases. Segments from the stories created by Martin (1972) were utilized in Phase I. Several pages of narrative material were reduced in order to ascertain general trends that were followed in obtaining shortened passages.

Experimental materials in Phase II included two forms, a sentence form and a recording form. The sentences of the traditional (Trad) passage were numbered sequentially according to their position in the body of the story. Twenty sets of sentences were formed with each set containing 8 to 15 sentences. Within each sentence, every word was numbered consecutively.

The recording form was composed of rows of 40 boxes printed lengthwise across 8-1/2 x 11 inch paper. The boxes in each row were numbered from 1 to 40.

The materials in the third phase of the experiment consisted of the traditional plus eight telegraphic versions of "Buena-I and Ralo" (Martin and Hope, 1972), an electronic timing device, a time recording form, a multiple choice test, a completion test, an IBM answer sheet, and a questionnaire designed to elicit the subjects' reactions to telegraphic prose. Four of the telegraphic versions were generated by the SHORT method at the 10, 30, 50, and 67% levels of reduction. The remaining four telegraphic versions were produced by the editorial method at the 10, 30, 50, and 67% deletion levels. The telegraphic versions of "Buena-I and Ralo" are presented in the Appendix, Volume II.

The timing device was an electronic digital display which registered the amount of time that had passed since the beginning of the task. The timer was set so that the numerals changed in ten second intervals. Subjects recorded the elapsed time when they finished reading the passage. A time recording form provided a place for the subject's name, the course number and section, and the elapsed time.

The multiple choice test consisted of the 28 most reliable multiple choice questions from Martin's (1972) study. Reliability of the questions was determined by item analysis. The completion test consisted of 22 items developed specifically for this experiment. Subjects recorded their answers to the multiple choice test on an IBM answer sheet and the completion items were answered on the test sheet. The 28-item multiple choice test and completion test are presented in the Appendix, Volume II.

The subjects also completed a two-page questionnaire (Appendix E). This form contained one paragraph explaining telegraphic prose, an example of telegraphic prose, and eight questions regarding subjects' opinions about the feasibility of telegraphic prose.

Procedure

Rules for producing telegraphic prose were developed in the initial phase of this study by reworking numerous sentences and paragraphs. Fifty sentences were reduced by 10, 30, and 50%, and the operations involved were recorded. The resultant sentences were then examined to determine their clarity. The operations were subjectively analyzed to ascertain general trends that were followed in attaining the abridged sentences.

Excess verbage in ten paragraphs was reduced to a minimum by the same general procedures. These procedures were noted and formed the basis for defining the operations to be used by a deletion editor in generating telegraphic prose.

Two methods were used to produce telegraphic materials in the second phase of the study. The first method, developed by Martin and Pantalion (1973), is the SHORT method which is the subjective ordering of words according to their importance in communicating the intended meaning of a sentence. Subjects were instructed to rank order each word in a given set of sentences according to its importance in conveying the essential meaning of the sentence. The subjects were to read the sentence, determine the least important word in the sentence, and place its number in the first box of the row on the recording form that had the same number as the sentence. Then they were to reread the sentence, determine the next least important word, and place its number in box two. They were to repeat this process until each word had been ordered. A rank of one indicated subject's perception of the least important word and a rank corresponding to the number of the total number of words in the sentence denoted the word perceived to be most important.

A total of 225 subjects rank ordered the words in the traditional passage. A mean rank order for each word was computed, and an index of agreement for each sentence was calculated. The data obtained were used to produce four telegraphic passages based on the SHORT method.

The passages were generated by an IBM 360/65 computer in WATFIV Fortran language. The computer printed each sentence in the story at the four specified levels of deletion. The original sentence and paragraph structure remained the same for all telegraphic versions.

Generation of the telegraphic passages by the SHORT method required an additional step since the specific words to be excluded were determined by the mean rank order of each word. If a tie existed between the mean ranks of two words, the word having the lower number on the sentence form was deleted.

The second method for producing telegraphic prose was the editorial method which followed the guidelines of Phase I. The 10, 30, and 50% editorially reduced versions of the passages were constructed by removing a specified number of words per sentence. A 67% passage was based upon a paragraph reduction procedure.

A total of 268 subjects read the telegraphic passages in Phase III of the experiment. Test packages containing the following materials were randomly assigned to 212 subjects: one version of the story, a time recording form, a multiple choice test, a completion test, an IBM answer sheet, and a questionnaire. The subjects were instructed to read the passage once at their own pace. When each subject finished the passage, the elapsed reading time was recorded, and then the subject responded to the questions without looking back through the story. The remaining 56 subjects did not read the story, but they answered the test questions to determine the chance performance level for the tests. Delayed retention was measured one week after the initial testing by having all subjects again answer the multiple choice and completion items.

Design and Analysis

The operations for producing telegraphic sentences in Phase I were subjectively analyzed to determine general trends that were followed in reducing those sentences. These trends formed the basis for specifying the reduction rules for the editorial method.

The data obtained from the rank ordering of the words in each sentence in the second phase of this experiment were analyzed to determine the degree of agreement among subjects concerning the relative importance of the words in each sentence. The Kendall Coefficient of Concordance ($\underline{W}$) (Ostle, 1963) was computed for each sentence. A Chi-square value for each coefficient of correlation indicated the significance of the index of agreement on the rank ordering of the words.

A comparison was made between the grammatical categories eliminated by each method in producing the telegraphic passages. Each word was classified into one of eight grammatical classes: (1) articles, (2) conjunctions, (3) prepositions, (4) adjectives, (5) adverbs, (6) pronouns, (7) nouns, and (8) verbs. The percentage of deleted words in each group was obtained for both methods and a comparison of grammatical categories removed was made on that basis.

The dependent variables analyzed in Phase III were: comprehension, reading rate, reading time, presentation efficiency, and long term retention. Three different measures of comprehension were employed: a multiple choice test, a completion test, and total comprehension (C) which was the sum of the scores on the multiple choice and completion items. The presentation efficiency of the passage was calculated by multiplying the total comprehension score by 100 and dividing the reading time (R_t); thus, $E_t = \frac{C \times 100}{R_t}$. The independent variables were Deletion Level and Method of Reduction.

A 1 x 9 ANOVA design was used to determine if any differences existed among the treatment conditions on each dependent variable. A 2 x 4 ANOVA design was employed to test for any possible interaction effects. The Scheffé analysis was used in conjunction with the 1 x 9 and the 2 x 4 ANOVAs to determine the exact location of significant differences. A 1 x 10 ANOVA design was used on the comprehension variables in order to assess whether test scores were above chance level. A 2 x 2 x 4 ANOVA design was performed in order to assess immediate and delayed retention as a function of Method of Reduction, Deletion Level, and any possible interaction effects.

Delayed retention scores were correlated with the two comprehension measures, reading time, reading rate, and presentation efficiency. The questionnaire was analyzed in terms of percentages of subjects selecting each alternative. A total percentage of responses to each option was calculated for each question. Within these calculated percentages, a further breakdown was made to indicate the percentage of subjects in each treatment condition choosing that alternative. Finally, Chi-square values were calculated for each question in order to determine whether the subjects' responses were independent of the version of the story which they read.

Results and Discussion

This section is organized according to the three phases of this experiment. Phase I results involve the rules that were established for producing telegraphic prose by the editorial method. It is realized that the Phase I results are not quantitative in nature. However, the purpose of this section is to specify as objectively as possible the system of rules derived for the editorial deletion technique. Phase II results consist of the data obtained in the generation of the telegraphic passages. Phase III results consist of the comprehension measures resulting from the various telegraphic treatment conditions.

Phase I

One aspect of this investigation was the formulation of a system of rules that can be used to derive telegraphic prose from traditional narrative passages. Guidelines for reducing passages at both the sentence and conceptual levels were attempted in this phase of the study. These guidelines are presented in outline form in Table 9.1.

When sentences composed the unit being shortened, a 10% reduction of the passage could generally be produced by deleting the articles, "a, an, the." Of the 188 sentences in the Trad passage, approximately 70% of them could be reduced 10% by removing the articles. However, 22 of the sentences in the passage contained no articles. Where no articles were present or composed less than 10% of the sentence, the rules for producing the next level of deletion were applied.

This system for generating telegraphic prose was cumulative. A 30% reduction of the Trad passage included: (1) the exclusion of all articles; (2) the deletion of single words; and (3) the transformation of phrases and clauses. Three categories of individual words were eliminated at the 30% level of deletion. The first class was nonessential adjectives and adverbs. "Nonessential" indicated that they were not quantitative, that is, they did not express relationship and were not emphatic nor intense. For example, "desperately" is intense; therefore, it would be retained. Defining a word

TABLE 9.1

Guidelines for the Editorial Deletion Technique

I. 10% Deletion

A. Delete articles--"a, an, the"
B. If articles make up less than 10% of sentence, delete according to rules for 30% deletion

II. 30% Deletion

A. Cumulative scheme so these rules are used in addition to those for lesser deletions
B. Transformation of phrases and clauses
   1. Prepositional phrases transformed to adjective + noun--"problems of leadership" to "leadership problems"
   2. Prepositional phrases transformed to possessives--"need for rich ore deposits on Buena-I" to "need for Buena-I's rich ore deposits"
   3. Infinitive phrases transformed to gerunds--"answer to problem of how to populate and work productively" to "answer to problem of populating and working productively"
   4. Subordinate clauses reduced to adverbs, adjectives, possessives, or nouns dependent upon their function in the sentence--"to main the precarious economic balance between the two supernations that co-existed on Tierra" to "to main the precarious economic balance between Tierra's two supernations"
C. Deletion of single words
   1. Nonessential adjectives and adverbs--"many years earlier" to "years earlier"
   2. Auxiliary verbs--"three decades had passed uneventfully" to "three decades passed uneventfully"
   3. Conjunctions--"springs and rivers" to "springs, rivers"
D. If usage of these rules results in reduction less than 30%, delete according to rules for 50% reduction

III. 50% Deletion

A. Cumulative scheme so these rules are used in addition to those for lesser deletions
B. Restructure sentence
   1. Subordinate clauses reduced as per 30% scheme except more drastically and transformed into independent clauses; this involves a change in their position in the sentence
      a. "They left all problems of leadership and government to Chan, to whom they were completely devoted and loyal." to "Left Chan leadership, government problems; devoted, loyal to him."

TABLE 9.1 (contd)

b. "If Bonese were willing to 'give' them the copper in exchange for the abundant water of Ralo, then let them do all the work." to "Bonese willing to exchange copper for water; let them do all work."

2. Use of single word synonyms for word phrases, clauses, etc.:
    a. "Decision point had been reached" to "Decision point arrived"
    b. "while they waited for" to "while awaiting"
3. Use of punctuation such as colons and dashes to replace deleted words and thus transmit meaning
    a. Punctuation will most often replace verbs
    b. "Multiple births were the problem." to "Problem: multiple births."

C. Deletion of single words
1. Nouns (nonessential)--"seemed the best choice" to "seemed best"
2. Pronouns (when referrent is obvious)--"they named it Ralo" to "named it Ralo"
3. Verbs (usually replaced by punctuation)--"Life was easy for the Raloans" to "Raloans' life easy"
4. Subject (when referrent is obvious)--"They named their new homeland Ralo." to "Named it Ralo."

IV. 67% Deletion

A. Reduces to deletion by paragraphs
B. Assume editor can find topic sentence
C. Transform each sentence into subject + verb + object
D. Delete those parts where the information is given in the topic sentence
E. For those parts retained (topic sentence is retained), examine subordinate clauses, phrases, etc. modifying them
    1. Delete all nonessential phrases
    2. Essential indicates that the phrase is quantitative, relational, emphatic, or gives a reason
F. Transform remaining phrases and clauses according to rules given in II.B and III.B of this table

as nonessential was subjective and varied on the number of words per sentence. If only one more word needed to be removed from the sentence, and all other nonessential words had been deleted, "desperately" might be omitted. Auxiliary verbs such as forms of "to be" and "to have" composed the second group of single words eliminated. Finally, conjunctions, especially "and," were removed.

Phrases and clauses were shortened by transforming them in one of four ways. Many prepositional phrases which modified nouns were changed to an adjective which modified the noun. This rule was particularly applicable to phrases in which "of" was the preposition. For example, "problems of leadership" was rearranged to read "leadership problems." Other prepositional phrases were transformed to possessives, e.g., "need for rich ore deposits on Buena-I" became "need for Buena-I's rich ore deposits." The third method of reducing phrases was to transform infinitive phrases into gerunds. Thus, the phrase "how to populate and work productively" was reduced to "populating and working productively." Finally, subordinate clauses were reduced to adverbs, adjectives, possessives, or nouns, depending on their function in the sentence. For example, "economic balance between the two supernations that co-existed on Tierra" was transfored to "economic balance between Tierra's two supernations." Transforming prepositional phrases usually resulted in eliminating only one word at this level. In combination with deleting single words, these transformation rules resulted in a greater than 30% reduction. Furthermore, this scheme appeared to produce a more readable passage. If these guidelines failed to produce the desired level of reduction, the instructions for arriving at a 50% reduced passage were followed.

The 50% telegraphic materials employed the rules for lesser deletion levels, removed other individual words, and restructured the sentence. All nonessential nouns were eliminated. Furthermore, pronouns and subjects were eliminated when their referrents were obvious from the context. For example, "they named it Ralo" was altered to read "named it Ralo." Verbs, especially forms of "to be," were deleted. Usually the verb was replaced by a punctuation mark. Punctuation was used liberally to replace excluded words when it aided the transmission of meaning.

When the sentence was restructured, subordinate clauses were altered more drastically than for the 30% reduction although the reduction still depended upon the function of the clause in the sentence. Dependent clauses transformed into independent clauses often required a position change in the sentence. Wherever possible, single word synonyms replaced phrases and clauses.

Generating telegraphic materials on the basis of key concepts in the Trad passage was accomplished by examining each paragraph. It was assumed that the editor was able to recognize the topic sentence in each paragraph. Once the topic sentence was located, all other sentences in the paragraph were written in their simplest form as subject, verb, and object. Those parts of each basic sentence that repeated information given in the topic sentence were deleted. For those parts that remained, the subordinate clauses, phrases, and words that modified them were examined. All nonessential phrases were eliminated. Based on the sentence deletion rules, essential phrases were quantitative, related, or emphatic. In reduction by concepts, however, a phrase was considered essential if it expressed a reason. That is, statements preceded by such words as "because" and "since" were retained. The remaining phrases and clauses were transformed according to the guidelines established to obtain 30 and 50% deletion levels.

It should be noted that when concepts formed the basis for reduction, auxiliary verbs, prepositions, prepositional phrases, infinitives, conjunctions, pronouns, and even articles were frequently retained. The passages produced by this deletion scheme more closely resembled the style of traditionally written prose. The criterion for including such words was based on their importance in conveying the essential meaning of the paragraph. They were often needed to increase the readability of the passage due to the rather drastic level of reduction. The passage generated by using these operations resulted in a 67% reduction of the Trad passage.

It must be admitted that these rules are somewhat subjective. Use of these rules depended not only on the level of deletion desired but also on the readability of the resultant passage. Thus, these rules provide a general guideline for reduction rather than a straightforward reduction formula which is ideally desired.

Phase II

The actual generation of the telegraphic materials was accomplished in Phase II. Two methods were used to produce the reduced versions, the SHORT method and the editorial method. The data from the SHORT method indicated significant agreement among the subjects on the rank orders assigned the words in each sentence. The Kendall Coefficient of Concordance (W) was used to determine the degree of agreement on the ranking. Of the 188 sentences ranked, 187 were significant beyond the .01 level.

A comparison of words removed from Trad by each method at the 10% level is possible since the sentences were not restructured. Such a comparison was not possible at higher deletion levels because the editorial method relied heavily on rearranging word order in sentences. This is in contrast to the SHORT method whereby individual words were removed without reordering the sentence.

Each of the words removed from the Trad at the 10% deletion level was classified into one of eight grammatical categories: (1) nouns, (2) verbs, (3) adjectives, (4) adverbs, (5) conjunctions, (6) prepositions, (7) pronouns, and (8) articles. The percentage of words in each category was determined and a comparison was made on that basis. The editorial method removed the following: 84.5% articles; 3.63% pronouns; 3.39% prepositions; 3.15% conjunctions; 1.94% adverbs; 1.45% adjectives; 1.45% verbs; and .48% nouns.

The SHORT method removed the following: 69.08% articles; 3.14% pronouns; 9.42% prepositions; 6.52% conjunctions; 4.83% adverbs; 4.59% adjectives; 1.69% verbs; and .72% nouns.

At the 10% level of deletion both versions are quite similar. As the level of reduction increases, however, the differences in the passages generated by the two methods also increase.

It should be noted that the SHORT 50% passage contained 52 fewer words than the editorial 50% passage due to an error in calculations made by the experimenter. Which words were omitted from the SHORT version while being retained in the editorial version was determined, and they were then classified into grammatical categories. In addition, the frequency of these words was determined. Only 5 of the words were nouns, 11 were verbs, 6 were pronouns, 8 were adjectives, 8 were adverbs, 4 were conjunctions, and 10 were prepositions. The nouns, pronouns, adjectives, and adverbs were low frequency words. The verbs, conjunctions, and prepositions occurred in the passage with high frequency. Experiment III indicated that low frequency words, nouns and verbs, were most important for comprehension. Thus, most of the words eliminated were not essential for comprehension. In order to further determine whether the omission of these 52 words was detrimental to the SHORT 50% condition, the comprehension measures were examined. All of the items on both tests could be answered from the SHORT 50% passage just as it was generated by the computer.

Phase III

A 2 x 4 ANOVA of the multiple choice test was performed on the number of correct responses. The means and standard deviations for correct multiple choice items are presented in Table 9.2. Although the Method of Reduction main effect was not significant, there were significant differences ($F(3,180) = 10.02$, $p<.0001$) for the Deletion Level main effect. The Scheffé analysis of post hoc comparisons indicated that subjects assigned the 10% deletions scored significantly higher than subjects reading the 50 and 67% deletions. Scores for the 30% versions were also significantly higher than those for the 67% deleted passages. In addition, there was an interaction effect ($F(3,180) = 3.12$, $p<.03$) for the multiple choice dependent variable. The Scheffé analysis revealed that

TABLE 9.2

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

Method of Reduction	Deletion Level			
	10%	30%	50%	67%
SHORT				
Mean	22.92	18.79	17.54	14.52
S.D.	4.01	4.87	3.79	3.85
Editorial				
Mean	20.57	20.65	18.17	18.30
S.D.	6.06	5.42	6.07	4.79

Traditional Mean = 23.13 S.D. = 5.24

subjects assigned the SHORT 10% and the editorial 10 and 30% passages obtained significantly higher scores than those reading the SHORT 67% version. Figure 9.1 presents the interaction effects of Deletion Level and Method of Reduction on the multiple choice test.

A 2 x 4 ANOVA was also performed for the completion test. The means and standard deviations for correct completion items are presented in Table 9.3. The Method of Reduction main effect was not significant, although it did approach significance ($F(3,180) = 3.71$, $p<.0526$). There were significant differences ($F(3,180) = 7.83$, $p<.0002$) for the Deletion Level main effect. The subjects reading the 10% versions scored significantly higher than those reading the 50 and 67% reductions. An interaction effect ($F(3,180) = 4.53$, $p<.005$) was also present and is shown in Figure 9.2. Those subjects assigned the SHORT 10% passages and the editorial 10 and 30% passages scored significantly higher on the completion test than subjects reading the SHORT 67% version. Scores from the SHORT 10% passage were also significantly higher than those from the SHORT 50% passage.

Total comprehension, which is the sum of correct responses on the two tests, was also analyzed using a 2 x 4 ANOVA design. Table 9.4 presents the means and standard deviations for the total number of correct items. Similar to the results for the other comprehension measures, the Method of Reduction main effect was not significant. There were significant differences ($F(3,180) = 10.34$, $p<.0001$) for the Deletion Level main effect. Total comprehension scores from the 10% versions were significantly higher than scores from the 50 and 67% passages. In addition, the scores from the 30% passages were higher than those from the 67% reductions. The interaction effect ($F(3,180) = 4.22$, $p<.0068$) was also significant. The Scheffé test revealed that total comprehension scores in the SHORT 10% condition were higher than those in the SHORT 50 or 67% conditions; editorial 10 and 30% scores were also higher than those in the SHORT 67% condition. Figure 9.3 shows the interaction between Deletion Level and Method of Reduction on total comprehension scores.

The 2 x 4 ANOVA for reading time indicated that Method of Reduction was not significant but Deletion Level was significant ($F(3,180) = 23.83$, $p<.0001$). The subjects assigned the 67% reduced passages had reading times which were significantly shorter than subjects assigned the 10, 30, and 50% passages. In addition, the reading times for the 50% reduced stories were significantly shorter than for the 10 and 30% passages. No significant interaction effects were present. Table 9.5 presents the means and standard deviations for the reading times.

Reading rates were also analyzed using a 2 x 4 ANOVA design. Table 9.6 presents the means and standard deviations for this dependent variable. Method of Reduction was not

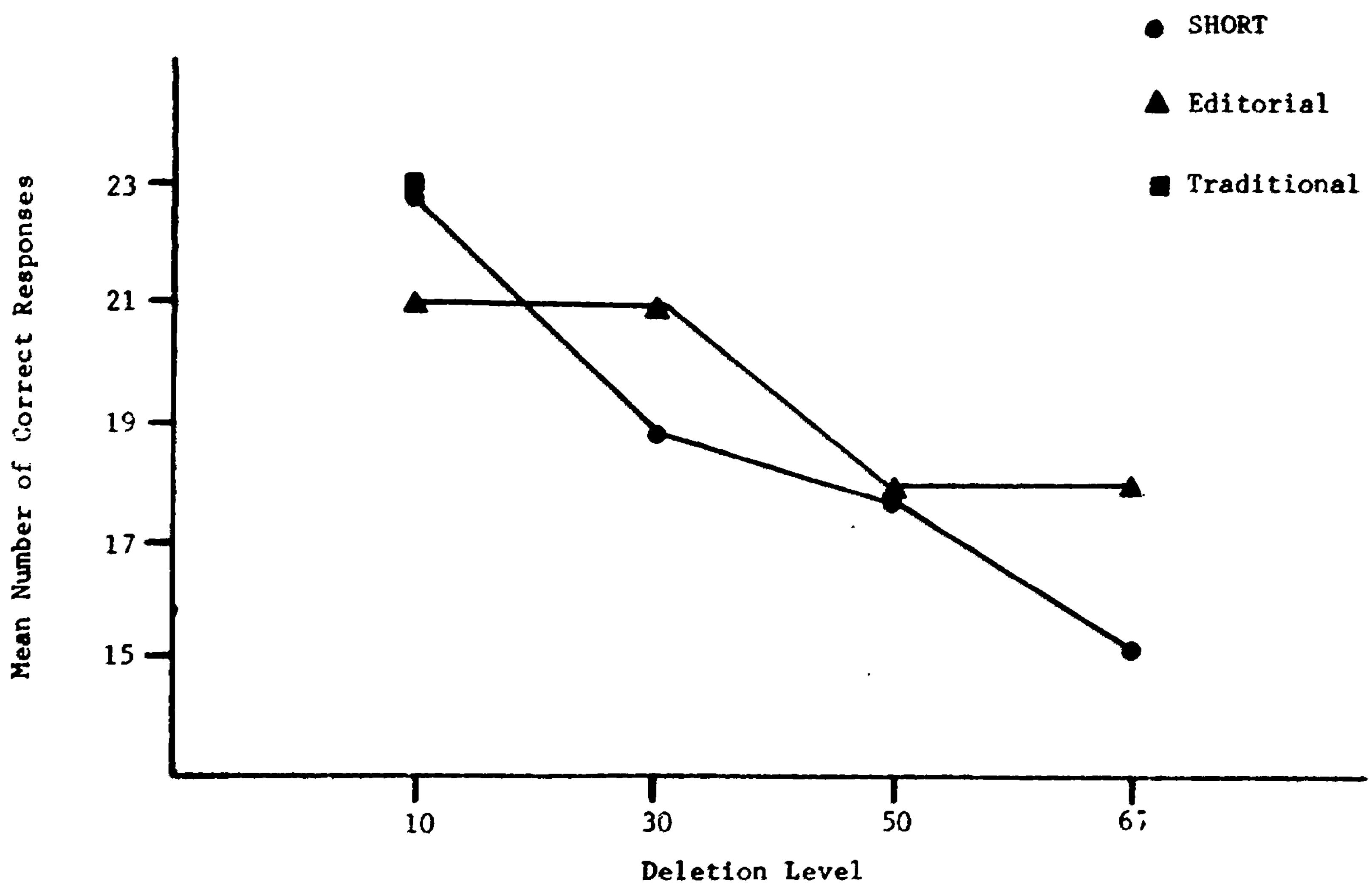

Figure 9.1. Interaction of Deletion Level and Method of Reduction on the multiple choice test.

TABLE 9.3

Means and Standard Deviations for Number of Correct Responses on the Completion Test for the Nine Treatment Conditions

Method of Reduction	Deletion Level 10%	30%	50%	67%
SHORT				
Mean	12.17	8.79	7.41	5.39
S.D.	3.28	3.35	3.94	3.22
Editorial				
Mean	10.13	10.00	8.88	9.43
S.D.	4.12	5.06	4.02	4.37
Traditional	Mean = 12.54		S.D. = 5.45	

TABLE 9.4

Means and Standard Deviations for Total Comprehension Scores for the Nine Treatment Conditions

Method of Reduction	Deletion Level 10%	30%	50%	67%
SHORT				
Mean	35.08	27.58	24.96	19.91
S.D.	6.79	7.69	7.30	6.28
Editorial				
Mean	30.70	30.65	27.04	27.74
S.D.	9.32	9.96	9.74	8.46
Traditional	Mean = 35.67		S.D. = 10.48	

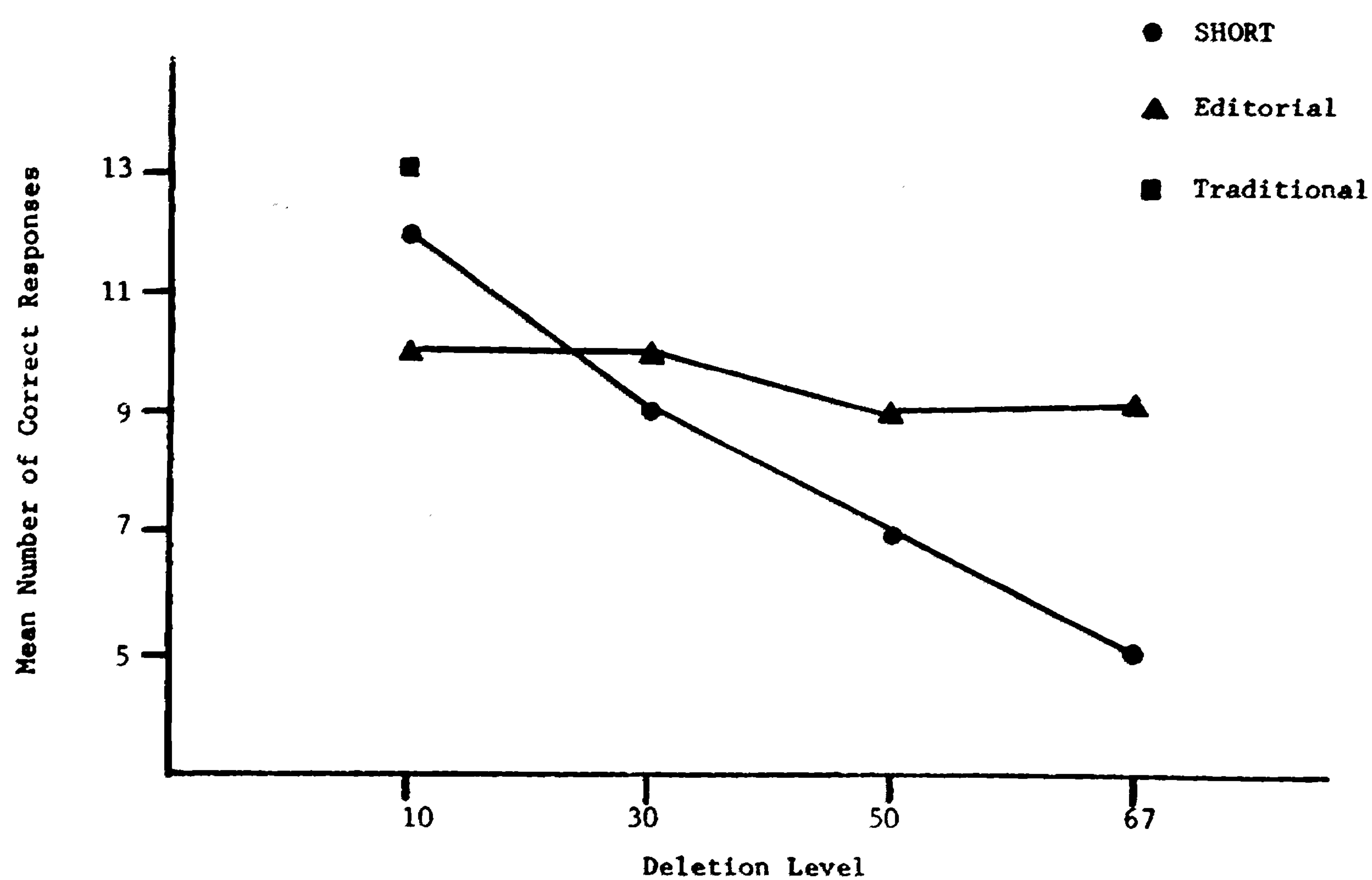

Figure 9.2. Interaction of Deletion Level and Method of Reduction on the completion test.

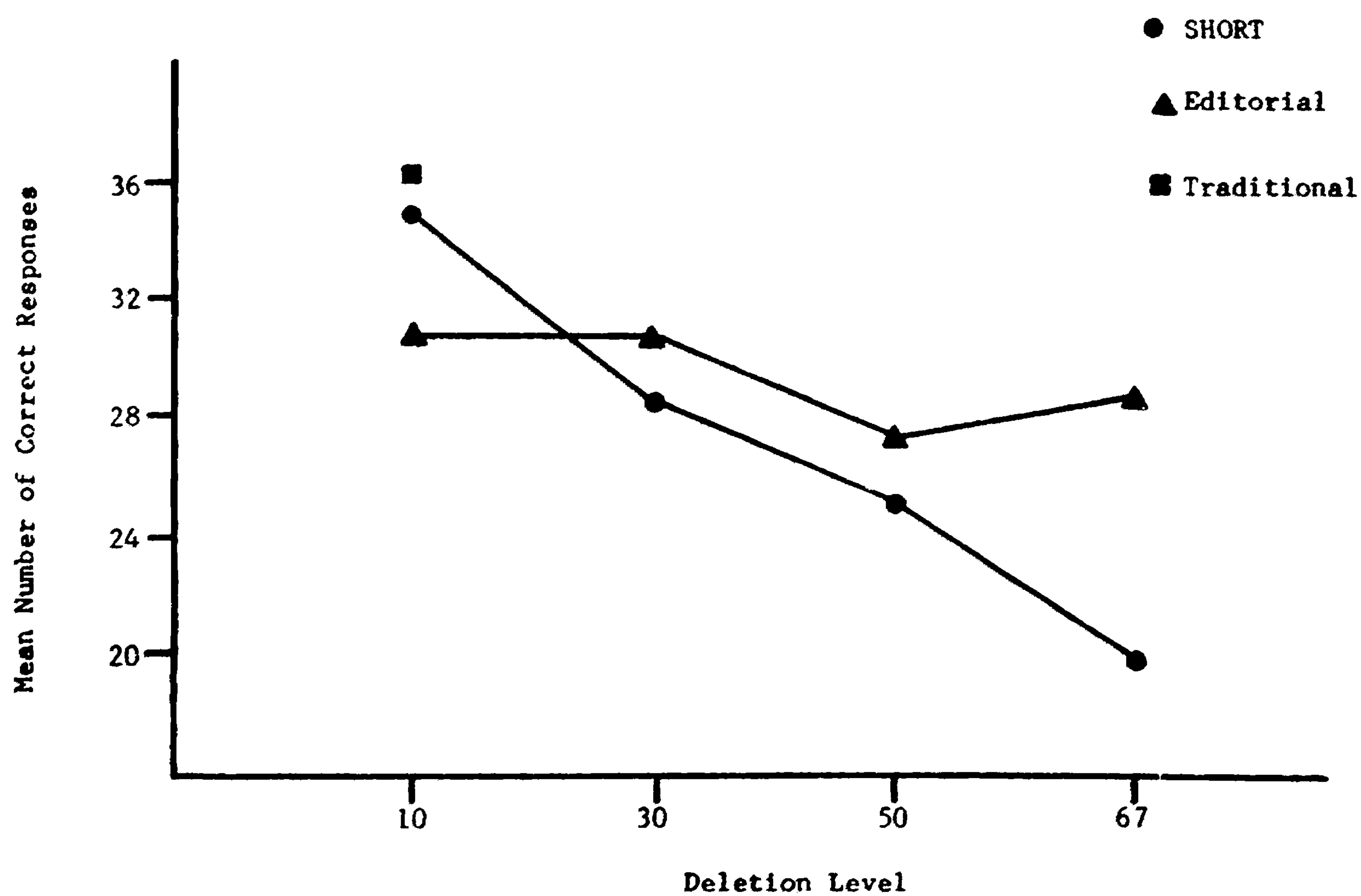

Figure 9.3. Interaction of Deletion Level and Method of Reduction on the total comprehension score.

TABLE 9.5

Means and Standard Deviations for Reading Time for the Nine Treatment Conditions

Method of Reduction	Deletion Level 10%	30%	50%	67%
SHORT				
Mean	16.20	16.42	13.74	11.75
S.D.	4.29	3.85	4.04	3.73
Editorial				
Mean	16.52	15.98	14.10	9.25
S.D.	3.61	3.85	3.66	2.83
Traditional	Mean = 15.97		S.D. = 4.36	

TABLE 9.6

Means and Standard Deviations for Reading Rates for the Nine Treatment Conditions

Method of Reduction	Deletion Level 10%	30%	50%	67%
SHORT				
Mean	235.81	177.60	154.97	136.06
S.D.	71.02	44.24	58.71	106.51
Editorial				
Mean	223.74	182.07	149.81	153.39
S.D.	46.94	41.54	39.69	43.75
Traditional	Mean = 264.53		S.D. = 67.62	

significant, but there was significance ($\underline{F}(3,180) = 19.14$, $\underline{p}<.0001$) for the Deletion Level main effect. The reading rates for the 10% reduced passages were significantly faster than for the 30, 50, and 67% passages. The rates for the 30% condition were also significantly faster than for the 67% condition.

A 2 x 4 ANOVA was performed on the efficiency scores ($E_t = \frac{C \times 100}{R_t}$). Table 9.7 presents the mean presentation efficiency scores and standard deviations for each treatment condition. Method of Reduction was again not significant although it did approach significance ($\underline{F}(1,180) = 3.51$, $\underline{p}<.0594$). The Deletion Level main effect was significant ($\underline{F}(3,180) = 4.57$, $\underline{p}<.005$). The passages reduced by 67% were significantly more efficient than the 30 and 50% reductions. A significant interaction effect ($\underline{F}(3,180) = 5.03$, $\underline{p}<.003$) was also present. Figure 9.4 presents the interaction of Deletion Level and Method of Reduction on the efficiency scores. The editorial 67% passage efficiency scores were significantly higher than the efficiency scores for the SHORT 30, 50, and 67% passages and the editorial 10, 30, and 50% passages.

The three measures of retention were analyzed using a 2 x 4 ANOVA design. Table 9.8 presents the mean scores and standard deviations for retention as measured by the multiple choice test. There were no significant differences for the Method of Reduction main effect, but Deletion Level was significant ($\underline{F}(3,169) = 6.18$, $\underline{p}<.0008$). Those subjects assigned the 10% passages scored significantly higher on the retention multiple choice items than those reading the 67% versions. The interaction effect as presented in Figure 9.5 was also significant ($\underline{F}(3,169) = 3.88$, $\underline{p}<.01$). The scores from the SHORT 10% passage were significantly higher than those from the SHORT 50 and 67% passages.

A 2 x 4 ANOVA was used to analyze the retention data from the completion test. Table 9.9 presents the means and standard deviations for the completion scores for each condition. Method of Reduction was not significant, but there were significant differences ($\underline{F}(3,169) = 3.37$, $\underline{p}<.02$) for the Deletion Level main effect. The subjects reading the 10% reductions scored significantly higher on completion items than those reading the 67% versions. An interaction effect ($\underline{F}(3,169) = 3.70$, $\underline{p}<.01$) was also present (Figure 9.6). The completion scores for the SHORT 10% passage were significantly higher than those for the SHORT 67% passage.

The total comprehension scores for retention were analyzed using a 2 x 4 ANOVA. Table 9.10 presents the mean total comprehension scores and standard deviations for each condition. The Method of Reduction main effect was not significant. A significant difference ($\underline{F}(3,169) = 5.69$, $\underline{p}<.001$) was obtained for the Deletion Level main effect. The total comprehension

TABLE 9.7

Means and Standard Deviations for the Efficiency Scores for the Nine Treatment Conditions

Method of Reduction	Deletion Level 10%	30%	50%	67%
SHORT				
Mean	237.39	175.08	200.60	204.34
S.D.	96.97	56.82	102.40	155.26
Editorial				
Mean	195.06	206.64	204.50	328.95
S.D.	73.68	97.04	86.50	148.49

Traditional Mean = 241.05 S.D. = 100.10

TABLE 9.8

Means and Standard Deviations for Number of Correct Responses on the Delayed Retention Multiple Choice Test for the Nine Treatment Conditions

Method of Reduction	Deletion Level 10%	30%	50%	67%
SHORT				
Mean	22.46	18.75	16.30	13.85
S.D.	4.92	5.15	5.28	3.03
Editorial				
Mean	18.83	19.19	18.67	17.71
S.D.	7.23	6.33	5.63	4.95

Traditional Mean = 22.77 S.D. = 5.54

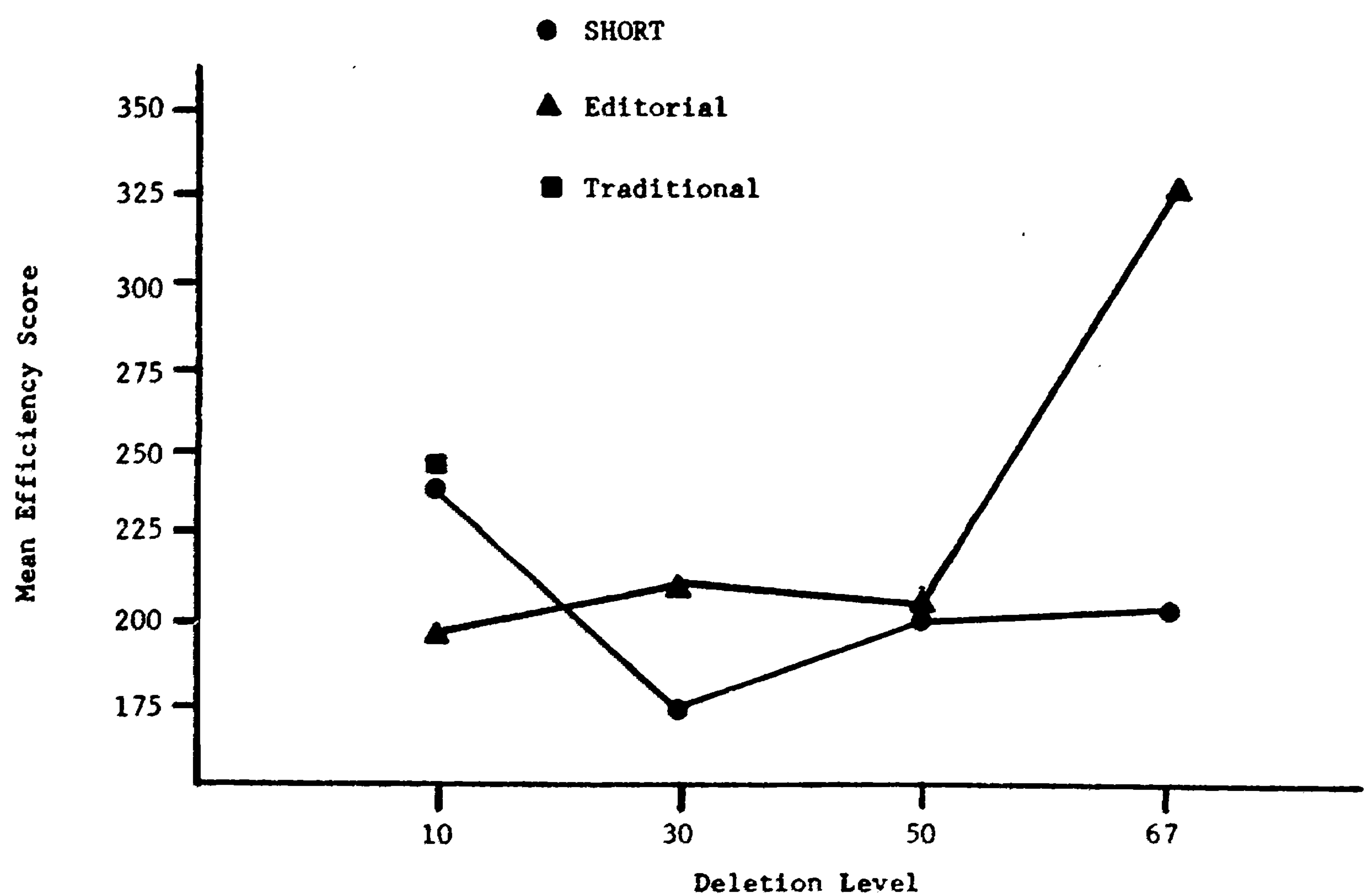

Figure 9.4. Interaction of Deletion Level and Method of Reduction on the efficiency dependent variable.

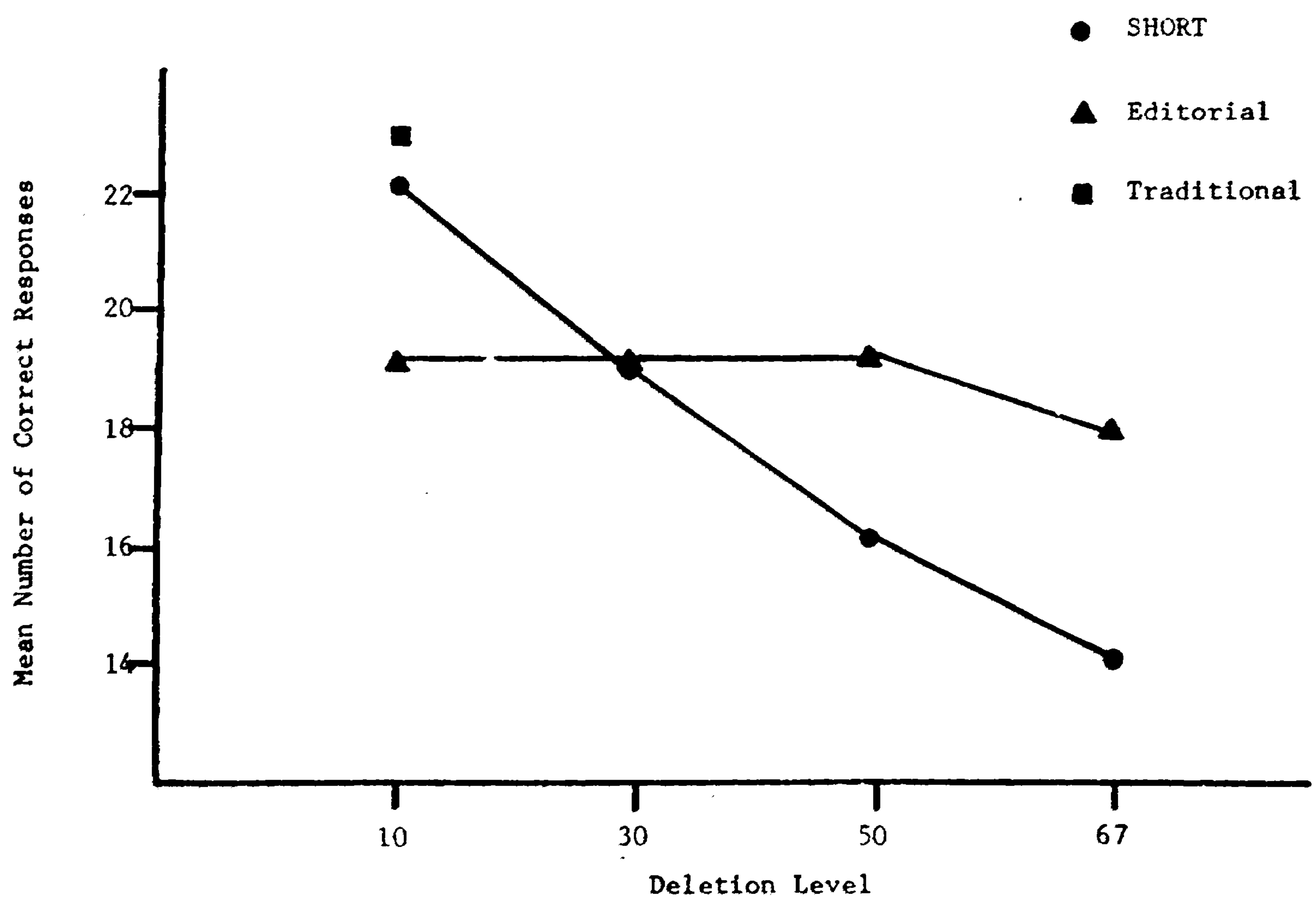

Figure 9.5. Interaction of Deletion Level and Method of Reduction on the retention of the multiple choice items.

TABLE 9.9

Means and Standard Deviations for Number of Correct Responses on the Delayed Retention Completion Test for the Nine Treatment Conditions

Method of Reduction	Deletion Level			
	10%	30%	50%	67%
SHORT				
Mean	11.25	8.67	7.70	5.95
S.D.	3.52	3.73	3.34	3.43
Editorial				
Mean	8.87	9.86	8.95	9.05
S.D.	4.31	4.75	4.25	4.09

Traditional Mean = 12.18 S.D. = 5.29

TABLE 9.10

Means and Standard Deviations for the Delayed Retention Total Comprehension Scores for the Nine Treatment Conditions

Method of Reduction	Deletion Level			
	10%	30%	50%	67%
SHORT				
Mean	33.71	27.42	24.00	19.80
S.D.	7.74	8.18	7.95	5.87
Editorial				
Mean	27.70	29.05	27.62	26.76
S.D.	10.96	10.27	9.28	8.38

Traditional Mean = 34.95 S.D. = 10.39

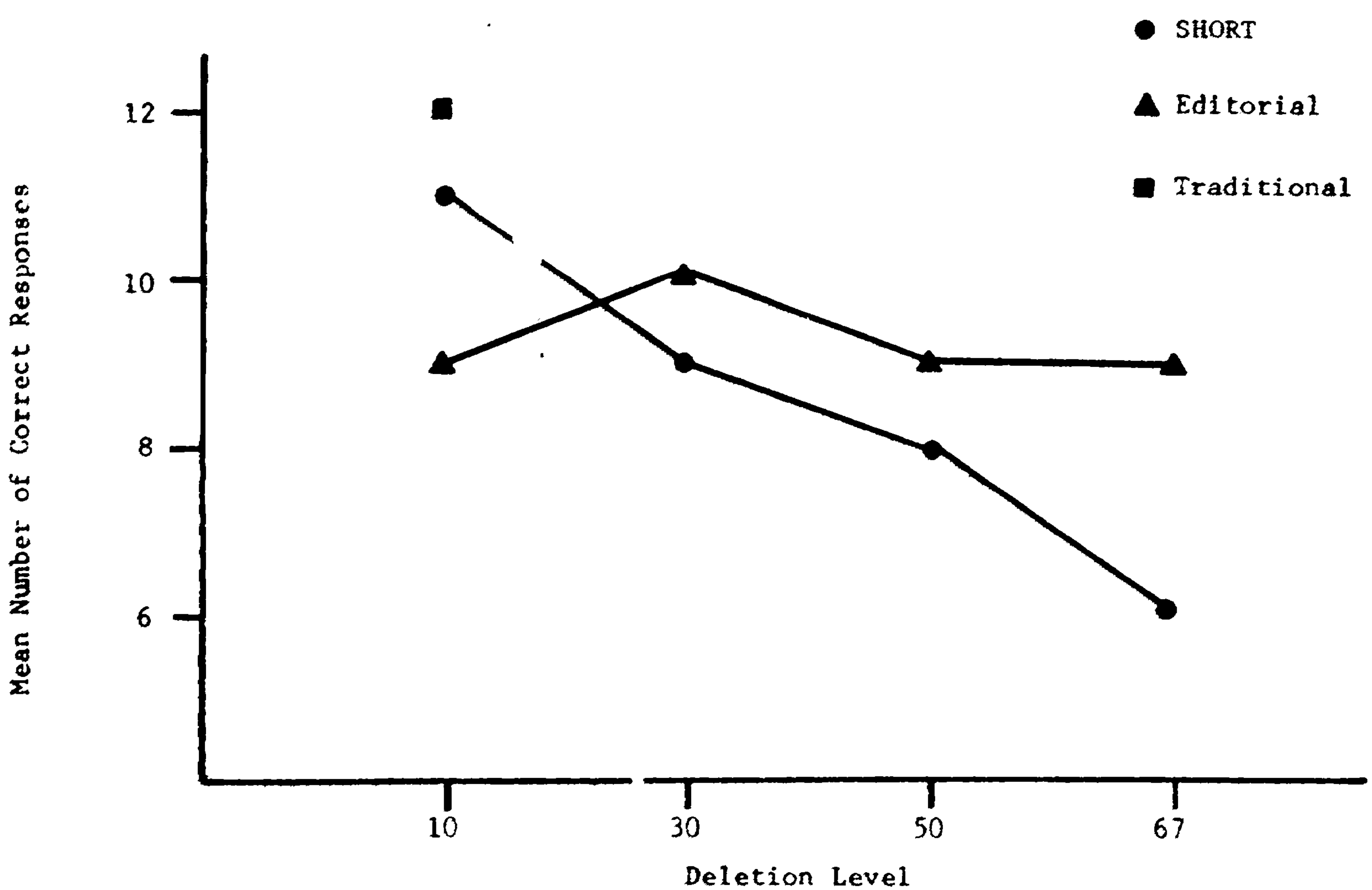

Figure 9.6. Interaction of Deletion Level and Method of Reduction on the retention of the completion items.

scores for retention of the SHORT 10% condition were significantly higher than for the SHORT 67% condition. A significant interaction effect ($F(3,169) = 4.37$, $p<.006$) was also present. Figure 9.7 represents this interaction. Total comprehension scores for retention for subjects reading the SHORT 10% passage were significantly higher than those for subjects assigned the SHORT 67% version.

The data from the 2 x 4 ANOVAs clearly demonstrates that the Method of Reduction main effect was not significant for any of the dependent variables. On the other hand, the Deletion Level main effect was significant for all of the dependent variables. Interaction effects were also present for all of the dependent variables except reading rate and reading time. The scores for all three of the comprehension measures for both the initial testing and delayed retention were significantly higher for the 10% passages than for the 67% passages. The reading rates for the 10% passages were significantly faster than those for all of the other versions. The reading times for the 67% reduced passages, however, were significantly shorter than the times for the 10, 30, and 50% reductions. The times for the 50% versions were also significantly shorter than those for the 10 and 30% passages. The 67% versions were more efficient than the 30 and 50% versions. Thus, concerning comprehension, the 10% reductions seem best. The 67% reduced passages were just as efficient as the 10% reductions, however. This large amount of deletion results in only about 17% less total comprehension than the 10% passage. When the interaction of Deletion Level and Method of Reduction were considered, both 10% passages still resulted in higher comprehension than the SHORT 67% passage. There were no significant differences, however, among the editorial versions themselves. Regarding efficiency, the editorial 67% passage was more efficient than all other passages with the exception of the SHORT 10% passage.

A 1 x 9 ANOVA design was used to compare the Trad with the telegraphic forms. Significant differences were found on all of the dependent variables.

The 1 x 9 ANOVA indicated significant differences ($F(8,203) = 6.89$, $p<.0001$) for the multiple choice test. The Scheffé analysis revealed that scores for the Trad, SHORT 10, and the editorial 10 and 30% passages were significantly higher than those for the SHORT 67% passage.

A 1 x 9 ANOVA was also performed for the completion scores and significant differences ($F(8,203) = 6.47$, $p<.0001$) were obtained. The Scheffé test indicated that completion scores for the Trad and SHORT 10% passages were significantly higher than for the SHORT 67% passage. The Trad scores were also significantly higher than for the SHORT 50% reduction.

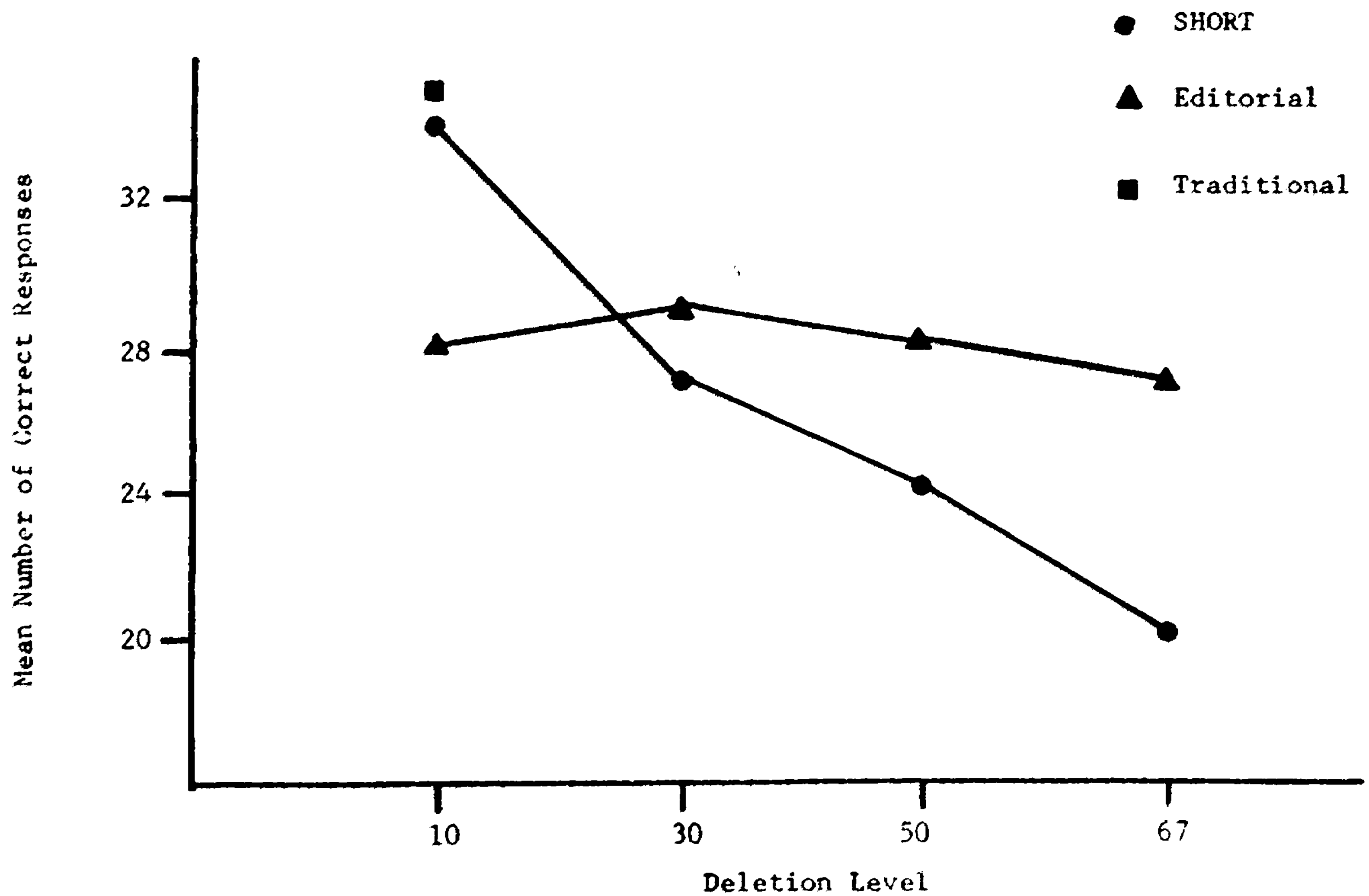

Figure 9.7. Interaction of Deletion Level and Method of Reduction on the total comprehension scores for retention.

Significant differences ($F(8,203) = 7.53$, $p<.0001$) were obtained on the 1 x 9 ANOVA for total comprehension. The Scheffé analysis showed that Trad, SHORT 10, and editorial 10 and 30% total comprehension scores were significantly higher than those for the SHORT 67% passage. In addition, Trad and SHORT 10% scores were significantly higher than those for the SHORT 50% passage.

A 1 x 9 ANOVA was performed on the retention multiple choice scores and significant differences ($F(8,190) = 5.40$, $p<.0001$) were obtained. The Scheffé test showed that scores in the Trad and SHORT 10% conditions were significantly higher than those in the SHORT 67% condition.

Significant differences ($F(8,190) = 4.15$, $p<.0003$) were obtained from the 1 x 9 ANOVA performed on retention completion scores. The Scheffé test revealed that Trad and SHORT 10% scores were significantly higher than SHORT 67% scores.

The 1 x 9 ANOVA for total comprehension scores for retention also indicated significant differences ($F(8,190) = 5.53$, $p<.0001$). The Scheffé post hoc analysis showed that total comprehension scores for the Trad and SHORT 10% passages were significantly higher than for the SHORT 67% reduction. In addition, the subjects reading the Trad story scored significantly higher in total comprehension than subjects assigned the SHORT 50% reduction.

The 1 x 9 ANOVA which was performed for reading times indicated that significant differences ($F(8,203) = 9.75$, $p<.0001$) existed. The Scheffé analysis revealed that reading times for the editorial 67% passage were significantly shorter than reading times for Trad, SHORT 10 and 30, and editorial 10, 30, and 50% passages. Reading times for the SHORT 67% passage were also significantly faster than reading times for editorial 10% and SHORT 30% passages.

The 1 x 9 ANOVA for reading rates indicated that significant differences ($F(8,203) = 12.64$, $p<.0001$) were present. The Scheffé analysis revealed the location of these differences. Reading rates for the Trad were significantly faster than reading rates for SHORT 30, 50, and 67% and editorial 30, 50, and 67% passages. In addition, reading rates for the SHORT 10% passage were significantly faster than reading rates for both the SHORT and editorial 50 and 67% passages. Finally, reading rates for the editorial 10% passage were significantly faster than for the SHORT 67% and editorial 50% passages.

A 1 x 9 ANOVA was performed for the presentation efficiency scores and significant differences ($F(8,203) = 4.21$, $p<.0002$) were obtained. The Scheffé test showed that the editorial 67% passage was significantly more efficient than the SHORT 30, 50, and 67% and the editorial 10 and 50% passages.

The data from the 1 x 9 ANOVAs showed that the 10% reduced passages produced by both methods did not differ significantly from the Trad on any of the dependent variables. This evidence lends support to the feasibility of applying telegraphic prose on a practical basis. It should be noted that the subjects reading editorial reductions did not differ from each other nor from subjects reading the Trad passage on the comprehension measures, regardless of deletion level. In addition, the editorial 67% passage was more efficient than all others except for the SHORT 10%, editorial 50%, and Trad passages. These findings support the idea that techniques for large levels of reductions should employ paragraphs as the unit of reduction instead of sentences.

It is interesting that no differences existed in comprehension between the two methods at each deletion level, while comprehension scores for subjects reading the SHORT 50 and 67% passages were significantly lower than for subjects reading the Trad. At the same time, however, comprehension scores for subjects reading the editorial 50 and 67% passages did not differ significantly from scores for subjects assigned the Trad. The explanation lies in the fact that the scores for the SHORT 50 and 67% passages were only slightly lower than those for the editorial 50 and 67% passages. The scores from the Trad were slightly higher than those for the editorial passages. The differences between the SHORT scores and the editorial scores were not large enough to be significant. Neither were the differences in scores for the Trad and the editorial passages large enough to be significant. The difference between the scores for Trad and for the SHORT passages were large enough to be significant, however. Figure 9.8 is a graphic representation of this explanation.

Three 1 x 10 ANOVAs were performed in order to determine whether scores on the comprehension measures were above chance level. The means and standard deviations for the chance scores on the comprehension tests are presented in Table 9.11. Significant differences($F(9,258) = 26.13$, $p<.0001$) were obtained for the multiple choice scores. The Scheffé analysis revealed that chance scores were significantly lower than scores for all treatment conditions except the SHORT 67% condition. In addition, the SHORT 67% scores were significantly lower than scores for Trad, SHORT 10, and editorial 10 and 30% versions.

The 1 x 10 ANOVA for completion scores also indicated significant differences ($F(9,258) = 20.22$, $p<.0001$). The Scheffé test again showed that chance scores were significantly lower than scores for all conditions except for the SHORT 67% condition. In addition, completion scores for the SHORT 50 and 67% passages were significantly lower than scores for Trad and SHORT 10% passages.

Significant differences ($F(9,258) = 27.45$, $p<.0001$) were also obtained in the 1 x 10 ANOVA performed on total comprehension scores. The Scheffé test showed the location of the

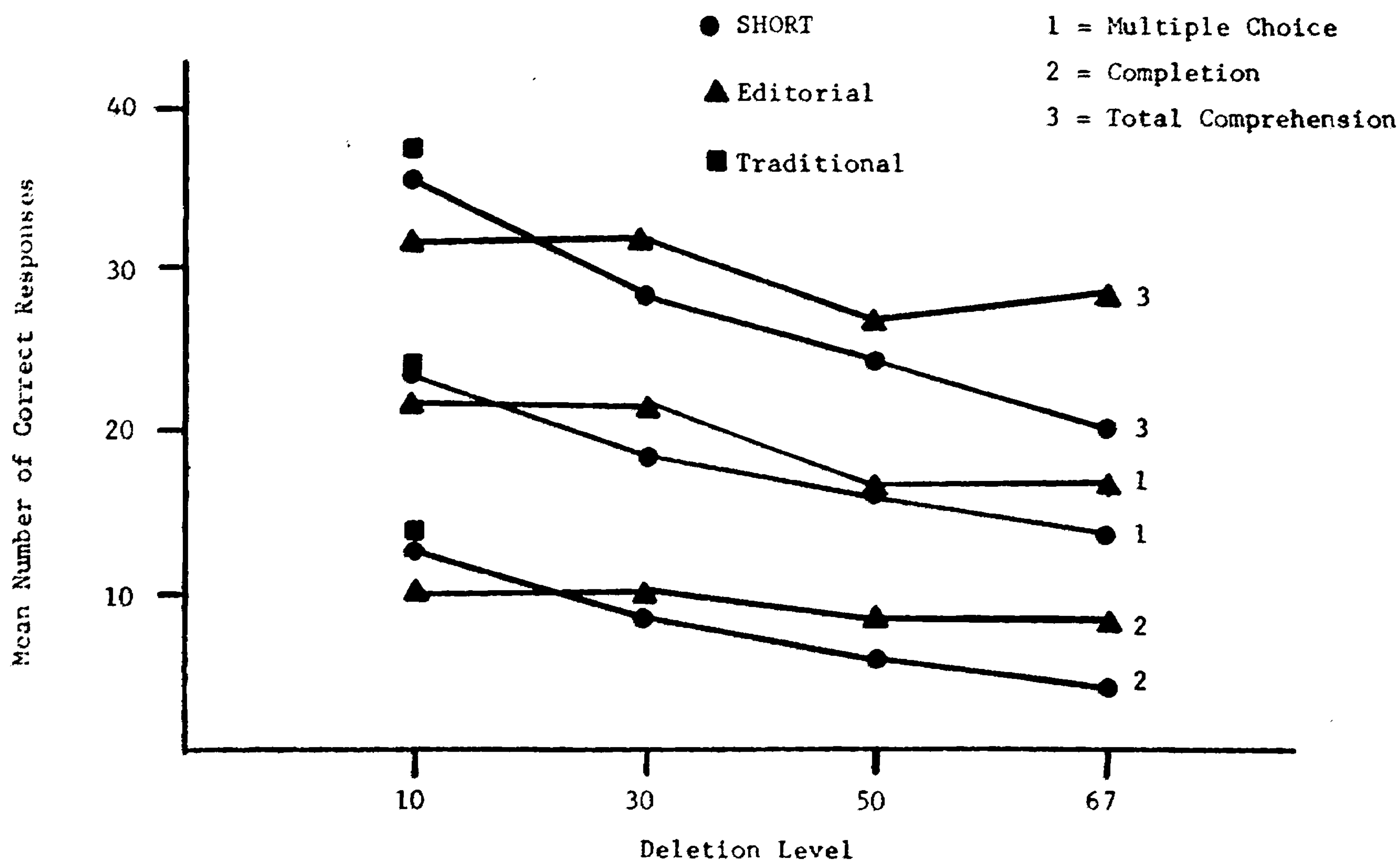

Figure 9.8. Comparison of mean scores for the immediate comprehension measures for all treatment conditions.

TABLE 9.11

Means and Standard Deviations for the Chance Scores on the Three Immediate Comprehension Measures

Chance Scores	Multiple Choice	Completion	Total Comprehension
Mean	9.88	2.96	12.84
S.D.	3.81	2.42	4.81

differences. Similar to the other comprehension measures, chance scores were significantly lower than scores for all passages except the SHORT 67% condition. In addition, SHORT 67% scores were significantly lower than Trad and SHORT 10% scores, and scores for the SHORT 50% condition were significantly lower than those for the Trad, SHORT 10, and editorial 10 and 30% conditions.

The 1 x 10 ANOVAs indicated that all subjects functioned above chance levels except for subjects reading the SHORT 67% passage. Those subjects who read the SHORT 67% passage scored no higher on the comprehension measures than subjects who took the tests without reading the story.

The three delayed retention measures were correlated with the remaining dependent variables in order to determine whether any relationships were present. Table 9.12 lists the correlation coefficients. All three delayed retention comprehension measures were significantly ($p<.0001$) correlated with the immediate comprehension variables. This was expected because the delayed retention items were identical to the immediate comprehension questions. There was not a significant relationship between reading times and the delayed retention total comprehension scores. Reading times, however, were significantly ($p<.05$) correlated with the delayed retention multiple choice scores. All three delayed retention measures at or beyond the .001 level were significant for reading rate and presentation efficiency scores.

Table 9.13 presents the correlations of the immediate comprehension measures with reading times, reading rates, and presentation efficiency scores. All three comprehension measures were significantly ($p<.0001$) correlated with reading rates and presentation efficiency scores. The multiple choice scores were significantly ($p<.01$) related to reading times, but the completion scores were not. Total comprehension scores were also significantly ($p<.05$) correlated with reading times.

A 2 x 2 x 4 ANOVA design was performed on the three comprehension measures for the retention variable. In addition to Deletion Level and Method of Reduction main effects, a Time (immediate or delayed) main effect was added. There was a significant difference ($F(1,360) = 7.90$, $p<.005$) for the Time main effect. As expected, the immediate comprehension scores were significantly higher than the delayed retention scores. The Deletion Level main effect was also significant ($F(3,360) = 17.62$, $p<.0001$). The Scheffé analysis indicated that the scores for the 10% reduced passages were significantly higher than for the 50 and 67% reduced versions. The passages reduced by 30% also produced scores which were significantly higher than those produced by the 67% versions. An interaction effect ($F(3,360) = 5.41$, $p<.002$) between Method of Reduction and Deletion Level on the multiple choice scores was also present.

TABLE 9.12

Correlation of the Delayed Retention Measures
With the Remaining Dependent Variables

Immediate Retention Measures	Delayed Retention Measures		
	Multiple Choice	Completion	Total Comprehension
Multiple Choice	.87****	.72****	.86****
Completion	.76****	.87****	.86****
Total Comprehension	.87****	.83****	.91****
Reading Times	.09*	.05 N.S.	.08 N.S.
Reading Rates	.19****	.16***	.19****
Efficiency	.24****	.25****	.26****

* $p<.05$

*** $p<.001$

**** $p<.0001$

TABLE 9.13

Correlation of the Immediate Comprehension
Measures With Reading Times,
Reading Rates, and Efficiency

Remaining Variables	Immediate Comprehension Measures		
	Multiple Choice	Completion	Total Comprehension
Reading Times	.11**	.47 N.S.	.09*
Reading Rates	.25****	.21****	.25****
Efficiency	.26****	.27****	.28****

* $p<.05$

** $p<.01$

**** $p<.0001$

The initial and retention multiple choice scores for the SHORT 10% passage were significantly higher than the retention multiple choice scores for the SHORT 67% passage.

A 2 x 2 x 4 ANOVA was also performed for the completion items. There were significant differences ($F(3,360) = 12.78$, $p<.0001$) for the Deletion Level main effect. The completion scores on the delayed retention test for the 10% passages were significantly higher than for the 50 and 67% passages. In addition, scores from the 30% reduced versions were significantly higher than scores for the 67% passages. The F-ratios ($F(3,360) = 7.48$, $p<.0002$) also indicated that there was a significant interaction effect. The Scheffé test revealed the location of the interaction. The completion scores on the initial test for the SHORT 10% condition were significantly higher than both the immediate and delayed retention scores for the SHORT 67% condition.

A third 2 x 2 x 4 ANOVA was performed on the total comprehension measure for delayed retention. There was a significant difference ($F(1,360) = 6.21$, $p<.01$) for the Time main effect, with the immediate recall scores being significantly higher than the delayed retention scores. The Deletion Level main effect was also significant ($F(3,360) = 17.59$, $p<.0001$). Following the pattern of the previous ANOVAs, the total comprehension scores for the 10% reduced passages were significantly higher than scores for the 50 and 67% passages. In addition, the scores from the 30% passages were significantly higher than those from the 67% passages. An interaction effect ($F(3,360) = 7.06$, $p<.0003$) was present. The Scheffé analysis indicated that the immediate retention test scores for the SHORT 10% condition were significantly higher than both immediate and delayed retention scores for the SHORT 67% condition.

The data from the 2 x 2 x 4 ANOVAs confirmed the fact that the Method of Reduction did not have a significant effect upon comprehension.

An item analysis was performed in order to determine the reliability of the multiple choice and completion tests. The analysis was performed for both the chance and nonchance data, with analysis of the nonchance data made for all treatment conditions. The major findings are summarized in Table 9.14. The Kuder-Richardson #20 reliability coefficient (K-R #20) indicated fairly good test reliability for both tests on the nonchance condition. In the chance condition, however, the reliability coefficient is relatively low. This should be expected since these subjects did not read the material.

All of the multiple choice and completion items in the nonchance condition had point-biserial coefficients of correlation (r_{pbis}) that were significant at the .01 level. This indicated that both tests had good internal consistency. In the chance condition, however, eight of the multiple choice

TABLE 9.14

Summary of Item Analyses

Item	Chance		Nonchance	
	Multiple Choice	Completion	Multiple Choice	Completion
Mean Correct	9.82	2.96	19.41	9.42
S.D.	3.77	2.42	5.57	4.63
Standard Error Measurement	2.38	1.41	2.13	1.90
Reliability Coefficient	0.60	0.66	0.85	0.83
Average r_{pbis}	0.28	0.31	0.44	0.46
Average Item Discrimination	0.33	0.26	0.49	0.53
Number of Items	28	22	28	22
Number of Subjects	56	56	212	212

items and ten of the completion items were not significant. This lack of internal consistency was expected since subjects guessed at the answers in the chance condition.

Analysis of the data from the questionnaire revealed subjects' opinions concerning telegraphic prose. The major findings are summaried in Tables 9.15 and 9.16. Most of the subjects (81%) thought textbooks could be reduced while maintaining essential information, with only 16% thinking this was impossible. There was a definite shift, however, when the reduction of materials read for pleasure was the question. Only 67% indicated that such material could be written in telegraphic prose, while 28% said it was impossible to reduce leisure reading materials. In this question, subjects were not answering in terms of the possibility of reducing such material, but rather, in terms of whether they would like to read the reduced forms. Many subjects commented that novels probably could be written in telegraphic prose but that would defeat their purpose. Thus, subjects generally support the reduction of required reading materials, but they are negative about writing pleasure materials in telegraphic form.

Reservation about telegraphic prose was also expressed by the subjects when they stated their preference between traditional and telegraphic styles. Traditional materials were preferred by 74%, whereas only 26% chose telegraphic prose. On the other hand, 76% of the subjects indicated that if telegraphic materials were familiar to them, this style of writing would facilitate their reading. This finding has important implications for the practical applications of telegraphic prose. If students were taught to read this style from the beginning of their education, their reading would be much more efficient. They might even begin to prefer to read the telegraphic materials just as they prefer reading modern English to Old English. Undoubtedly, the unfamiliarity of telegraphic prose plays a large role in subjects' lack of preference for this style. Probably this also results in reading rates, efficiency, and comprehension scores which are lower than could be obtained if subjects were accustomed to reading telegraphic prose.

Each question was analyzed in terms of the percentage of students responding to each alternative. These percentages were then examined to determine what effect the treatment condition had upon subjects' responses. In only one question (number four) was there a significant ($X^2 = 27.72$, $p<.03$) relationship between treatment condition and responses indicated. Table 9.17 shows the choices of subjects in each experimental condition.

The subjects' responses to the question concerning the omission of high or low frequency words shows an almost even split. This question was probably misunderstood, particularly in view of the results obtained in question six.

TABLE 9.15

Percentage of Subjects Responding to Each Alternative on the Questionnaire Concerning Telegraphic Prose

Question Number	Question	Responses Possible	% Each Response
1	Can textbooks be written in telegraphic prose?	Definitely	11%
		Possibly	70%
		Impossible	16%
		Don't Know	3%
2	Can novels, newspapers, and magazines be written in telegraphic prose?	Definitely	13%
		Possibly	54%
		Impossible	28%
		Don't Know	5%
3	Which version would you prefer to read?	Traditional	74%
		Telegraphic	26%
4	If telegraphic materials were familiar to you, would they facilitate your reading?	Yes	76%
		No	24%
5	To produce telegraphic prose, should high or low frequency words be omitted?	High	51%
		Low	49%
6	In which order would you eliminate words from each grammatical category in order to produce telegraphic prose?	(See Table 9.16)	
7	What percentage of the words should be removed from the traditional to produce telegraphic prose?	10%	26%
		20%	42%
		30%	21%
		40%	4%
		50%	1%
		Other	6%
8	Would telegraphic prose benefit a slow or handicapped reader?	Yes	50%
		No	50%

TABLE 9.16

Percentage of Subjects Responding to Each Rank for the Five Grammatical Categories

Rank Order	Nouns	Verbs	Prepositions	Adjectives & Adverbs	Articles & Conjunctions
1	.5%	1%	23%	17%	58%
2	.5%	0%	45%	26%	29%
3	1%	3%	32%	53%	11%
4	54%	41%	0%	4%	1%
5	44%	55%	0%	0%	1%

TABLE 9.17

Percentage of Subjects Expressing Favorable or Unfavorable Responses Toward the Effects of Practice Upon Reading Telegraphic Materials

Alternative	Trad	10%	30%	50%	67%
Yes	9.71%	S=10.68 E= 7.77	S= 9.22 E= 8.74	S= 9.22 E= 6.31	S= 5.83 E= 8.25
		18.45	17.96	15.53	14.08
No	.97%	S= .97 E= 2.43	S= 2.43 E= 1.94	S= 2.43 E= 5.34	S= 4.85 E= 2.91
		3.40	4.37	7.77	7.76

S = SHORT E = Editorial

The ranks assigned each grammatical category were in agreement with the findings of previous studies. The ranks also point to the fact that the editorial method is a valid technique for producing telegraphic prose since this method retains the most important grammatical categories at even the highest levels of deletion. The subjects indicated that nouns, pronouns, and verbs should be the last words to be omitted. Adjectives, adverbs, and prepositions were given intermediate ranks, while articles and conjunctions would be removed first by the subjects. Articles and conjunctions are high frequency words, so the rankings in question six contradict the responses to question five. This contradition, combined with the 49-51% split, indicates that question five was poorly written and consequently misunderstood by the subjects.

The responses concerning the optimum number of words to be omitted approximate a normal curve (Figure 9.9). Most subjects indicated that reductions between 10 and 30% were best. The subjects' responses concur with previous findings which show in general that up to 30% of a passage can be omitted without significantly reducing comprehension.

The subjects' answers were evenly split relative to the beneficial aspects of telegraphic prose for slow or handicapped readers.

Conclusions

The specific hypotheses or general expectations were concerned with three main areas: (1) the formulation of rules for editorial production of telegraphic prose, (2) the generation of the telegraphic materials, and (3) the results of the analyses for the 10% reduced passages. As predicted, the lowest level of deletion was generally obtained by the omission of articles and the higher deletion levels were produced by restructuring the sentences. The type of restructuring used depended on the desired level of reduction.

The index of agreement on the rank ordering of the words in the sentences was significant for all of the sentences except one. It should be noted that the ordering of some sentences was much more difficult than for others. In fact, an additional set of sentences had to be constructed in order to obtain the minimum number of subjects needed for the correct ranking of the words. ("Correct" indicates that each word was ranked and that no words received the same ranks.) The number of subjects required for the SHORT method is very large, which increases the cost in terms of experimental materials and time. Although the SHORT method has produced good results in the past, an alternative to this technique is needed which will reduce the drain on time, personnel, and financial resources.

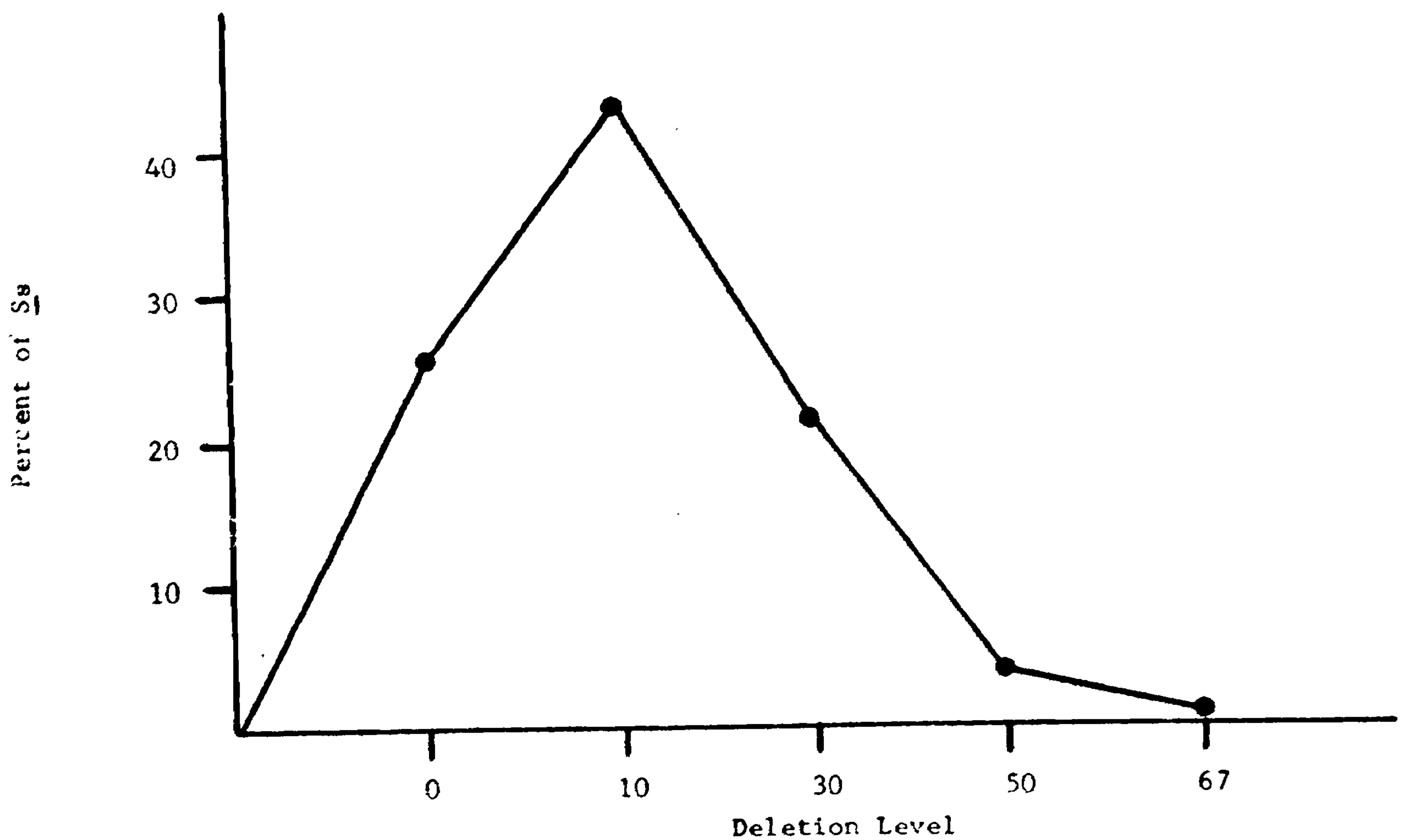

Figure 9.9. Percent of subjects choosing each alternative as optimum level of deletion

The 10% reduced passages produced by the two methods appeared to be very similar as expected. The main difference in the two versions was that the editorial passage eliminated 15.42% more articles than the SHORT form. The percent of words eliminated from the remaining grammatical categories was quite similar.

The hypothesis concerning the results for the analyses of the 10% reduced passages was also supported. The SHORT and editorially produced passages reduced by 10% did not differ from each other nor from the Trad on any of the nine dependent variables. This is taken as support for the feasibility of telegraphic prose at lower deletion levels.

The remaining hypotheses concerning the results for the analyses of the 50 and 67% reduced passages were not fully supported. It was hypothesized that subjects reading the SHORT 50 and 67% reductions would score significantly lower than those reading the Trad passage on all three initial measures of comprehension. This was generally true. However, the scores on the multiple choice items for subjects reading the SHORT 50% passage did not differ significantly from the scores for subjects reading the Trad. For the completion and total comprehension measures, scores from SHORT 50 and 67% passages were significantly lower than those for the Trad. In addition, total comprehension scores for subjects reading SHORT 50 and 67% passages were significantly lower than scores for subjects reading the Trad.

It was also hypothesized that subjects reading the editorial 50 and 67% reductions would not differ significantly from those reading the Trad on the comprehension measures, but that their reading rates would be significantly faster, their reading times would be significantly shorter, and their presentation efficiency scores would be significantly higher. The results showed that editorial 50 and 67% passages did not differ from the Trad on the comprehension measures. The support for this hypothesis ends there, however. The reading rates for subjects reading the editorial 50 and 67% passages were significantly slower than the reading rates for subjects reading the Trad. Although the reading time for the editorial 67% passage was significantly shorter than for the Trad, the reading time for the editorial 50% did not differ significantly from the reading time for the Trad. In addition, editorial 50 and 67% scores for efficiency did not differ significantly from Trad efficiency scores. These data are taken as support for the idea that the editorial method is better than the SHORT method for producing high levels of deletion. Using the editorial method, comprehension does not decrease, but reading times do. Although the editorial passages were not more efficient than the Trad, they were as efficient as the Trad passage.

The hypothesis that the passages generated by the editorial method would be superior to the SHORT passages on the comprehension variables at all levels except the 10% deletion level was not supported. It was true that the 10% versions did not differ from each other on any of the comprehension measures. In fact, comparison of the versions produced by the two methods at each deletion level revealed that no significant differences existed between them at any level.

Likewise, there were no significant differences on the delayed retention measures when comparisons were made within deletion levels between the two methods. This result was predicted for the 10% level. It was hypothesized, however, that subjects reading SHORT 50 and 67% reductions would retain significantly less material than subjects reading the editorial 50 and 67% passages. This hypothesis was not supported.

Overall, the results of this investigation indicated that few significant differences existed between the two methods at any of the deletion levels. Comprehension scores of the editorial versions did not differ significantly from the comprehension of the Trad passage. Although comprehension scores for the editorial passages were not significantly higher than those for the SHORT versions, all editorial scores were higher than SHORT scores except at the 10% level. Furthermore, the editorial scores demonstrated a plateau effect as the deletion level increased, whereas the SHORT scores decreased rapidly at the higher deletion levels. Even though the editorial method was not demonstrated to be significantly better than the SHORT method, the fact that no differences existed between them supports the idea that the editorial method can be substituted for the SHORT method of producing telegraphic prose. If the editorial method were used instead of the SHORT method, immense savings could be made in terms of subjects, research personnel, experimental materials, and financial resources.

With the editorial method, one person handles the generation of the telegraphic passages, whereas the SHORT method necessitates a large number of subjects, additional materials (sentence and recording forms), and a computer. Since there is no difference in comprehension when the editorial method is used, and since the guidelines for producing telegraphic prose by the editorial method insure the inclusion of grammatical categories important for comprehension, it seems that the editorial method could easily replace the SHORT method.

CHAPTER X

CONCLUSIONS

This section is organized on the basis of the major dependent variables used throughout the eight major experiments. These variables were: comprehension, reading rate, reading time, and in some experiments an efficiency measure. In many of the analyses 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 in applied settings is related to this general issue.

Comprehension of Telegraphic Prose

Generally, the results showed that as deletion level increased there was a corresponding decrease in comprehension as measured by the multiple choice tests, set relation tests, or the cloze tests. The important question concerns the deletion levels which produced significant differences in comparison to the traditional version.

Experiment I results showed that the 50% deleted version did not produce significantly lower comprehension scores compared to the traditional version. Seventy percent reductions did produce significantly poorer comprehension. No practice effects were obtained in Experiment I. Subjects who had four prior practice sessions reading telegraphic prose did not comprehend more than subjects who had no prior practice. It is important to note that in Experiment I there was an average of 8% less comprehension of telegraphic passages, but 70% less time was required for the transmission of the telegraphic message.

In Experiment II, comprehension generally decreased as the percent reduction in the various grammatical categories increased. Reduction of nouns and pronouns resulted in significant decrements in comprehension beyond the 40% level. Deletions within the verb category as well as the article and conjunction category revealed no differences in comprehension between the traditional and all passages up to and including the 60% deletion level. Deletion up to and including 80% of the preposition category produced no significant differences with respect to comprehension. Broadly speaking, the results indicated that deletions within the various grammatical categories did differentially affect comprehension. Decrements were most apparent when high content words such as nouns and pronouns were eliminated.

The comprehension results in Experiment III which were based upon two stories were similar. On one story, a significant interaction effect was obtained between Frequency Level and Deletion Level, indicating no significant loss of comprehension as high frequency words were deleted; but comprehension dropped sharply when 30 and 50% of the medium and low frequency words were deleted. Although no interaction effect was found for the second story, comprehension was least affected when high frequency words rather than medium or low frequency words were deleted. It was concluded that a 50% deletion of low information words in the high frequency range did not significantly interfere with comprehension.

Comprehension was successfully maintained up to and including 40% word reduction of the traditional passage in Experiment IV. Telegraphic reductions in this experiment were based upon subjects rank-ordering of the importance of each word in the sentence. Reduced passages at 10, 20, 30, and 40% were statistically equivalent to the traditional passage on comprehension. Comprehension may have been enhanced by more closely selecting optimum deletion levels appropriate for given sentences, but the results obtained by deleting set percentages from all sentences were encouraging.

In the results of Experiment V, comprehension was affected by both the type of reduction method used and the percentage of words reduced. Higher levels of deletion were possible by the subjective method than either the frequency or grammatical methods without the adverse effect of decreasing comprehension. Across the three reduction methods used, both the 10 and 30% passages were generally comparable to the traditional on comprehension. Comprehension decreased significantly at the 50% level from the traditional and 10% versions with the exception of the subjectively reduced 50% passage of the news story. Experiment V demonstrated that a reduction of the traditional passages up to the 30% level for the grammatical and frequency methods was feasible. Further reduction was possible when the subjective method was used. In addition, type of traditional material, such as fiction, news or science articles, had no differentiating effect upon the generation of telegraphic prose. Instead, analysis of the readability levels of all passages at each increasing level of reduction indicated that readability of the traditional passages was significantly affected by reduction of the redundant words.

Blind subjects in Experiment VI were capable of maintaining a satisfactory level of comprehension when reading telegraphic materials reduced by the subjective method. The 30 and 50% versions were comparable to the traditional version on the comprehension measures. Performance on comprehension by the sighted subjects assigned the 50% reduced passage decreased. It was concluded that differences in reading braille as opposed to reading traditionally written material resulted in the differential effects of telegraphic passages on blind and sighted subjects. Blind as well as slow sighted readers may benefit relatively more from telegraphic materials than average or rapid readers.

Experiment VII reported that the input rate of information can be significantly increased without loss of comprehension by learning techniques such as the combination of telegraphic prose, compressed speech and modality. Although extremely rapid presentation rates and large reduction levels caused comprehension to drop markedly, comprehension was adequately maintained at 175 or 275 wpm at near 40% reduction. Adequate comprehension may also be possible at 400 wpm when low levels of word reduction are used. It was further concluded that consistently higher comprehension scores resulted from the combined listening/reading modality than the listening treatments, but the listening/reading modality failed to produce higher comprehension scores than simply reading the traditional version. It was concluded, however, that for the 40 and 60% telegraphic versions, subjects did not rely on the reading modality alone for the listening/reading conditions at 275 and 400 wpm.

Results of Experiment VIII indicated that comprehension did not differ significantly when either a single word subjective method or an editorial method was used to reduce prose. Only at the 50 and 67% reduction levels were some differences found between the high reduction levels and the traditional passage in favor of the editorial method. However, comprehension did not differ significantly between the two methods at any level of reduction. Thus, it was concluded that the editorial method which was based upon reduction of single words, phrases, sentences and paragraphs was statistically no better than the subjective method which was based upon reduction of single words.

Reading Rates for Telegraphic Prose

Reading rate generally decreased at the higher levels of telegraphic prose. The results tend to suggest that the compact form of telegraphic input reduces the rate at which information can be processed.

Experiment I provided a comprehensive examination of the effects of practice on reading rate. No practice effect was obtained, therefore, it was assumed that practice sessions were not effective in increasing reading rates. As was expected, reading rate decreased significantly at high levels of telegraphic prose. It was concluded that when information is compactly presented in high telegraphic format, rate of information input is voluntarily reduced.

Grammatical reduction in Experiment II had little effect upon reading rate. Reading rate did not decrease as a function of deletion level as had been found in prior research.

Experiment III results on reading rate obtained from analyses of two stories were inconsistent. For one story, reading rates did not differ significantly among treatment conditions;while on the other story they were significantly slower for subjects assigned passages in which high frequency words were omitted.

Reading rates in Experiment IV generally decreased at the higher deletion levels, whereas reading rates for the 10 and 20% subjective versions were statistically equivalent to the traditional passage. It was concluded that unfamiliarity with telegraphic materials as well as compactness of information contributed to a decrease in reading rate.

In Experiment V no one reduction method resulted in significantly higher reading rates than the others, although there was some tendency in favor of the subjective method in the science passages. Reading rate generally dropped significantly at the 30 and 50% levels in comparison with the traditional and 10% versions. From the analyses obtained on the readability levels of each passage, it was concluded that high levels of word reduction, which resulted in significantly lower readability scores, had a major effect upon the corresponding reductions in reading rate.

The subjective method used in Experiment VI with blind subjects indicated that for deleted passages, reading rates were not reduced. The lower reading rate for braille undoubtedly accounted for the equivalent reading rates across all treatment conditions. Among the sighted subjects, reading rate decreased at the 30 and 50% deletion levels.

In Experiment VII, reading rate for the reading treatment conditions at the 40 and 60% telegraphic levels was significantly lower than the traditional passage. The results support the contention that telegraphic material is more compact. It was further concluded that subjects may be able to comprehend material at faster input rates if they are forced to do so.

Reading rate in Experiment VIII was affected by the Deletion Level main effect. Reading rates for the 10% passages were significantly faster than those for all other reduced versions. Thus, only the 10% versions of both the subjective and editorial reduction methods compared favorably with the traditional passage.

Reading Time for Telegraphic Prose

Amount of time required to read a telegraphic passage generally decreased as the deletion level increased. In Experiment I, total time required to read the written treatment passages was significantly less for the Hi-Tel version. Approximately 70% less time was required for either listening or reading the Hi-Tel version.

From the results of Experiment II, it was concluded that the time required to read the experimental passages was not affected by the deletion of any of the five grammatical categories or five deletion levels. The result was somewhat surprising in view of the fact that the passage in which 80% of the nouns and pronouns had been deleted contained 25% fewer words than the traditional passage.

In Experiment III, subjects assigned the passages in which the high frequency words had been deleted required significantly more reading time than subjects assigned passages in which low frequency words were deleted. As Weaver (1962) suggests, it is the high frequency function words which provide the structural framework for the low frequency content words. When many of the structural words were missing, as was true of the passage in which 50% of the high frequency words were deleted, subjects required more time to process the remaining words.

It was generally concluded from Experiment IV that reading time was significantly reduced when high levels of words were deleted. Based upon the results from the earlier experiments, reading time was expected to decrease as the number of words in the passages decreased.

Type of reduction method in Experiment V had no effect upon reading time. With respect to reduction level, it was necessary to eliminate 50% of the words in order to obtain a significant reduction in reading time. The results of reading time closely paralleled the results of reading rate and readability level.

Reading times in Experiment VI decreased at each increasing level of word reduction. Comparison of reading time between the traditional and the reduced versions was significant among the blind subjects. Reductions in reading time were not as dramatic among the sighted subjects due, in part, to the reduced reading rate among subjects assigned to the telegraphic versions.

In Experiment VII, presentation time was controlled in all treatment conditions except the reading conditions. In the reading conditions, less time was required to read the telegraphic versions than the traditional version. However, due to the reduction in reading rate at the 60% level, reading time increased at that level in comparison to the 20 and 40% versions.

In Experiment VIII, reading time decreased as deletion level increased. Reading time decreased significantly at the 67% level for both the editorial and subjective methods. Few differences were found between the two reduction methods with respect to reading time.

Efficiency of Telegraphic Prose

The effective use of telegraphic materials is dependent upon the efficiency of acquiring a satisfactory amount of information from a written passage in a shorter amount of time. An effort was made to measure the efficiency of telegraphic passages by computing the ratio of comprehension and reading time.

In Experiment I, it was concluded that the Hi-Tel version was most efficient due to the relatively small amount of reading time required to attain a satisfactory amount of comprehension.

In Experiment III, the efficiency measure generally indicated no differences among the treatment passages. However, some differences were found among the "San Francisco" passages indicating that the deletion of high percentages of low frequency words resulted in the lowest efficiency scores.

The results of the efficiency measure in Experiment IV supported the feasibility of a subjective method of generating telegraphic prose. Subject generated passages were superior to the traditional at each deletion level.

The efficiency results of Experiment V showed the subjective method to be significantly superior to either the grammatical or frequency methods. The superiority of the subjective method reflects similar results found in Experiment IV. Reduction level in Experiment V generally had no effect on efficiency.

In Experiment VI, the efficiency variable was not significant among blind or among sighted subjects. However, a difference in efficiency was found between blind and sighted subjects which was attributed primarily to differences in reading times. Telegraphic materials were more efficient for sighted subjects than for blind subjects.

Experiment VII showed that the 400 wpm input rate was comprehended better than predicted and produced a higher efficiency level than the reading control treatment. In addition, the reading treatments were generally no more efficient than the aural treatments. The combination of telegraphic prose and compressed speech generally increased learning efficiency.

In Experiment VIII, the efficiency measure did not generally distinguish between the editorial method and the subjective method. However, the 10% subjective passage was more efficient than all other passages.

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 IV 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 results of Experiment V showed the SHORT method to be more effective than either the frequency or grammatical methods, these methods did fair rather well considering their 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 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 eight 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 eight experiments have demonstrated that some amount of material could be deleted without seriously affecting either comprehension or reading rate.

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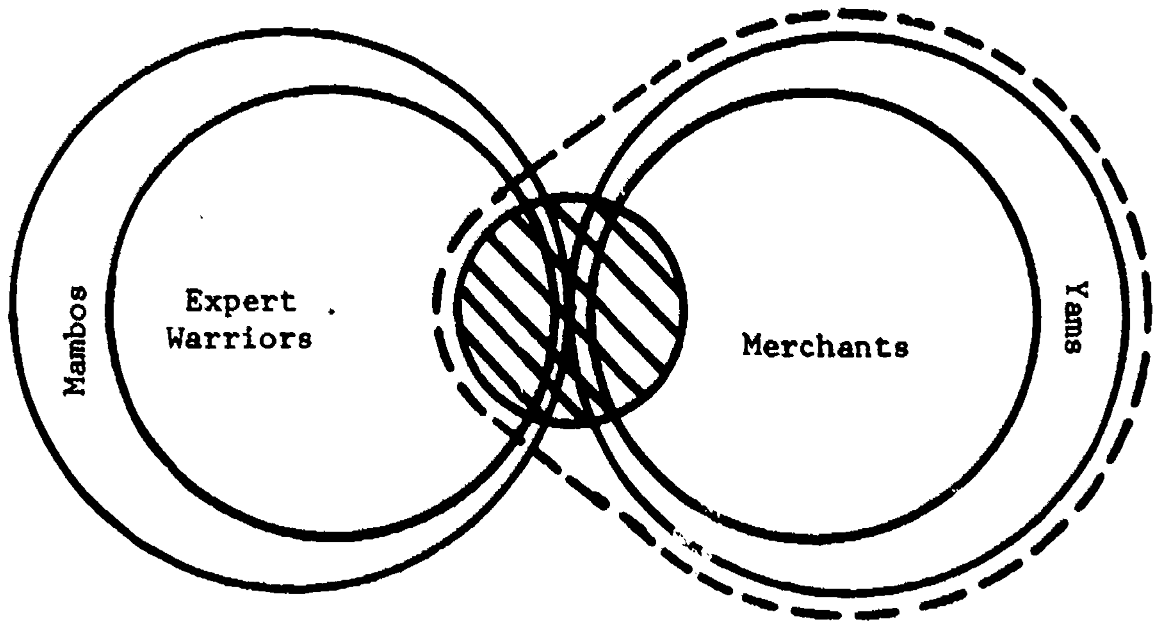
APPENDICES

VOLUME I

APPENDIX A

SET RELATION DIAGRAMS



Mambo and Yam. Set relations existing before the battle.

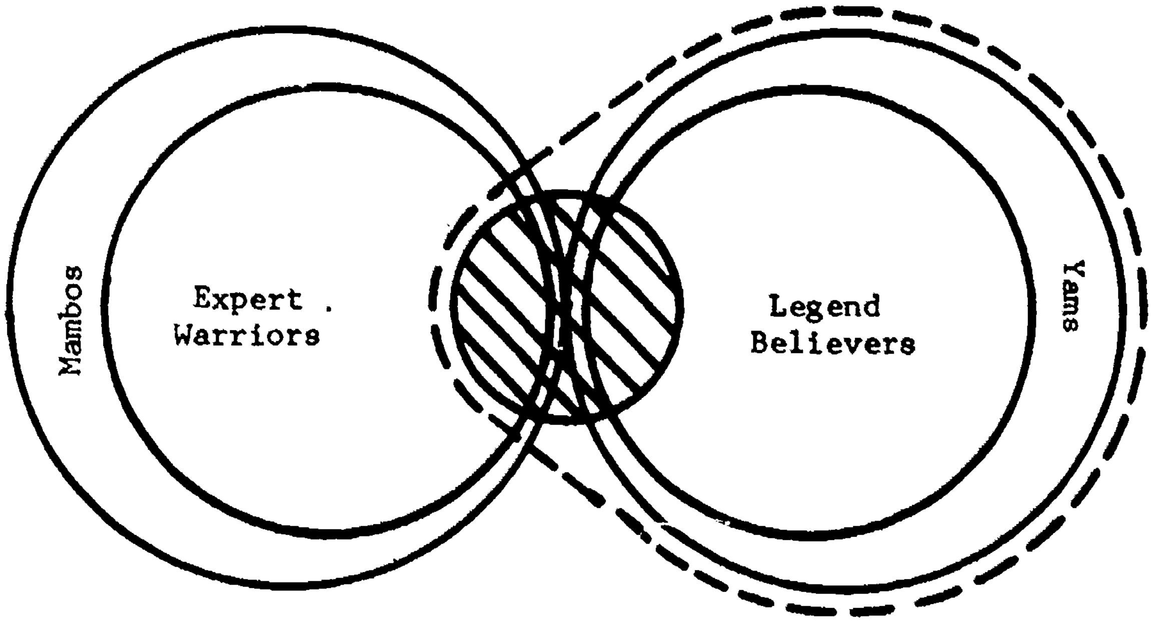
Area surrounded by dashes = Lester followers
Shaded area = Pro Lester Union

Nested Relations

All expert warriors are Mambos.
All merchants are Yams.
All Yams are Lester followers.
All merchants are Lester followers.
All members of the Pro Lester Union are Lester followers.

Disjunctive Relations

Some Mambos are Lester followers.
Some expert warriors are Lester followers.
Some Mambo are members of the Pre Lester Union.
Some expert warriors are members of the Pro Lester Union.
Some merchants are members of the Pro Lester Union.
Some Yams are members of the Pro Lester Union.



Mambo and Yam. Set relations existing after the battle.

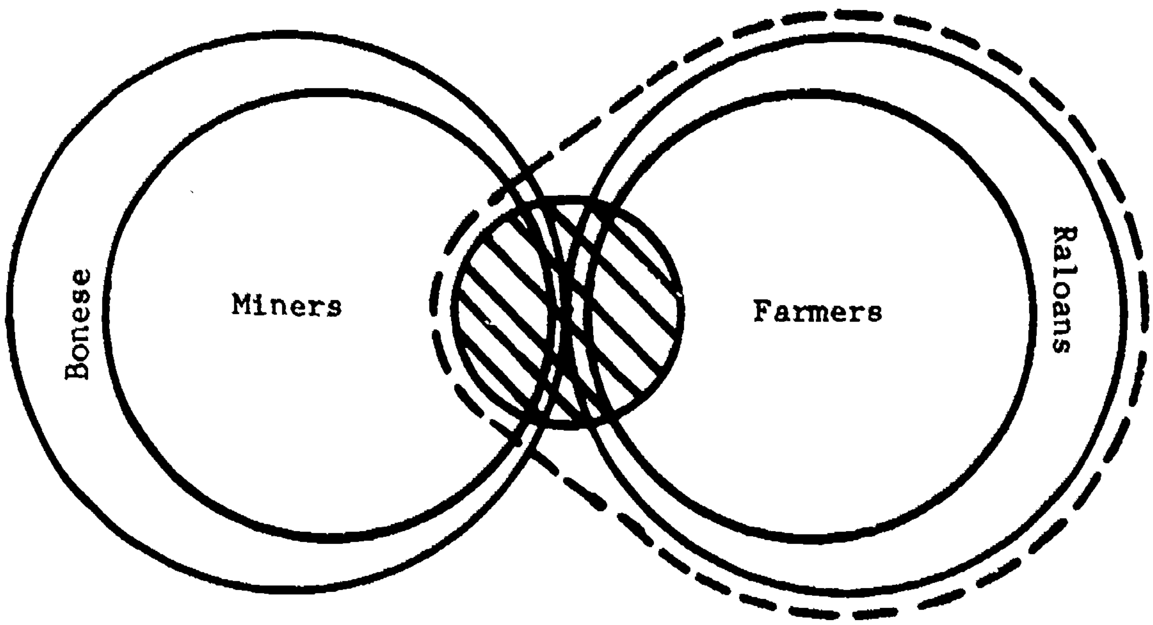
Area surrounded by dashes = Slaves
Shaded area = Freedom Group

Nested Relations

All expert warriors are Mambos.
All legend believers are slaves.
All Yams are slaves.
All legend believers are Yams.
All members of the Freedom Group are slaves.

Disjunctive Relations

Some members of the Freedom Group are Mambos.
Some members of the Freedom Group are Yams.
Some members of the Freedom Group are legend believers.
Some members of the Freedom Group are expert warriors.
Some Mambos are slaves.
Some expert warriors are slaves.



Buena-I and Ralo. Set relations existing before the killing of Chan.

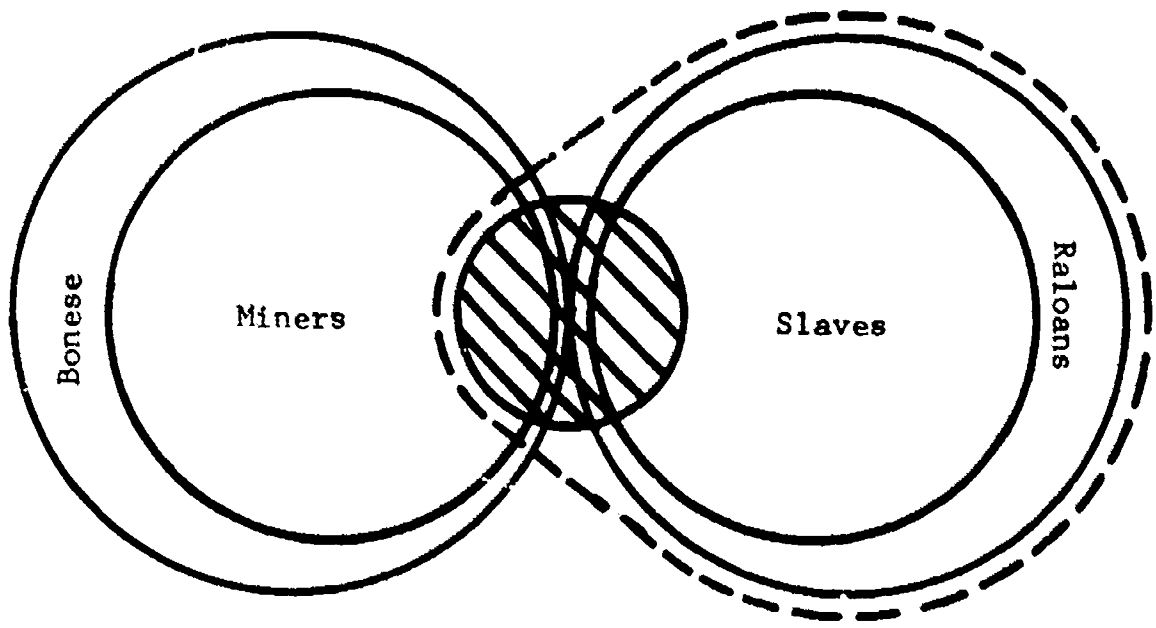
Area surrounded by dashes = followers of Chan
Shaded area = Ra-Bon Group

Nested Relations

All miners are Bonese.
All farmers are Raloans.
All Raloans are followers of Chan.
All farmers are followers of Chan.
All members of the Ra-Bon Group are followers of Chan.

Disjunctive Relations

Some Bonese are followers of Chan.
Some miners are followers of Chan.
Some Bonese are members of Ra-Bon Group.
Some miners are members of Ra-Bon Group.
Some Raloans are members of Ra-Bon Group.
Some farmers are members of Ra-Bon Broup.



Buena-I and Ralo. Set relations existing before final destruction.

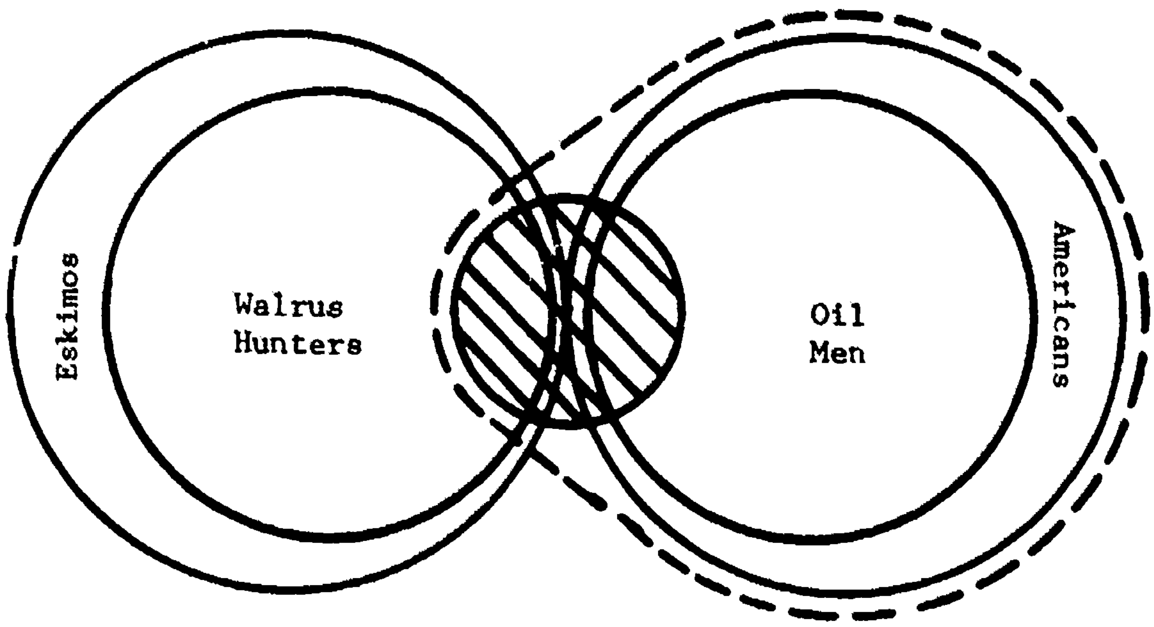
Area surrounded by dashes = Konrad's union
Shaded area = Saboteur Team

Nested Relations

All miners are Bonese.
All slaves are Raloans.
All Raloans are members of Konrad's union.
All slaves are members of Konrad's union.
All of the Saboteur Team are members of Konrad's union.

Disjunctive Relations

Some Bonese are members of Konrad's union.
Some miners are members of Konrad's union.
Some of the Saboteur Team are Bonese.
Some of the Saboteur Team are Raloans.
Some of the Saboteur Team are miners.
Some of the Saboteur Team are slaves.



The Eskimo. Set relations existing during time old Nago was chief.

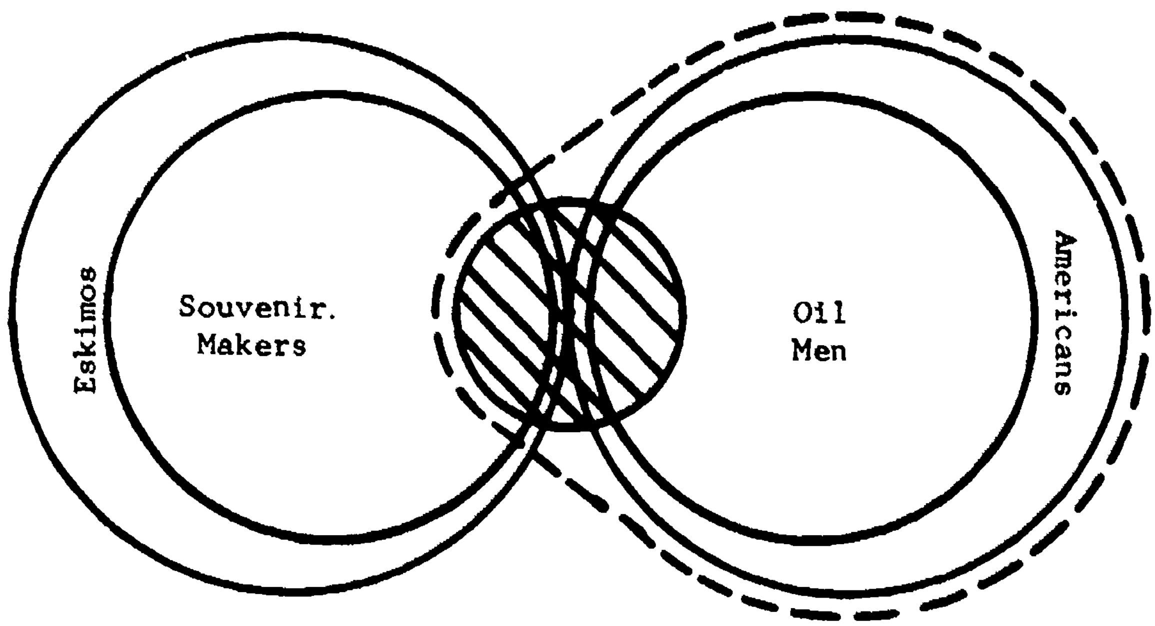
Area surrounded by dashes = employees of Johnson's division
Shaded area = O'Malley's roughnecks

Nested Relations

All walrus hunters were Eskimos.
All oil men were Americans.
All Americans were employees of Johnson's division.
All oil men were employees of Johnson's division.
All of O'Malley's roughnecks were employees of Johnson's division.

Disjunctive Relations

Some Eskimos were employees of Johnson's division.
Some walrus hunters were employees of Johnson's division.
Some Eskimos were O'Malley's roughnecks.
Some walrus hunters were O'Malley's roughnecks.
Some oil men were O'Malley's roughnecks.
Some Americans were O'Malley's roughnecks.



The Eskimo. Set relations existing after Aktu became chief.

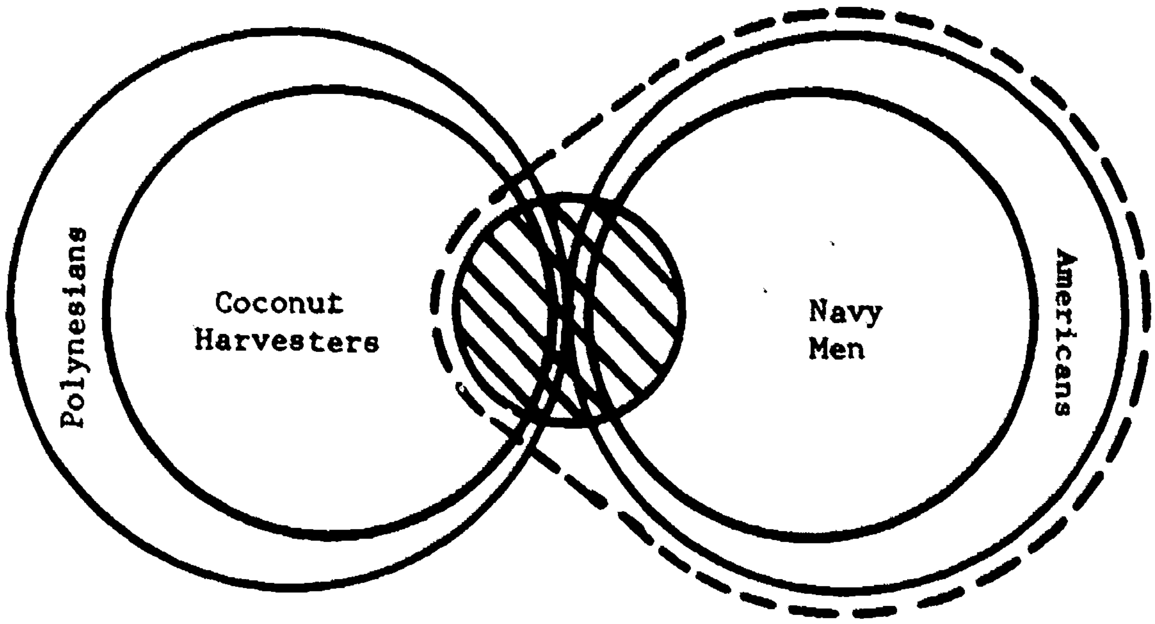
Area surrounded by dashes = workers for Aktu
Shaded area = officers of the souvenir company

Nested Relations

All souvenir makers are Eskimos.
All souvenir makers are workers for Aktu.
All Eskimos are workers for Aktu.
All officers of the souvenir company are workers for Aktu.
All oil men are Americans.

Disjunctive Relations

Some officers of the souvenir company are Eskimos.
Some officers of the souvenir company are Americans.
Some officers of the souvenir company are souvenir makers.
Some officers of the souvenir company are oil men.
Some Americans are workers for Aktu.
Some oil men are workers for Aktu.



Vanua Lava Island. Set relations existing while the Navy was at the island.

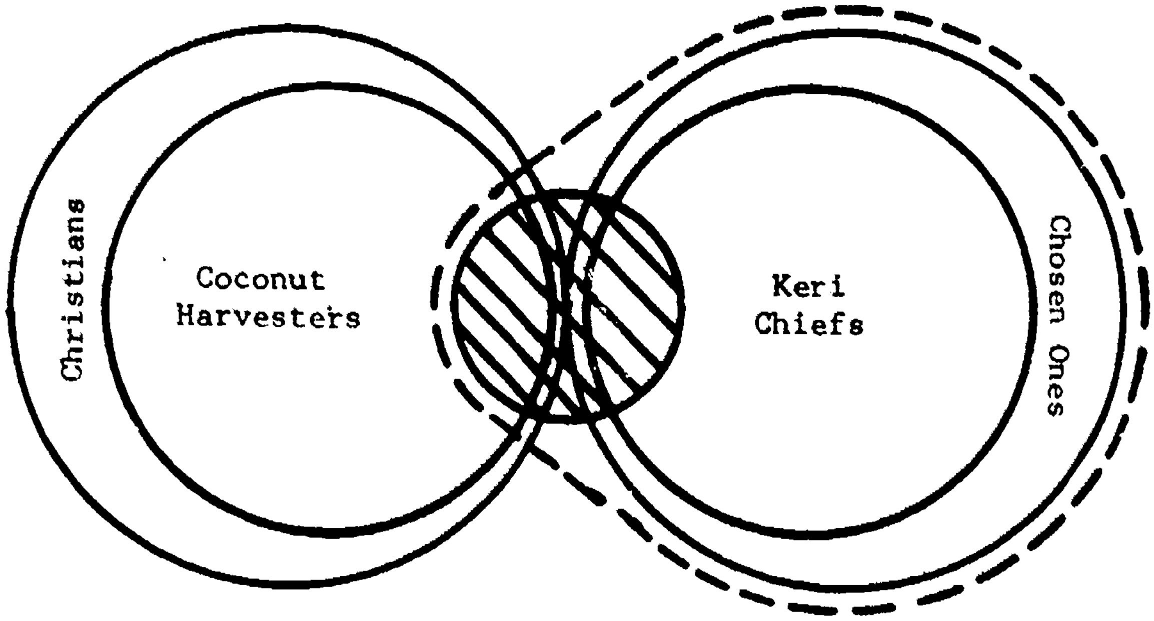
Area surrounded by dashes = command of Captain Morrison
Shaded area = shore station crew

Nested Relations

All coconut harvesters were Polynesian.
All Navy men were Americans.
All Americans were under the command of Captain Morrison.
All Navy men were under the command of Captain Morrison.
All members of the shore station crew were under the command of Captain Morrison.

Disjunctive Relations

Some Polynesians were under the command of Captain Morrison.
Some coconut harvesters were under the command of Captain Morrison.
Some Polynesians were members of the shore station crew.
Some coconut harvesters were members of the shore station crew.
Some Navy men were members of the shore station crew.
Some Americans were members of the shore station crew.



Vanua Lava Island. Set relations existing after the Navy left.

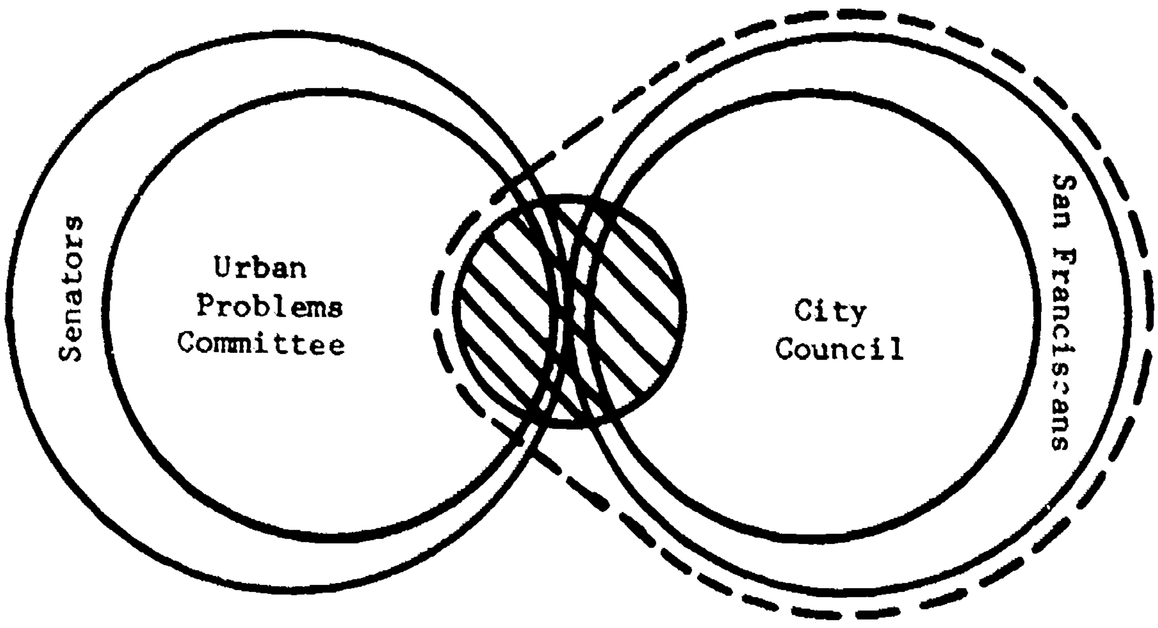
Area surrounded by dashes = believers of the Navy myth
Shaded area = altar builders

Nested Relations

All coconut harvesters were Christians.
All Keri chiefs were believers of the Navy myth.
All members of the Chosen Ones were believers of the Navy myth.
All Keri chiefs were members of the Chosen Ones.
All altar builders were believers of the Navy myth.

Disjunctive Relations

Some altar builders were Christians.
Some alter builders were members of the Chosen Ones.
Some altar builders were Keri chiefs.
Some alter builders were coconut harvesters.
Some Christians were believers of the Navy myth.
Some coconut harvesters were believers of the Navy myth.



San Francisco. Set relations existing before Mayor St. John was killed.

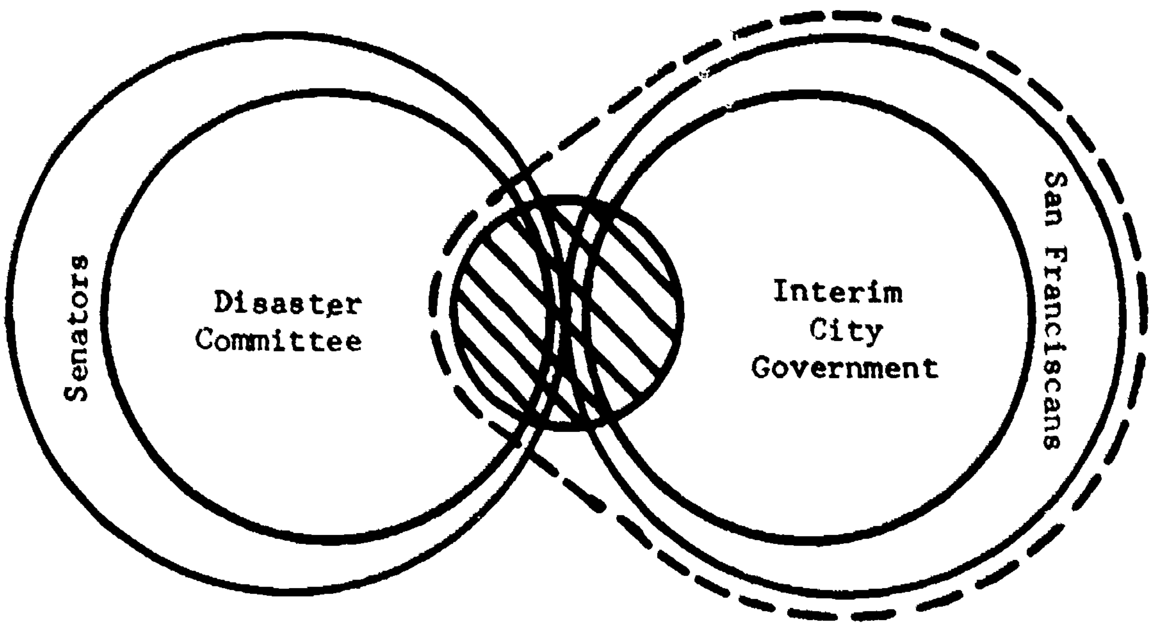
Area surrounded by dashes = leadership of Mayor St. John
Shaded area = Action Group

Nested Relations

All members of the Urban Problems Committee were senators.
All city councilmen were San Franciscans.
All San Franciscans were under the leadership of Mayor St. John.
All city councilmen were under the leadership of Mayor St. John.
All of the Action Group was under the leadership of Mayor St. John.

Disjunctive Relations

Some senators were under the leadership of Mayor St. John.
Some members of the Urban Problems Committee were under the leadership of Mayor St. John.
Some senators were in the Action Group.
Some members of the Urban Problems Committee were in the Action Group.
Some San Franciscans were in the Action Group.
Some city councilmen were in the Action Group.



San Francisco. Set relations existing after the death of Mayor St. John.

Area surrounded by dashes = followers of Atkins
Shaded area = Volunteers for Hope

Nested Relations

All of the disaster committee members were senators.
All officials of the interim city government were San Franciscans.
All San Franciscans were followers of Atkins.
All officials of the interim city government were followers of Atkins.
All Volunteers for Hope were followers of Atkins.

Disjunctive Relations

Some of the senators were followers of Atkins.
Some of the disaster committee members were followers of Atkins.
Some of the senators belonged to the Volunteers for Hope.
Some of the disaster committee members belonged to the Volunteers for Hope.
Some of the San Franciscans belonged to the Volunteers for Hope.
Some of the officials of the interim city government belonged to the Volunteers for Hope.

APPENDIX B

STORIES PRESENTATION ORDER FOR EACH OF THE THREE GROUPS

EXPERIMENT I

Stories Presentation Order for

Each of the Three Groups

BI = Buena-[illegible] and Ralo   E = The Eskimo   MY = Mambo and Yam
SF = San Francisco   VL = Vanua Lava Island

0 Practice Sessions

SF	E	MY	VL	BI
SF	MY	VL	BI	E
SF	MY	BI	VL	E
SF	BI	MY	VL	E
SF	E	BI	VL	MY
SF	MY	VL	E	BI
SF	E	BI	MY	VL
SF	VL	MY	E	BI
SF	MY	E	VL	BI
SF	VL	E	MY	BI
SF	VL	MY	BI	E
SF	E	BI	MY	VL
SF	E	VL	MY	BI
SF	VL	BI	MY	E
SF	E	VL	BI	MY
SF	BI	E	MY	VL

2 Practice Sessions

VL	MY	SF	BI	E
BI	MY	SF	VL	E
BI	VL	SF	MY	E
E	BI	SF	VL	MY
VL	E	SF	BI	MY
E	BI	SF	MY	VL
MY	VL	SF	E	BI
E	MY	SF	VL	BI
MY	VL	SF	BI	E
BI	E	SF	MY	VL
E	VL	SF	MY	BI
MY	E	SF	VL	BI
MY	BI	SF	VL	E
VL	BI	SF	E	MY
BI	MY	SF	E	VL

4 Practice Sessions

E	VL	MY	BI	SF
BI	MY	E	VL	SF
BI	VL	MY	E	SF
BI	E	MY	VL	SF
E	MY	VL	BI	SF
VL	BI	E	MY	SF
E	BI	VL	MY	SF
MY	VL	BI	E	SF
MY	VL	E	BI	SF
MY	BI	E	VL	SF
MY	E	VL	BI	SF
VL	BI	MY	E	SF
VL	E	BI	MY	SF
VL	MY	E	BI	SF
BI	E	VL	MY	SF

APPENDIX C

EXPERIMENT I

INSTRUCTIONS FOR WRITTEN GROUPS AND AURAL GROUPS

Experiment I

Instructions for Written Groups

In this session, you will read a prose selection, and then you will take two different types of tests on the contents of the selection. You have been given a time information sheet, a story, two test booklets, and two answer sheets. Do not open your packet until instructed.

As you are reading the story, read at a rate that is comfortable to you.

PLEASE DO NOT REREAD SENTENCES

When you have finished reading the passage, close your story and do not open it again. Look at the clock IN THE FRONT OF THE ROOM and record the time showing on the clock (HOUR, MINUTE, SECOND) on the time information sheet. We will record the time you begin--you must record the time you finish reading. After you have recorded this time information, open Test Booklet I and begin working, recording your answers on the answer sheet for Test I. There are 20 multiple choice questions in Test I. For Test I, there are two statements for each numbered item. If the correct answer is the (A) statement, fill in number (1) on the answer sheet. If the correct statement is (B), fill in number (2) on the answer sheet. After you have finished Test I, begin on Test Booklet II. Please record these answers on the other answer sheet provided. The second test will be a four-choice multiple choice test. When you are finished, please clip your packet together and turn them into the examiner. Also, please return the pencils. There are extra stories available in case you should have one with a missing page or other error. There are also extra tests available. Students will finish at different times--please leave quietly.

Experiment I

Instructions for Aural Groups

In this session, you will listen to a prose selection, and then you will take two different types of tests on the contents of the selection. You have been given a time information sheet, two test booklets, and two answer sheets. Do not start your tape player until instructed. Place the headphones (or ear plugs) on your ears before starting the tape player. If you need help in starting your tape player, raise your hand for assistance. After the tape player is started, do not try to repeat any section of the tape. When you have finished listening to the passage, stop the tape player. If you need help in stopping the tape player, raise your hand for assistance.

Look at the clock IN THE FRONT OF THE ROOM and record the time showing on the clock (HOUR, MINUTE, SECOND) on the time information sheet. After you have recorded this time information, open Test Booklet I and begin work, recording your answers on the answer sheet for Test I. There are 20 multiple choice questions in Test I. For Test I, there are two statements for each numbered item. If the correct answer is the (A), fill in number (1) on the answer sheet. If the correct statement is (B), fill in number (2) on the answer sheet. After you have finished Test I, begin on Test Booklet II. Please record these answers on the other answer sheet provided. Test II will be a four-choice multiple choice test. When you are finished, please clip your packet together and turn them in to the examiner. Also, please return the pencils. If you have any difficulty, please raise your hand.

APPENDIX D

EXPERIMENT V

INTERCORRELATION MATRICES

TABLE 1

Intercorrelation Matrix for Form 1 of the Cloze Test

	noun/verb deletion 1	fifth word deletion 2	noun/verb deletion 3	fifth word deletion 4	noun/verb deletion 5
noun/verb deletion 1	1.00	0.68	0.62	0.70	0.33
fifth word deletion 2	--	1.00	0.55	0.59	0.37
noun/verb deletion 3	--	--	1.00	0.62	0.23
fifth word deletion 4	--	---	--	1.00	0.62
noun/verb deletion 5	--	--	--	--	1.00

TABLE 2

Factor Matrix for Form 1 of the Cloze Test

	1	2	3	4	5
1	0.77	0.07	-0.17	-0.11	0.00
2	0.69	-0.20	-0.00	0.08	0.00
3	0.67	0.06	-0.19	0.08	0.00
4	0.79	-0.19	0.22	-0.04	0.00
5	0.53	0.37	0.17	0.03	0.00

TABLE 3

Intercorrelation Matrix for Form 2 of the Cloze Test

	fifth word deletion 1	noun/verb deletion 2	fifth word deletion 3	noun/verb deletion 4	fifth word deletion 5
1	1.00	0.07	0.10	0.33	0.27
2	--	1.00	0.18	0.43	0.50
3	--	--	1.00	0.33	0.56
4	--	--	--	1.00	0.49
5	--	--	--	--	1.00

TABLE 4

Factor Matrix for Form 2 of the Cloze Test

	1	2	3	4	5
1	0.30	0.20	0.07	0.11	0.08
2	0.51	0.23	0.09	-0.05	-0.09
3	0.51	0.22	-0.16	-0.01	0.02
4	0.54	-0.18	0.04	-0.11	0.09
5	0.65	-0.29	-0.02	0.09	-0.05

APPENDIX E

EXPERIMENT VIII QUESTIONNAIRE

Experiment VIII Questionnaire

The basic assumption of this research is that certain words, phrases, and even sentences are not necessary for the comprehension of a message. It has been demonstrated that people can, with varying degrees of accuracy, predict missing letters or words in a passage on the basis of the remaining material. Furthermore, textbook definitions of a sentence do not furnish the actual criteria we often use in communicating. For example, requests, commands, and telegrams all have missing words which are understood and must be supplied by the receiver in order to fit the grammatical definitions of a sentence. The fact that omitted words, or synonyms for them, can be supplied by the average person provides supporting evidence for the feasibility of developing a style of writing (called telegraphic prose) such that the redundancy of language is minimized.

Example of traditional sentence: The cat has jumped on the sofa.

Example of a telegraphic sentence: Cat jumped on sofa.

1. Do you think that textbooks can be shortened by eliminating nonessential words, phrases, and sentences while still retaining the original amount of information?

_____ Definitely texts can be reduced this way

_____ Possibly texts can be reduced this way

_____ Impossible to reduce texts this way

_____ Don't know

2. Do you think that other types of material such as newspapers, magazines, and novels could be reduced this way?

   _____ Don't know

   _____ Impossible to reduce such material this way

   _____ Possibly such material can be reduced this way

   _____ Definitely such material can be reduced this way

3. If you had a choice between reading the full length traditional version of a passage and reading a shortened telegraphic version of the passage, which would you prefer?

   _____ Traditional

   _____ Telegraphic

4. If you were familiar with telegraphic materials, do you think that this style of writing would facilitate your reading?

   _____ Yes

   _____ No

5. If words were to be omitted from a passage in order to produce a reduced version of the message while maintaining the essential information, which would produce the most understandable passage?

   _____ Removing high frequency words

   _____ Removing low frequency words

6. Suppose a passage were to be shortened on the basis of eliminating words from specified grammatical categories. Rank the following categories according to the order in

which you would omit words from them. (1 indicates the category to be eliminated first)

_____ Nouns and Pronouns

_____ Adjectives and Adverbs

_____ Articles and Conjunctions

_____ Prepositions

_____ Verbs

7. If a passage were to be shortened, what percentage of the words in it would you remove in order to produce a version in which all nonessential material was omitted but all necessary information was retained?

_____ 10% _____ 40%

_____ 20% _____ 50%

_____ 30% _____ Other (specify the percentage)

8. Do you think that a telegraphic style of writing would benefit a slow or handicapped reader?

_____ No

_____ Yes

APPENDIX F

EXPERIMENT VII WRITTEN INSTRUCTIONS FOR THE LISTENING, LISTENING/READING AND READING TREATMENT GROUPS

Experiment VII

Instructions for Listening and Listening/Reading Treatments

This project is concerned with finding out how well university students can comprehend material presented at faster than average speech rates and with varying percentages of words deleted.

Listen as carefully as possible to the story on the tape. You will be listening at 275 wpm which is twice as fast as normal speech rate for tape recordings. Forty percent of the words have been deleted from the original version so it will sound something like a telegram being read at a very fast rate. (The two previous sentences were modified according to the exact treatment condition.) The volume should be set correctly, but you may adjust it if you wish. The tape will be started as soon as you have the earphones on and are ready. Some students find it helpful to close your eyes or to put their heads down while listening; you may want to try this to maintain maximum concentration. Remove the earphones as soon as the tape ends and you will then be given an 80-item objective test which covers the important facts, events, and names in the story.

This project is concerned with finding out how well university students can comprehend material presented at faster than average speech rates and with varying percentages of words deleted.

You will be listening to the story and reading at the same time. Therefore, read or follow the written text while you listen to the identical selection on the tape. The same words have been omitted from the text as from the tape recording. You will be listening at 275 wpm which is twice as fast as normal speech rate for tape recordings. Forty percent of the words have been deleted from the original version so it will sound something like a telegram being read at a very fast rate. (The two previous sentences were modified according to the exact treatment condition.) The volume should be set correctly, but you may adjust it if you wish. As soon as you have the earphones on and are ready, the tape will be started and you may turn the story booklet over and begin reading at the same time. You must stop reading as soon as the aural tape is finished. Remove the earphones as soon as the tape ends and you will then be given an 80-item objective test which covers the important facts, events, and names in the story.

Experiment VII

Instructions for Reading Treatments

The purpose of this study is to determine the effects of deleting varying percentages of words from a story on comprehension and reading rate. Twenty students will read the story in its original 2692-word form. Others will read the same type story in one of three versions from which 20, 40, or 60% of the words have been deleted. You each have on your desk a story booklet and an IBM answer sheet.

The exact procedure for the experiment is as follows: Read the story as rapidly as you can without sacrificing comprehension. Those of you who are reading the highly deleted versions may find the telegraphic style disconcerting but read it as rapidly as possible, again without undue sacrifice of comprehension.

As soon as you finish reading, raise your hand and look up at the blackboard to note your exact reading time. Your instructor will write the elapsed times on the blackboard at five second intervals as soon as the first student in the class finishes reading. (This is the procedure these classes normally followed in recording reading time.) Record your reading time on the IBM answer sheet which you have. As soon as you have done this you will be given a test booklet. The test has 80 items and takes approximately 25 minutes to complete. You will have ample time to finish it comfortably during this class period. Note that the answer sheets are numbered horizontally across the page.

Please put both your name and the version of the story which you will be reading, designated by T, 20, 40, or 60% at the top of your reading booklet, on the IBM answer sheet at this time. You will be given your wpm reading rate, test score, and ranking for the group of 20 students who will be reading each version of the material next week in this class. Are there any questions? Please turn your reading booklet over and begin reading.